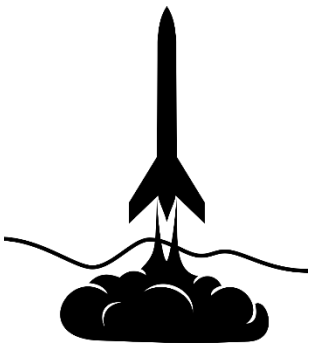


# Spaceport America Cup

## Range Standard Operating Procedures

# Revision History

| REVISION | DESCRIPTION | DATE |
|---|---|---|
| Draft | Draft Published | 06/18/2018 |
| Baseline | 1. Section 4.0 – All subsections updated to<br>a. Reflect revisions made in Consolidated Flight Card & Post Flight Record v1.1 and Flight Safety Resolution Form v2.0<br>b. Assure custody of forms for record keeping<br>2. Section 4.3 revised to reflect Flight Card issuance at conclusion of payload inspection based on 2018 Lessons Learned<br>3. Section 4.3 revised to reflect Flight Card issuance at conclusion of payload inspection based on 2018 Lessons Learned<br>4. Section 7.1 revised to maintain Consolidated Flight Card & Post Flight Record in competition official custody based on 2018 Lessons Learned<br>5. Hyperlinked cross references<br>6. General edits for spelling, grammar, and clarity | 06/03/2019 |
| 2022-A | Correction of typographical, spelling, grammar edits | 03/17/2022 |
| 2022-B | Draft corrections for 2022 logistics | 05/17/2022 |
| 2022-C | Draft Corrections for 2023 logistics | 11/2/2022 |
| 2022-D | Edited with Updates provided from TRA Board relating to access requirements | 11/22/2022 |
| 2023-A | Updates for Drone requirements | 6/15/2023 |

# Table of Contents

## 1.0 Introduction

The Experimental Sounding Rocket Association (ESRA) and Spaceport America 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 “smoke and fire,” noise, high speeds, and sleek aerodynamics of rocketry encourage students to pursue science, technology, and mathematics-based careers. They have "Rocket Fever!", and competition motivates them to extend themselves beyond the classroom to design and build the rockets themselves. These students also learn to work as a team, solving real world problems under the same pressures they'll experience in their future careers.

ESRA held the first annual IREC in 2006. The competition achieved international status in 2011 when Canadian and Brazilian universities threw their hats in the ring. These schools have since been joined by others from every continent except Antarctica. In fact, the competition has roughly doubled in size every year since 2013, becoming the largest known collegiate level rocket engineering competition in the world in 2014. Attendance in 2016 included as many as 600 participants – including faculty, family, and friends of students from over 50 colleges and universities. The next year marked the start of a new era with the inaugural Spaceport America Cup. In 2022, the Cup had over 1,500 students from nearly 90 universities representing 27 countries.

## 1.2 Purpose and Scope

This document promotes flight safety at the SA Cup by defining the overarching "run-rules" governing rocket launch related activities (aka "the launch") occurring on Spaceport America property (aka "the Spaceport") during the Cup – to include all IREC launches as well as all non-competing, demonstration launches. These activities include the flight safety review process, the final launch setup and countdown procedure(s), and safe rocket retrieval practices. This document's intended audience includes all participants in the launch – to include the roles and

responsibilities of collegiate team members (aka "fliers") as well as the launch organizers. It is not the purpose of this document to dictate how these roles are assigned to people but to share some examples of how others have organized launches. Understanding that no single document can encompass the full range of unique technical and environmental considerations possible at the SA Cup, the launch facilitators reserve the right to adapt and amend this document's guidance in real time as necessitated by "real-world" conditions.

This document incorporates the *Tripoli Rocketry Association (TRA) Safety Code*, the *National Fire Protection Association (NFPA) Code for High Power Rocketry (NFPA 1127)*, and ESRA's observations on student launch initiatives. These documents remain excellent resources for student researchers to learn more about best practices adopted by the amateur high-power rocketry (HPR) community.

Departures from these rules and procedures, or from any tailored instructions by event staff and volunteers may negatively impact an offending team's flight status or result in ejection from the launch – depending on the degree of severity or frequency of infraction. Furthermore, the competition related penalties for unsafe or unsportsmanlike conduct by IREC participants are defined in Sections 2.7.1.5 and 2.8 of the *IREC Rules & Requirements Document*.

### 1.3 Revision

It is expected the *IREC Range Standard Operating Procedures* may require revision from one competition to the next, based on the experiences and lessons learned by both host organizations and the participants. Major revisions will be accomplished by complete document reissue. "Real-world events" may require smaller revisions to this document in the months leading up to a competition. Such revisions will be reflected in updates to the document's effective date. The authority to issue revised versions of this document rests with ESRA and Spaceport America. Revisions will be approved either by ESRA, or jointly by both organizations as appropriate.

### 1.4 Documentation

The following documents include standards, guidelines, schedules, or required standard forms. The documents listed in this section are either applicable to the extent specified in this document, or contain reference information useful in the application of this document.

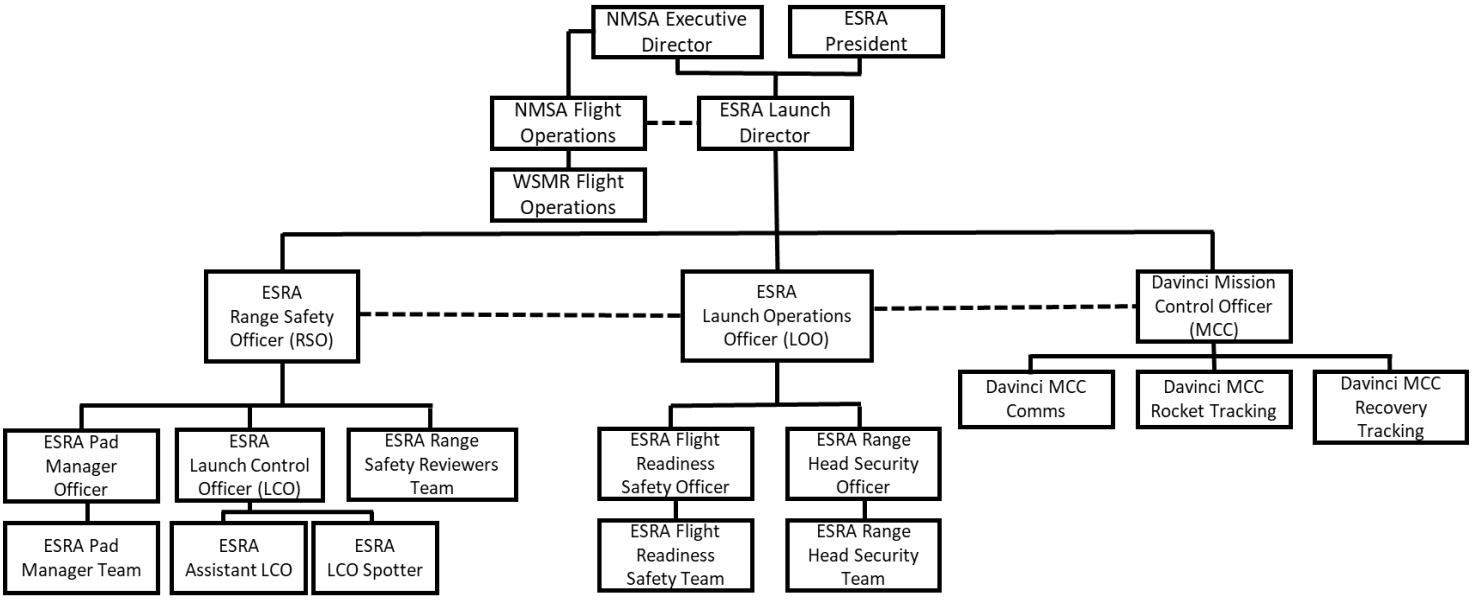
| DOCUMENT | FILE LOCATION |
|---|---|
| IREC Design, Test, & Evaluation Guide | http://www.soundingrocket.org/sac-documents--forms.html |
| SA Cup Integrated Master Schedule Document | http://www.soundingrocket.org/sac-documents--forms.html |
| IREC Rules & Requirements Document | http://www.soundingrocket.org/sac-documents--forms.html |
| Sample SA Cup Flight Safety Review Resolution Form | http://www.soundingrocket.org/sac-documents--forms.html |
| Sample SA Cup Consolidated Flight Card and Post Flight Record | http://www.soundingrocket.org/sac-documents--forms.html |
| TRA Safety Code | http://www.tripoli.org/SafetyCode |

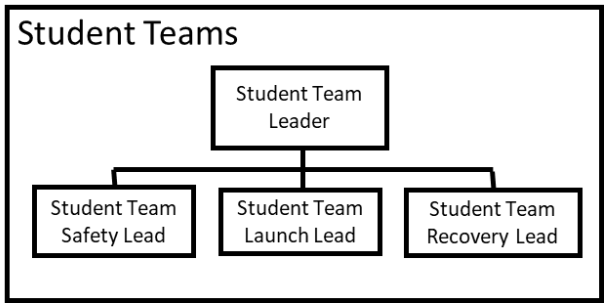
| DOCUMENT | FILE LOCATION |
|---|---|
| NFPA 1127: Code for High-Power Rocketry | https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1127 |
| 14 CFR, Part 1, 1.1 General Definitions | http://www.ecfr.gov/cgi-bin/text-idx?SID=795aaa37494b6c99641135267af8161e&mc=true&node=se14.1.1_11&rgn=div8 |
| 14 CFR, Part 101, Subpart C, 101.22 Definitions | http://www.ecfr.gov/cgi-bin/text-idx?SID=795aaa37494b6c99641135267af8161e&mc=true&node=se14.2.101_122&rgn=div8 |

## 2.0 Organization of Launch Roles and Responsibilities

While safety is a responsibility of all participants, there are certain *roles* that require different sets of specialized skills and focus – listed and overviewed as a hierarchy in the figure below. Those roles will be defined in more detail in the following sections and referenced throughout the rest of this document.

- Launch Director and Launch Operations Team
- Range Safety Officer (RSO) and his/her staff
- Launch Control Officer (LCO) and his/her staff
- Davinci Mission Control Officer and his/her staff
- Student Team Members (aka Fliers)


NMSA Executive Director
ESRA President
NMSA Flight Operations
ESRA Launch Director
WSMR Flight Operations
ESRA Range Safety Officer (RSO)
ESRA Launch Operations Officer (LOO)
Davinci Mission Control Officer (MCC)
Davinci MCC Comms
Davinci MCC Rocket Tracking
Davinci MCC Recovery Tracking
ESRA Pad Manager Officer
ESRA Launch Control Officer (LCO)
ESRA Range Safety Reviewers Team
ESRA Flight Readiness Safety Officer
ESRA Range Head Security Officer
ESRA Pad Manager Team
ESRA Assistant LCO
ESRA LCO Spotter
ESRA Flight Readiness Safety Team
ESRA Range Head Security Team


Student Teams
Student Team Leader
Student Team Safety Lead
Student Team Launch Lead
Student Team Recovery Lead

Before reading further, users of this document should consider the following. Although this functional decomposition of roles and responsibilities may be clearly defined on an org-chart, it is almost certainly true that when assigning these roles to actual individuals, most launches will have functional overlap. For example, the Range Safety Officer may also be the Launch Control Officer. Similarly, while every person in a leadership position – including Student Team Leadership – should identify a deputy for him/herself (to assume their his/her full role/ responsibilities during shift-work, to take over if the primary becomes unavailable, etc...), this may not always be possible due to staffing limitations. Finally, any roles' authorities can be delegated to any other reasonably qualified individual(s).

| First Name | Last Name | Role(s) | Email Address | Cell |
|---|---|---|---|---|
| Steve | Taylor | ESRA President | president@esrarocket.org | 469-247-6397 |
| Andrew | Berger | ESRA Executive Director | execdir@esrarocket.org | 281-804-3190 |
| Ken | Overton | ESRA Range Safety Officer | launchsafety@esrarocket.org | 469-358-3571 |
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### 2.1 Launch Director

The Launch Director has responsibility for facilitating the launch in its entirety. The Launch Director's primary responsibility is continually ensuring all conditions required for a safe and legal launch activity are being followed. The Launch Director is empowered to terminate the launch at any time, for any reason (e.g. general safety concerns, weather conditions, change in governing authority approval, etc...). The Launch Director shall nominally delegate specialized, subordinate role responsibilities to three officer appointees of his/her own choosing – a Range Safety Officer, a Launch Control Officer, and a Mission Control Officer. It is the responsibility of the Launch Director to assign/delegate people to the roles necessary to organize and run the launch. If the Launch Director chooses to not delegate a particular role to a subordinate, then the Launch Director will assume that role by default.

### 2.2 Range Safety Officer, Flight Readiness Reviewers and Range Safety Reviewers(s)

The Range Safety Officer (RSO) is a Launch Director appointee responsible for minimizing the risks to personnel and property involved in the handling, preparation, and launch operations of HPR launches. A qualified RSO must have greater than entry-level experience in HPR practices, be knowledgeable in rocketry theory, and well versed in foundational safety regulations/guidelines. The spirit and intent of the RSO's responsibilities are summarized in *The Cardinal Principal* – limit the exposure to hazardous situations to a minimum number of persons for a minimum

time, consistent with safe and efficient operations. The RSO will carry out *The Cardinal Principle* through his/her monitoring and execution of the roles outlined below.

- *Site Inspection:* The RSO shall make an examination of all rocket assembly and launch areas to ensure adequate barriers, markings, and other safety measures exist to prevent unauthorized persons from entering, and alert authorized persons to hazardous conditions. Furthermore, the RSO shall be aware of the largest propulsion system that may be supported by each launch area.
- *Range Operations and Status:* The RSO is responsible for determining the status of range operations, communicated using Range Status Flags defined in Section 5.1 of this document, the Public Address system, and voice transmission systems. The RSO shall reassess the range status prior to any launch salvo and immediately following any mishap. The RSO is empowered to alter the range status at any time, for any reason (e.g. general safety concerns, weather conditions, change in governing authority approval, etc...).
- *Airspace:* The RSO must have knowledge the launch is authorized by authorities governing the affected ground and airspace – including any provisions that come with that authorization (e.g. time windows, altitude ceiling etc...). The NMSA Flight Operations Team and the WSMR Flight Operations teams are responsible for communicating airspace status and any changes to the RSO and LCO immediately.
- *Weather:* The RSO must have clear and convincing evidence the conditions at the launch site do not violate any weather-related go/no-go criteria defined in Section 6.1.1of this document.
- *Launch Pads:* The RSO shall familiarize him/her-self with the types of launch pads available at the launch and make a cursory inspection to ensure all pads are located appropriately.
- *Launch Control Systems:* The RSO should become familiar with the launch control systems at the launch and ensure that sufficient safety interlocks are in place to prevent unauthorized ignitions.
- *Emergency*: The RSO shall confirm adequate safety equipment exists at the launch site – to include sufficient firefighting equipment, first aid supplies, and reliable means of communication with other facilitators. Furthermore, the RSO has personal access to reliable means of communication with local fire departments, emergency medical, and security/protective services.
- *Fliers Meeting:* The RSO and Launch Operations Director shall conduct at least one Fliers Meeting every morning, reminding representatives from all teams of the launch-rules for the day, general safe conduct principles, and communicating any necessary updates to standing instructions.
- *Flight Safety Review:* The RSO and his Range Safety Review team shall perform a Flight Safety Review (FSR) of all rockets intended for launch, as described in Section 4.1 of this document.
- *Flight Readiness Review:* The Flight Readiness Review Officer and his/her team will perform final safety inspection of each rocket prior to the team being released to the Range Head Safety Officer for pad bank designation and traffic control.

The Range Safety Officer shall nominally delegate a portion of his/her responsibilities to one or more appointees of his/her own choosing – the Flight Safety Reviewer(s). These assistants are empowered to perform FSRs but are expected to consult with the RSO for input as needed. The RSO may similarly consult with the Launch Director in making determinations; however, the RSO's final decision will supersede all others. Together, the RSO and his/her Flight Safety Reviewer(s) constitute the Flight Safety Team. Only the Flight Safety Team may conduct FSRs, and only the Flight Safety Team may approve the resolution of "major" issues identified during the FSR.

It is important to note the RSO has more responsibilities than his/her assistants that perform FSRs. In literal terms, the role of "range safety" should be concerned with the entire range, and not just reviewing the rockets themselves. Like the Launch Director, the RSO is empowered to terminate the launch at any time, for any reason (e.g. general safety concerns, weather conditions, change in governing authority approval, etc...). A decision to terminate by only one of these individuals is required to cease operations, such that in the case of disagreement, the decision to terminate always takes precedence.

## 2.3 Launch control Officer AND Range Head Manager(s)

The Launch Control Officer (LCO) is a Launch Director appointee responsible for coordinating actual flight operations. It is the responsibility of the LCO to set the tempo of the flight operations, to make sure that launches occur in a timely manner and in accordance with foundational safety regulations/guidelines. The LCO will carry out this coordination through his/her monitoring and execution of the roles outlined below.

- *Site Access:* The LCO (or his/her delegate) shall control personnel access to the rocket assembly and launch areas to include operating the Range Status Flags defined in Section 5.1of this document based on the RSO's guidance. The LCO will direct the Range Head Security Officer to allow teams to proceed to the pads.
- *Flight Cards:* The LCO (or his/her delegate) shall utilize Flight Safety Cards to manage control of rockets once it is determined all issues identified during the FSR are resolved, manage the cards' use to coordinate each flight with a unique launch pad assignment, and disseminate relevant information recorded on each Flight Card with all participants and staff using radio communications, Public Address, and Voice Transmission systems.
- *Flight Readiness Safety Inspection:* The Flight Readiness Safety Officer and his team shall perform a cursory, final safety inspection of each rocket shortly before sending it to the Range Head Security Officer in preparation for departure to the pads for final launch preparations. This final inspection is intended to verify (with little-to-no disassembly) such criteria as the fins being securely mounted and properly aligned, the launch lugs securely mounted and properly located, the airframe joints being sufficiently stiff, the nose cone properly secured, etc...
- *Launchpad Integration:* The Pad Manager and his/her team shall direct and guide Fliers with mating and erecting their rocket on the launch rail – while assuring the pad area is cleared of combustible material, and the launch azimuth and elevation are set according to the constraints described in Section 5.4 of this document. The Pad Manager team will also strictly control the arming of electronics and final integration of igniters. The Pad Manager team is also responsible for ensuring that everyone clears away from the areas prior to Imminent Launch (Red Flag) condition.
- *Situational Awareness:* The LCO shall promote situational awareness of each flight by communicating the status of a particular rocket – including any associated safety hazards it may pose – to all participants and spectators using radio communications, Public Address, and Voice Transmission systems.
- *Launch Control Systems:* The LCO shall configure, test, and operate the ESRA provided launch control system, as well as supervise the use of any flier provided launch control systems.
- *Countdown:* The LCO shall coordinate with Davinci Mission Control Center (MCC) prior to performing a countdown procedure. The LCO shall utilize radio communications, Public Address, and Voice Transmission systems – including all status checks, readiness polls, announcements defined in Section 6.0 of this document, prior to every launch attempt.

Together, the LCO, Range Head Security Manager, Pad Manager and their team constitute the Launch Operations Team. The Launch Operations Team may approve the resolution of "minor" issues identified during the FSR. The LCO may choose to hold flights temporarily at any time, for any reason (e.g. general safety concerns, weather conditions, change in governing authority approval, etc...), however; only the RSO and the Launch Director may choose to terminate the overall launch in its entirety.

## 2.4 Davinci Mission Control Officer and Mission Manager(s)

The Davinci Mission Control Officer (MCO) is a Launch Director appointee responsible for enabling and coordinating command, control, and communications (C3) for the Flight Safety and Launch Operations Teams, as well as student teams engaged in rocket search and recovery at the SA Cup. The MCO and his/her team will facilitate these capabilities through his/her monitoring and execution of the roles outlined below.

- *Radio Communication Networks:* The MCO shall establish and manage use of long-range radio communication networks supporting launch operations and recovery operations, assuring uncluttered communications within these two domains.
- *Public Address System:* The MCO shall establish and manage use of a networked speaker system, which facilitates the LCO's situational awareness announcements using loudspeakers in the rocket assembly and spectator areas.
- *Voice Transmission System:* The MCO shall establish and manage use of a radio transmission system which all participants can listen to using standard radios. This extends the LCO's situational awareness announcements to personnel in remote locations.
- *Command and Control:* The MCO shall maintain command and control (C2) of student teams engaged in search and recovery of their rocket by authorizing each team's deployment, maintaining two way status communications with each team over radio, persistent tracking of each team through GPS, and compelling each teams return – as described in Section 7.0 of this document.
- *Weather Monitoring:* The MCO will (as an additional duty) monitor local area weather reports and data feeds from wind measurement instruments at each launch area, immediately disseminating actionable information on any unsafe condition defined in 6.1.1 of this document to the LCO, RSO and Launch Director – until a decision is made to codify this role in either the MCO's official responsibilities or with another position at the launch.

The MCO shall nominally select of his/her own choosing, or have assigned to them, one or more assistants – the Mission Manager(s). Together, the MCO and his/her Mission Managers constitute the Davinci Mission Operations Team. The MCO may hold a flight temporarily by responding in the negative to a countdown readiness poll or otherwise aborting a countdown, as described in Section 6.0 of this document, but a decision to hold flights at any other time must be requested of the LCO. Similarly, only the RSO and the Launch Director may choose to terminate the overall launch entirely.

### 2.5 Student Teams

Individuals and organizations attempting to fly rockets at HPR launches are commonly referred to as "Fliers". Fliers at the SA Cup are assumed to be collegiate student project teams and their individual members – including faculty advisors and other mentors. The term Flier may be used interchangeably, in reference to either a Student Team or its individual members. Regardless of each organization's unique internal division of responsibilities and leadership structure, each Student Team shall provide a member to fulfill each of the following roles. Although these should be separate individuals, it is understandable for these roles to be shared among as few as two or three team members. Furthermore, while each individual in a leadership position should identify a deputy for him/herself (to assume their full role and responsibilities to facilitate shift-work, to take over if the primary person becomes unavailable, etc...), launch organizers understand this may not always be possible due to staffing limitations.

- *Student Team Leader:* Each Student Team shall designate a Team Leader for itself, ultimately responsible for all the team's actions/activities at the SA Cup, similar to the Launch Director's responsibility for organizing the overall launch.
- *Flier of Record:* Each student team in the COTS and SRAD/Solid or SRAD Hybrid categories must have a TRA Certified Flier of Record (FoR). This FoR must be an active TRA member in good standing and be certified appropriately to launch the team's rocket following TRA Safety Code.
- *Safety Operations Lead:* Each Student Team shall designate a Safety Operations Lead for itself (other than the Team Leader), to assist the Team Leader in assuring the team's actions meet the spirit and intent of this document, and account for any unique hazards associated with the team's particular project.

- *Launch Operations Lead:* Each Student Team shall designate a Launch Operations Lead for itself, responsible for the physical act of launching the rocket, as well as understanding and familiarizing the Launch Control Officer with any countdown procedures unique to the team's particular project.
- *Recovery Operations Lead:* Each Student Team shall designate a Recovery Operations Lead for itself, responsible for organizing and leading the team members who will recover the rocket after it launches.

While there may be various launch organizers guiding Student Teams through the launch processes at the SA Cup, it is ultimately the Student Team's responsibility to ensure its rocket launch is safe. Each Student Team's Leader and Safety Operations lead shall attend each Flyers Meeting (up until they successfully launch), hosted by the RSO/LCO on each day launches are scheduled to occur. These two individuals will in turn be responsible for briefing the rest of their team. Finally, each Student Team is responsible for ensuring its members are sufficiently well versed (as a collective, if not necessarily as individuals) in their project, to address questions or concerns raised by the Flight Safety Team during the FSR – described in Section 4.1 of this document.

Each Student Team is responsible for its own members actions, assuring their actions adhere to the spirit and intent of this document as well as any additional direction given by those facilitating the launch. Therefore, it is very important that all fliers are familiar with this document, and bring departures observed during the event to the attention of launch organizers.

> *Important: All official written and verbal communications at the SA Cup, including all launch operations, are conducted entirely in English. Inability to understand and react to these communications in a timely manner can create significant safety hazards for all participants. Therefore, it is very important for (at a minimum) the leadership of each student team to have a high degree of fluency in both written and spoken English. For the safety of all participants, the launch organizers strongly recommend against the participation of any student teams unable to meet this requirement.*

## 3.0 Procedure For Acquiring Credentials to Access Spaceport America Property

All participants at the SA Cup shall bring an acceptable form of government issued photo ID and proof of the team's fee payments to access the Spaceport. A valid passport, United States driver’s license, or Canadian health card are all considered acceptable forms of government issued photo ID.

Student team members (including mentors, advisors, Flyers of Record and faculty) will receive their event badges when they register on Monday as specified in the *Spaceport America Cup Integrated Master Schedule Document*. To receive the badges, all members of the student team (including advisors, mentors, faculty, FoRs, etc) must check in and provide the following:

- The team's proof of fee payments. In many cases, ESRA will already have this information, but it is highly recommended to have a printed copy in case there was a technical issue.
- A complete list of attending team members' names, contact information (phone number, e-mail addresses where they may be reached during the SA Cup) – including mentors, advisors, Flyers of Record and faculty.
- Team leaders should also have full EMERGENCY contact information for each of their team members. This information will be provided during the Check-In process for use in contingencies during an incident or emergency. The emergency contact information must be maintained by the team leader with an additional copy being held by the Safety Officer.
- Student team members (including mentors, advisors, Fliers of Record and Faculty) and SPA Cup staff must verify that they have agreed to and signed the Spaceport America Cup Liability Waiver.

- Student team members (including mentors, advisors, Fliers of Record and Faculty) and SPA Cup staff will have a blue dot with a 0, 1, 2 or 3 written on their security badges. Wearing this badge signifies that the individual has been confirmed as a TRA certified member. The number represents the certification level.
- No student, volunteer or ESRA staff will be permitted downrange without a verified Blue Dot on their badge. The only exception would be for Spaceport America staff.
- If competing in the IREC, then receipt of all required deliverables will be verified. It is recommended that the team representative have digital copies, and email receipts readily available, in digital or printed form. Every year, one or two teams arrive with missing items. Having this information will help fix the problem quickly.

Once given these materials, event staff will issue the team the requisite number of Rocketeer Badges. They will also issue one or more (as needed) Vehicle Placards. Finally, they will receive their sponsor shirts, gift bags/swag items being offered that year.

Any team members arriving late to the SA Cup (missing the team photo) must make separate arrangements with their team to receive their Rocketeer Badge from a teammate outside Spaceport America property. Late arriving team members who attempt entering the Spaceport without first picking up their Rocketeer Badge from a teammate should expect significant delays before being granted access. This potential conflict should be communicated to ESRA volunteers at Monday's check-in if ESRA or Spaceport America staff need to be involved.

All participants at the SA Cup shall wear their badges at all times while at the Convention Center or on Spaceport America property. Badges shall be worn above the waist, where they are clearly visible – clipped either to a garment or a provided lanyard. Only vehicles (not including trailers) with a Vehicle Placard will be admitted onto Spaceport America property. Placards shall be displayed prominently – either on top of the dashboard or hanging from the rearview mirror.

Finally, all participants shall also carry their respective form of government issued photo ID with them at all times, while on Spaceport America property. Spaceport America Protective Services may request a participant's ID at any time to confirm the individual's identity.

The following sections describe the access granted to participants issued Rocketeer Badges, as well as the access granted to other badged personnel at the SA Cup. All personnel have a shared responsibility for maintaining situational awareness and assuring that only appropriately badged personnel enter a given area.

### 3.1 "Rocketeer" Badged Personnel

All student team competitors (including mentors, advisors, Fliers of Record and Faculty) at the SA Cup will be issued a red themed badge, marked with a large letter "R" and the word "Rocketeer". This badge grants them access onto the Spaceport, and unescorted access within the SA Cup Parking Area, Spectator Area(s), and Rocket Assembly Area(s).

During launch operations, student team competitors (including mentors, advisors, Fliers of Record and Faculty) with a Rocketeer badge and the associated Blue Dot (for active Tripoli Rocketry Association Membership) are granted access to the Launch Area(s) in accordance with the LCO and RSO's latest instructions – provided at least one Launch Operations or Flight Safety Team member is supervising those area(s) at the time.

Finally, student team competitors with rocketeer badges assigned to recovery teams must adhere to all instructions provided to them from the Mission Control Center Team while in search of their rockets. These members must also have the rocketeer badge with the blue dot and must have completed the recovery team team training course.

## 3.2 "ESRA" Badged Personnel

All members of the Launch Operations Team, Flight Safety Team, Launch Operations Team, and other Competition Officials will be issued a dark-blue themed badge, marked with a large letter “E” and the word “ESRA”. This badge grants them access onto the Spaceport, and unescorted access within the designated SA Cup Parking Area, Spectator Area(s), and Rocket Assembly Area(s).

An ESRA badged person's access to downrange areas during launch operations REQUIRES a verified Tripoli Rocketry Association membership. TRA membership will be denoted by a blue dot on their ESRA badge. ESRA members without a Tripoli membership will not be allowed downrange during launch operations. Launch Operations Team members will not be issued a supplemental badge

### 3.2.1 Competition Official Credential

All competition officials at the SA Cup will be issued a supplemental dark-blue and yellow themed badge, marked with the words "Competition Official" and "Judge". During launch operations, such Competition Officials and/or Judges are NOT granted access downrange to the Launch and recovery areas.

### 3.2.2 Launch Operations Team Credential

All members of the Launch Operations Team will be issued a supplemental red and yellow themed badge, marked with the words "Launch Ops. Team". Launch Ops team members must be verified, active Tripoli Rocket Association members to be granted unsupervised access to the Launch Area(s) during launch operations.

### 3.2.3 Flight Safety Team Credential

All members of the Flight Safety Team will be issued a supplemental green and yellow themed badge, marked with the words "Flight Safety Team". Flight Safety team members must be verified, active Tripoli Rocket Association members to be granted unsupervised access to the Launch Area(s) during launch operations.

## 3.3 "VIP" Badged Personnel

All attending sponsor representatives, guest speakers, and other invited guests of the SA Cup host organizations will be issued a purple themed badge, marked with a large letter "V" and the word "VIP". This badge grants them access onto the Spaceport, and unescorted access within the SA Cup Parking Area, Spectator Areas, and Rocket Assembly Area(s). During launch operations, these individuals are not permitted into the Launch Areas. VIPs may participate in escorted/guided tours downrange during periods when launch operations are suspended.

## 3.4 "Press” Badged Personnel

All members of the media who previously coordinated their attendance with Spaceport America Public Affairs will be issued a green themed badge, marked with a large letter "P" and the word "Press". This badge grants them access onto the Spaceport, and unescorted access within the SA Cup Parking Area, Spectator Areas, and Rocket Assembly Area(s). During launch operations, these individuals are not permitted into the Launch Areas. Members of the Press may participate in escorted/guided tours downrange during periods when launch operations are suspended.

## 3.5 Spaceport America Staff, Protective, Fire, and Emergency Medical Services

All Spaceport America employees and contracted site services personnel – including all protective, fire, and emergency medical services – will be identified by Spaceport America staff ID cards and/or uniforms. These personnel are granted unescorted access to the entire Spaceport. All launch operations are suspended the moment any Spaceport America staff, including Fire, EMS, or Protective Services staff are downrange.

### 3.6 Spectators

The general public is limited to the spectator areas and will be managed by Spaceport America Protective Services. Friends and family with direct connection to a team, are welcome to come to be spectators at the launch. These individuals will be asked to pay a spectator fee at the entrance to the Spaceport in exchange for a wristband. This wristband grants them access onto the Spaceport, and unescorted access within the designated SA Cup Parking Area and Spectator Area(s). Spectators may be granted escorted access to the Rocket Assembly Area(s) – where escort is provided by either an ESRA badged person or a Spaceport America Staff member.

### 3.7 Other Personnel

Spaceport America Staff rely on a large number of community volunteers to augment contracted site services personnel throughout the SA Cup. These community volunteers will be issued a light-blue themed badge, marked with a large letter “T” and the word “Volunteer”. This badge grants them access onto the Spaceport, and unescorted access within the designated SA Cup Parking Area and Spectator Area(s). If necessary, volunteer badged personnel may be granted escorted access to the Rocket Assembly Area. Community Volunteers are never allowed downrange to the Launch Areas during launch operations.

## 4.0 Procedures for Receiving approval to Attempt Flight

Prior to attempting flight at the SA Cup, each rocket must pass an FSR and a subsequent final LCO Inspection. Furthermore, IREC competitors are responsible for submitting their payload(s) to inspection prior to fully integrating their launch vehicle for the LCO Inspection – when it is expected the payload(s) may no longer be easily removed. By completing these processes, the rocket’s Flight Card will be issued to the flier, completed by the flier, and ultimately received by the LCO. No rocket will be allowed to depart the Rocket Assembly Area(s) for the Launch Area(s) without an associated Flight Card in the LCO’s possession. The following sections overview each of these processes in the Flight Attempt Approval Procedure. Fliers seeking re-approval to attempt flight following any on-pad abort which forced the rocket's return to the Rocket Assembly Area(s) must begin the approval procedure over from the beginning; however, the FSR may be abbreviated in such situations at the Flight Safety Team's discretion.

### 4.1 Flight Safety Review and Initial Determination of Flight Status

The FSR is the first and most important step in the Flight Attempt Approval Procedure. This review assesses the quantitative and qualitative aspects of the proposed rocket flight, in an attempt to prevent any flight mishaps that might endanger human life or cause damage to property. Although the risk of such incidents can never be completely eliminated, the review process reduces these inherent risks while simultaneously enhancing the probability of a successful flight. In addition to checking for overall compliance with the *IREC Design Test & Evaluation Guide* – or for proof of design, analysis, testing and/or safety mitigations in instances of deviation from the guide – the FSR considers the rocket's general implementation of best practices and safety guidelines in the areas of rocket structures, payloads, propulsion, flight profile, and recovery systems. Ultimately, the Flight Safety Review ensures any residual risks are understood and within reasonable limits.

A more detailed overview of the complete FSR is recorded in Appendix B of this document. Whether a particular FSR rises to the full level of detail possible is at the discretion of the inspector. The inspector may choose to abbreviate his/her review based on the quality of verification & validation testing performed by a particular Student Team and/or the flight safety history of that Student Team known to the inspector.

The Flight Safety Team will nominally complete all FSRs during the Poster Session held throughout the SA Cup Conference day. Any FSRs not completed by the end of the Poster Session will be completed the following day, during launch preparations in the Rocket Assembly Area(s). Upon completion of the FSR the inspector will make a flight readiness status decision of either "nominal", "denied", or "provisional" in accordance with the definitions

recorded in Section 1.3 of the *IREC Design Test & Evaluation Guide.* This decision will be recorded on the 3-part (ie 3-carbon-copies) FSR Resolution Form.

#### 4.1.1 Nominal Flight Readiness Status

If the inspector determines the proposed rocket flight is "nominal", he/she will complete the FSR Resolution Form appropriately and initial both its "determination" and "resolution", making sure to record the date and time in the appropriate field of each row. The inspector may also list amended launch condition criteria (e.g. reduced launch elevation or lower permissible ground wind speed) for the Launch Operations Team to implement on this flight attempt. The inspector will leave one part with the Flier and retain the other two copies. The inspector maintains custody of one of these copies as notes for him/herself and deposits the other at a designated “ESRA Office” location for official record keeping. For Flight Safety Reviews performed during the conference component of the SA Cup, this copy for official record keeping will be given to the RSO at the end of the day for he/she to deposit at the ESRA office on the morning of the first launch day. At this point, the FSR is considered "resolved", and the Flier may continue launch preparations.

#### 4.1.2 Denied Flight Readiness Status

If the inspector determines the proposed rocket flight is "denied" based on unacceptable risks, which the Flier stands no reasonable chance of correcting within the time and resource constraints available, he/she will complete the FSR Resolution Form with the rationale for "grounding" and initial both its "determination" and "resolution", making sure to record the time and date in the appropriate field of each row. If the individual issue “Description” lines are insufficient to explain the reason(s) for grounding, the inspector may use the “Instructions to LCO " section to fully describe their rationale in paragraph form. The inspector will leave one part with the Flier and retain the other two copies. The inspector will maintain custody of one of these copies as notes for him/herself and deposit the other at a designated “ESRA Office” location for official record keeping. For Flight Safety Reviews performed during the conference component of the SA Cup, this copy for official record keeping will be given to the RSO at the end of the day for he/she to deposit at the ESRA office on the morning of the first launch day. At this point, the FSR is considered "resolved", and (if an IREC competitor) the Flier is disqualified. The Flier will make no further launch preparations.

The Flier may choose to appeal such a determination one time only to the RSO – provided the RSO him/herself was not the original inspector. The RSO's decision, once made, is final and supersedes all others. In the event the RSO chooses to overturn the original inspector's determination, he/she will generate a new FSR Resolution form and destroy the Flier's original.

#### 4.1.3 Provisional Flight Readiness Status

If the inspector determines the proposed rocket flight may proceed on a "provisional" basis once the Flier corrects one or more issues, he/or she will complete the FSR Resolution Form by listing these issues and categorizing each as either "minor" or "critical". The inspector may also list amended launch condition criteria (e.g. reduced launch elevation or lower permissible ground wind speed) for the Launch Operations Team to implement on this flight attempt. The inspector will only initial the FSR Resolution Form's "determination", making sure to record the time and date in the appropriate field of this row. The FSR Resolution form shall not be initialed as "resolved", and (if an IREC competitor) the Flier will be considered temporarily disqualified, until all listed issues have been corrected. The inspector will leave one part with the Flier and retain the other two copies. The inspector will maintain custody of one of these copies as notes for him/herself and deposit the other at a designated “ESRA Office” location for official record keeping. For Flight Safety Reviews performed during the conference component of the SA Cup, this copy for official record keeping will be given to the RSO at the end of the day for he/she to deposit at the ESRA office on the morning of the first launch day.

### 4.2 Resolving Issues Identified During the Flight Safety Review

Following a determination of "provisional" flight status, the inspector will inform the Flier of the issues requiring correction and instruct the Flier to request re-inspection only after taking appropriate corrective actions. Re-inspection and FSR "resolution" may be accomplished either by a member of the Flight Safety Team or the Launch Operations Team, depending on whether the issues identified on the FSR Resolution Form are categorized as "minor" or "critical".

- *Minor Issues:* These issues are easily remedied with quick fixes, which mitigate any associated flight safety concerns the issue had caused. A Flier whose FSR Resolution Form lists only "minor" issues may request re-inspection from either a member of the Flight Safety Team or the Launch Operations Team. If the inspector is satisfied the listed issues have all been corrected, he/she will initial the FSR Resolution Form's "resolution", making sure to record the time and date in the appropriate field of this row. At this point, the FSR is considered "resolved", and the Flier may continue launch preparations.
- *Critical Issues:* These issues pose major operational and/or flight safety concerns, the correction of which may be difficult and time consuming. A Flier whose FSR Resolution Form lists any "critical" issues may only request re-inspection from a member of the Flight Safety Team. If the inspector is satisfied the listed issues have all been corrected, he/she will initial the FSR Resolution Form's "resolution", making sure to record the time and date in the appropriate field of this row. At this point, the FSR is considered "resolved", and the Flier may continue launch preparations.

The FSR Resolution form shall not be initialed as "resolved", and (if an IREC competitor) the Flier will be considered temporarily disqualified, until all listed issues have been corrected. Proposed rocket flights deemed unsafe will not be launched under any circumstances. The Flight Safety Team, acting under the RSO's direction, reserves the right to reduce any determination (e.g. from "nominal" to "provisional", or from "provisional" to "denied") based on real-world events, observations, and interactions during the SA Cup. In the event such a reduction is made, the notifying official will generate a new FSR Resolution form and destroy the Flier's original.

### 4.3 Payload Inspection

IREC competitors are responsible for submitting their payload(s) to inspection prior to fully integrating their launch vehicle for the LCO Inspection – when it is expected the payload(s) may no longer be easily removed. After receiving their Flight Safety Review Resolution Form from the Flight Safety Team, IREC teams will bring both the FSR Resolution Form and their payload(s) to a designated payload inspection station. A Competition Official there will assess compliance with Section 2.2 of the *IREC Rules & Requirements Document* and any penalties or bonuses in accordance with Sections 2.7.1.6 and 2.7.1.7 of the same. Information pertinent to the Space Dynamics Laboratory (SDL) Payload Challenge may also be collected at this time. When finished, the inspector will issue the Flier a Consolidated Flight Card and Post Flight Record Form. The inspector will initial the Flight Card's "Issuance", making sure to record the time and date in the appropriate field of this row. The Flier is responsible for filling out the Flight Card side of this form prior to submitting their rocket for LCO Inspection. Flier's with a "provisional" flight readiness status determination should not wait for their FSR re-inspection to perform payload check-in.

### 4.4 Flight Card Issuance and LCO Inspection

Fliers with 'resolved" FSR Resolution Forms showing either "nominal" or "provisional" flight readiness status will bring their "resolved" FSR Resolution Form, their filled-out Flight Card, and their flight ready rocket to a designated LCO Inspection station. Range Managers there will perform a cursory, final safety inspection of each rocket – intended to verify (with little-to-no disassembly) such criteria as the fins being securely mounted and properly aligned, the launch lugs securely mounted, and properly located, the airframe being sufficiently stiff and strong, the nose cone properly secured, etc... Questions about shock cords, parachute attachments and motor retention may also

be asked. The flier will present the inspector with a hard copy pre-flight checklist and an appropriate number of motor/engine igniters. In an attempt to reduce misfires, all solid rocket motors shall use two igniters.

> *Important: In this context, "flight ready" does not mean in any way "armed". The flight ready rocket shall be presented for inspection with all motor/engine igniters removed and in an otherwise "safed" configuration, in accordance with the definitions of "armed" and "safed" recorded in Section 4.1 of the IREC Design Test & Evaluation Guide. Exemption from motor/engine igniter removal requirement may be granted only for designs implementing head-in ignition systems, and only at the discretion of the Flight Safety Team – sought by the Flier during the FSR. Similarly, Fliers with SRAD ignition configurations believed to obviate the requirement for two igniters, may seek exemption from this requirement during the FSR.*

At the start of the LCO Inspection, the inspector will take possession of the Flier's FSR Resolution Form and Flight Card. Upon completing his/her inspection, the inspector will verify with the flier that all required information on the Flight Card is recorded clearly and correctly before initialing the inspection's "Completion". In the event the LCO Inspection reveals a “minor” issue, the inspector will record the issue in the Flight Card margin (including the time and date of discovery) and return the form to the Flier's possession while they work to correct the issue. If the inspector believes any issue revealed to be "critical", he/she will seek the advice of a Flight Safety Team member before proceeding. If the Flight Safety Team Member confirms the issue is "critical", he/she will generate a new FSR Review Resolution Form and destroy the Flight Card as well as the first FSR Resolution Form.

Once an LCO Inspector is satisfied any "minor" issues revealed by the first LCO Inspection attempt are corrected, he/she will initial the inspection's "completion" and take possession of the Flight Card – stapling it atop the FSR Resolution Form already received from the Flier. The Flier will either be cleared to enter the Launch Area(s) with their rocket, or be instructed to hold-short while they're queued in the next available salvo. No rocket will be allowed to depart the Rocket Assembly Area(s) for the Launch Area(s) without an associated Flight Card in the Launch Operations Team's possession. It is the responsibility of the Launch Operations Team member(s) staffing the LCO Inspection Station to deliver the Flight Cards and attached FSR Resolution Forms associated with the upcoming salvo to the on-duty LCO at a designated Launch Control Center (LCC).

> *Note: In rare exceptions, where bringing the rocket to the inspection station is deemed completely impractical, a flier bearing the completed forms may request an LCO Inspector accompany them back to their individual prep area and conduct the inspection there. Such exceptions will be granted only by the Launch Operations Team member performing the inspection.*

## 5.0 General Provisions For Entering and Operating in Launch Area(s)

Pad Managers will be present in the Launch Pad Areas to supervise fliers in loading their rockets on the launchers, inserting igniters, and otherwise making final preparations for flight; however, it is the Flier's ultimate responsibility to assure the rocket's launch is safe. The following guidelines and directives shall be followed by all Fliers and Range Staff alike.

## 5.1 Launch Site Layout, Range Head, Pads and Public Address System

## 5.2 Range Status Flags

### 5.2.1 Determining Range Status

The RSO is responsible for determining the status of range operations, communicated using Range Status Flags. Range Status Flags will communicate the safety status of each Launch Pad Area. There are three separate Launch Operations (Pad) areas and each will have a Range Status Flag. The color of these flags will indicate the range status as either OPEN (Green), LIMITED (Yellow), or CLOSED (Red). All personnel shall check-in at a Range Head Queue area before entering or exiting the Launch Pad Area(s) while they are in an OPEN state. A lack of any flag will indicate an uncontrolled state. An uncontrolled state will exist only at the beginning and end of each launch day, when the Launch Director and Governing Authority deem flight activities have not yet commenced or are terminated until the next day.

- *Green:* The Launch Pad Area is OPEN to those who have business out on the range.
- *Yellow:* The Launch Pad Area is LIMITED to those essential to arm electronics and install igniters.
- *Red:* The Launch Area(s) are CLOSED due to either imminent rocket launches or the existence of a similar hazardous condition elsewhere in the Launch Pad Areas.

### 5.2.2 Range Status Operating Rules

- Red Flag at any Pad Bank:
    - Red Flag initiated when all teams at the Pad Bank have completed their igniter installation
    - Red Flag continues at the Pad area until all rockets have launched or have had a launch failure.
    - All travel to/from any pads will stop
    - Everyone at the Red Flag Pad Area will return to a designated safe area (LCO Range Head).
    - Student teams already at other Pad Banks can continue prepping for their flights.
    - During the countdown, all pad activities at all Pad Banks will stop and attention will be directed to the launch

- Yellow Flag at any Pad Bank:
    - Red at ANY Pad Bank overrides a Yellow relating to travel to/from pads.
    - Yellow Flag initiated when the Flight Avionics have been activated on all rockets at the pad bank
    - Non-critical team members (those not initiating Avionics or installing igniter) begin returning to the Range Head/LCO area.
    - Travel permitted to any Pad Bank with a Green Safety Flag
    - Everyone at the Yellow Flag area will begin departing back to the LCO
    - Launch Prep at all Pad areas can continue

- Green Flag at All Pad Bank:
    - Yellow at ANY Pad Bank overrides a Green
    - Travel to/from Pad Banks is approved

### 5.2.3 Altering Range Safety Status

The RSO is empowered to alter the range status at any time, for any reason (e.g. general safety concerns, weather conditions, change in governing authority approval, etc...). The RSO shall reassess the range status prior to any launch salvo and immediately following any mishap.

### 5.2.4 Communicating Range Safety Status Changes

Range Safety Status Flags are visual indicators and are intended to augment, but not to override, announcements made over Public Address System, or any other means of verbal communication available to the Flight Safety and Launch Operations Teams. Any personnel in the Launch Pads Areas who receive a verbal instruction from Flight Safety or Launch Operations Team members in conflict with the current Range Status Flag shall act in favor of the verbal instruction. It is the responsibility of all personnel in the Launch Pad Areas to monitor and act on all LCO and RSO directed safety instructions.

## 5.3 Required personal protective equipment

Personnel performing arming operations on stored-energy devices, working near armed stored-energy devices, or handling hazardous substances shall use appropriate personal protective equipment (PPE). The following table provides guidance on PPE appropriate to some common stored-energy devices and hazardous substances. Section 4.0 of the *IREC Design Test & Evaluation Guide* provides basic definitions for when these common stored-energy devices may be considered "armed" - as opposed to "safed", or "non-energetic". The appropriate Material Safety Data Sheet (MSDS) should always be used as the definitive resource when selecting appropriate PPE for hazardous substance handling.

| DEVICE OR SUBSTANCE CLASS | REQUIRED PPE |
|---|---|
| Armed Igniters/Squibs | Safety glasses or face shield |
| Armed Pyrogens (e.g. black powder) | Safety glasses or face shield (face shield preferred) |
| Armed Mechanical Devices | safety glasses or face shield (face shield preferred) |
| Armed Pressure Vessels | safety glasses or face shield (face shield preferred) |
| Nitrous Oxide, Cryogen, or similar cold fluid lines and valves handling | Leather gloves (or similar insulating protection approved for use with liquid nitrogen); safety glasses or face shield |
| Liquid Oxygen (LOX) handling | Leather gloves (or similar insulating protection approved for use with liquid oxygen); Safety glasses or face shield; *NOTE: It is especially important to avoid LOX contamination from synthetic material such as from synthetic cloth garments.* |
| Kerosene or similar liquid hydrocarbon handling | Chemical resistant gloves (e.g. PVC, neoprene, Viton, etc.); safety glasses or face shield |
| Hydrogen Peroxide handling | Chemical resistant gloves (e.g. PVC, neoprene, Viton, etc.); safety glasses or face shield |

### 5.4 Minimizing Essential Personnel Involved in Final Preparations

The number of personnel accompanying a particular rocket into the Launch Pad Areas shall not exceed the minimum number absolutely necessary to make final preparations necessary. Nominally, this number should not exceed five. The Flier may seek an exception for additional personnel from either the Flight Safety Team or the Launch Operations Team, during either the FSR or the LCO Inspection. Exceptions granted during the FSR will be recorded on the FSR Resolution Form as "instructions to the LCO". Examples for exceptions are made for either very large rocket projects or extremely complex launch preparation procedures.

The number of personnel accompanying a particular rocket at the launch pad should be further reduced to no more than two or three once "arming" flight computers, installing motor/engine igniters, and beginning fill procedures (if applicable) are the only tasks remaining to be completed – with all other personnel evacuating back to either the Flight Safety Team's forward deployed location or the Rocket Assembly Area(s) based on Range Manager instructions. The Flier may seek an exception for additional personnel from either the Flight Safety Team or the Launch Operations Team, during either the FSR or the LCO Inspection. Exceptions granted during the FSR will be recorded on the FSR Resolution Form as "instructions to the LCO".

### 5.5 Launch Pad Preparation and Launch Pad Elevation

The Flier and any assisting Range Manager(s) will inspect to make sure all combustible materials have been removed from the ground immediately surrounding the launch pad. Personnel should avoid pointing the rocket towards either the Rocket Assembly or Launch Area(s) while loading it on the launch rail. Once loaded, the Flier and any assisting Range Manager(s) will elevate the launch rail in accordance with azimuth and elevation requirements defined by the Range Safety Officer.

### 5.6 Arming Avionics, Installing Motor Igniters, and Propellant Loading

"Arming" flight computers, installing motor/engine igniters, and beginning fill procedures (if applicable) shall be the final tasks performed prior to the launch pad being completely evacuated. Electronics will always be "armed" before igniters are inserted or fill procedures are begun (if applicable). The Flier may use a stable platform (e.g. ladder) to reach electronics, if needed. Ladder use should always be a two person operation, with one individual at the base stabilizing and safety-spotting for the other ascending the ladder. All ladder activities should be under supervision of a pad manager.

When ready, the Flier shall seek permission from a Range Manager to install the motor igniters - leaving them shunted for a Range Manager to either be present while the Flier connects the firing line, or perform this final process him/herself. The installer shall verify the firing line is not "hot" before connecting to igniters, by touching the leads together and checking for sparks. Finally, the installer shall verify all non-essential personnel have evacuated the launch pad before connecting the firing line to the igniters and coordinating a continuity check with the launch control unit. Fill procedures (if applicable) may begin after this step.

In the event the rocket must be removed from the launcher for any reason, the firing line shall be disconnected, the igniter shunted and removed, flight computers disarmed, and any other onboard energetic devices "safed" before the launcher is lowered. The Flier shall consult with a Range Manager before initiating these steps.

## 6.0 Procedures For Launch Countdown, Scrub, and Mishap

Each salvo of flights shall be preceded by a Launch Readiness Poll conducted among the various officers facilitating the flights, coordinated by the LCO. Similarly, each flight in a salvo shall be preceded by a Final Countdown. These processes assure each officer and his/her support staff are prepared to support the flights, as well as to interrupt or terminate the procedure if any launch commit criteria within his/her area of responsibility are violated. The LCO may revise or amend these baseline processes as needed for unique flight attempts, based either on his/her personal experience or using information recorded on the FSR Resolution Form's "instructions to the LCO". Although he/she

is not included in the formal Launch Readiness Poll process, the Launch Director is responsible for monitoring the entire procedure, and may command its interruption or termination at any time for any reason.

### 6.1 Launch Readiness Poll

The Launch Readiness Poll begins when the RSO informs the LCO that Yellow Flag conditions are in effect in one or more Launch Area(s) - due to avionics arming, igniter installation, and propellant loading (if applicable) being underway. While it is understood by both parties the poll process will generally start at this time, the RSO should include a formal instruction for LCO to start the poll process – or to wait for further instructions, if the RSO believes these particular preparations will take longer to complete than typically expected. When instructed, or in the absence of instructions to wait, the LCO will initiate the Launch Readiness Poll Process by taking the following actions.

1. *Instructing available members of the Launch Operations Team to raise Yellow Range Status Flags at the appropriate location(s)*
2. *Announcing over Public Address and Giant Voice Systems the location(s) where Yellow Flag Conditions are in effect, and for personnel in the Rocket Assembly and Spectator Area(s) to listen for further announcements on launch status while continuing to go about their business*
3. *Instructing the MCO over the long-range radio communication network to begin advising deployed rocket recovery teams on the status of launch preparations, as well as directing any returning teams either around the affected Launch Area(s), or to hold their position (whichever is safest based on their current location)*
4. *Announcing over Public Address and Giant Voice Systems the rockets attempting flight in the upcoming salvo, by reading the associated Team ID, Project Name, and School Name(s) from the Flight Cards – received from the LCO Inspection Station – once again concluding by asking all personnel in the Rocket Assembly and Spectator Area(s) to listen for further announcements on launch status while continuing to go about their business*

If instructed by the RSO to wait before initiating the Launch Readiness Poll Process, the LCO will stand by after completing Step 4 before continuing on to Step 5, otherwise the LCO will proceed without pausing.

5. *Announcing over Public Address and Giant Voice Systems the Launch Readiness Poll has begun, and for personnel in the Rocket Assembly and Spectator Area(s) to listen for further announcements on launch status while continuing to go about their business*
6. *Instructing the MCO over the long-range radio communication network to advise deployed rocket recovery teams on the status of launch preparations, as well as directing any teams requesting permission to return to instead maintain a safe distance from the Launch Area(s) until the upcoming salvo has concluded*
7. *Instructing the MCO over the long-range radio communication network to respond whether his/her position is "Go for Flight" once he/she verifies the launch commit criteria defined in Section 6.1.1 of this document are met*

The LCO will stand by while awaiting the MCO's positive response to Step 7, before proceeding to Step 8. During this time it is also expected the RSO will inform the LCO that preparations are complete, final launch pad evacuations are underway, and Red Flag conditions are now in effect in one or more Launch Area(s). At whatever time the LCO receives this notification from the RSO, he/she will: (1) *Instruct available members of the Launch Operations Team to raise Red Range Status Flags at the appropriate location(s)* and (2) *Announce over Public Address and Giant Voice Systems the location(s) where Red Flag Conditions are in effect, and for personnel in the Rocket Assembly and Spectator Area(s) to listen for further announcements on launch status while continuing to go about their business.*

If after receiving the MCO's positive response to Step 7, the LCO has yet to receive word from the RSO of Red Flag Conditions being in effect, the LCO will query the RSO on the status of launch preparations – reminding him/her to report when preparations are complete, final launch pad evacuations are underway, and Red Flag conditions are in

effect. (The LCO may consider announcing a status update over Public Address and Giant Voice Systems, and for personnel in the Rocket Assembly and Spectator Area(s) to listen for further announcements on launch status while continuing to go about their business.) The LCO will proceed to Step 8 only after being informed by the RSO that Red Flag conditions are in effect, and taking the appropriate actions defined above.

8. *Instructing the RSO over the long range radio communication network to respond whether his/her position is "Go for Flight" once he/she verifies the launch commit criteria defined in Section 6.1.2 of this document are met.*

The LCO will stand by while awaiting the RSO's positive response to Step 8, before proceeding to Step 9.

9. *Announcing over the long-range radio communication network to whether his/her own position is "Go for Flight" once he/she verifies the launch commit criteria defined in Section 6.1.3 of this document are met.*
10. *Announcing over Public Address and Giant Voice Systems the Launch Readiness Poll is complete, all positions are "Go For Flight", and for personnel in the Rocket Assembly and Spectator Area(s) to listen for the start of each flight's Final Countdown Procedure defined in Section 6.2 of this document – reminding these personnel that only during the verbal "five count" announcement is everyone on the range asked to stop what they're doing, and observe the flight. No need to move or go to a flight line, but you should be listening and heads up. If physically able, people should step outside of their tent so that they can see above them.*

### 6.1.1 DaVinci Mission ConTroL Officer's Launch Readiness Criteria

The MCO will verify the following launch commit criteria are met before responding to the LCO's request for launch readiness status with a "Go for Flight" message.

- *Receive positive confirmation over the long-range radio communications network that all deployed Recovery Teams are aware of impending flights and are at safe locations.*
- *Confirm ground level winds in the affected Launch Area(s) do not exceed 20 mph.*
- *Confirm no lightning is detected within ten miles of the range.*

### 6.1.2 Range Safety Officer's Launch Readiness Criteria

The RSO will verify the following launch commit criteria are met before responding to the LCO's request for launch readiness status with a "Go for Flight" message.

- *Confirm that all personnel in the affected Launch Area(s) who remained to make final launch preparations have now retreated to safe location(s).*
- *Confirm no hazardous weather conditions – other than the MCO's criteria – exist in the affected Launch Area(s)in accordance with the "Good Sense Rule", which permits the RSO to hold a launch at any time based on the instability of the weather.*

If a flight is deemed unsafe, the RSO has authority to stop preparations, hold a launch, or terminate a launch. A flight deemed unsafe must not be launched under any circumstances.

### 6.1.3 Launch control Officer's Launch Readiness Criteria

After receiving a "Go for Flight" status confirmation from both the MCO and the RSO, the will verify the following launch commit criteria are met before concluding the Launch Readiness Poll.

- *Receive positive confirmation over the long-range radio communications network that all Range Managers, and other authorized personnel under the LCO' control, are aware of impending flights and have retreated to safe locations.*
- *Confirm no unauthorized personnel are in the affected Launch Area(s).*

- *Confirm the sky is clear of aircraft.*
- *Confirm any cloud cover will not interfere with visual tracking of the rocket in accordance with the five tenths cloud cover rule, which advises against launching a rocket when more than five tenths of the expected trajectory will be blocked by clouds.*

### 6.2 Final countdown and Launch

Each flight in a salvo shall be preceded by a Final Countdown process. The LCO will initiate the Final Countdown process by taking the following actions.

1. *Verifying the associated Student Team's Launch Operation's Lead – whose name is recorded on the Flight Card – is present at the LCC to perform the physical act of launching the rocket.*
2. *Announcing over Public Address and Giant Voice Systems the rocket about to attempt flight, by reading the associated Team ID, Project Name, School Name(s), and Mission Description from the Flight Card (The LCO reserves the right to abbreviate the mission description at his/her discretion in the interest of time management.)*
3. *Re-verifying the launch commit criteria defined in Section 6.1.3 of this document are met*
4. *Verifying any previously launched rockets in the salvo no longer pose any safety hazards*
5. *Arming the Launch Control Unit and verifying continuity with the appropriate launch pad*
6. *Announcing over Public Address and Giant Voice Systems the flight attempt is imminent, and those able in the Rocket Assembly and Spectator Areas should stop what they're doing and observe the flight*
7. *Announcing over Public Address and Giant Voice Systems a countdown from "five" to "one"*
8. *Instructing the associated Student Team's Launch Operations Lead to enter the launch command into the Launch Control Unit*
9. *Monitoring the flight attempt until it no longer poses any safety hazards, and entering into launch scrub or mishap procedures – defined in Sections 6.3 and 6.4 of this document respectively – if necessary*
10. *Safe-ing the Launch Control Unit, and quickly completing the Post Flight Record's "LCO Description of Launch Attempt", located on the reverse side of the Flight Card (The LCO's "additional comments" should strive to include a rough bearing of the rockets impact location or last observed drift direction.)*

The LCO will repeat the Final Countdown process from Step 1 until each rocket in the salvo has either achieved ignition, scrubbed, or he/she terminates the salvo due to a contingency.

### 6.3 Launch Scrub

A launch "scrub" occurs when a particular rocket's ignition system fails to trigger the motor/engine start process (aka "misfire"), or any other circumstance(s) which prevent a rocket from attempting ignition without risking either of the following occurring:

- *Non-catastrophic mission failure:* A non-destructive event which prevents achieving one or more critical mission criteria (typically due to on-board consumable resources depletion) as determined by the flier
- *Catastrophic failure (CATO):* A destructive event (due to depletion of on-board consumables or an off-nominal configuration change occurring since the time of launcher erection) resulting rocket loss

Following any scrubbed flight attempt, the LCO may take any one of the following courses of action. The LCO may revise this guidance as needed for unique flight attempts, based either on his/her personal experience or using information recorded on the FSR Resolution Form's "instructions to the LCO".

- *Press:* Continuing the salvo without pause by starting the Final Countdown process, defined in Section 6.2 of this document, at Step 1 for the next flight attempt
- *Recycle:* Re-attempting ignition by pausing to re-verifying continuity with the appropriate launch pad and re-entering the Final Countdown process, defined in Section 6.2 of this document, at Step 7

- *Hold:* Implement as long as a two minute hold before continuing to “Press” – in order to eliminate the possibility of a "hangfire" being "mistaken" for a misfire (A "hangfire" describes an ignition attempt whose success is not immediately obvious due to a longer than anticipated delay preceding thrust generation and first-motion.)

After facilitating all remaining flight attempts in the salvo, the LCO may choose again whether to reattempt ignition of any "misfires" at his/her discretion. Each re-attempt shall be preceded by the complete Final Countdown process defined in Section 6.2 of this document. The LCO will only record a "Pad Abort" or any “Other” scrub event on the *Post Flight Record's* "LCO Description of Launch Attempt" once either the Launch Director, RSO, LCO, or Flier determine the rocket should be removed from the launcher and returned to the Rocket Assembly Area(s). The LCO will retain any *Consolidated Flight Card and Post Flight Record* which records a "Pad Abort" or any “Other” scrub event in a file located at the LCC, marked "Non-Events".

A Flier whose rocket returns to the Rocket Assembly Area(s) must begin the approval procedure defined in Section 4.0of this document over from the beginning; however, the FSR may be abbreviated in such situations at the Flight Safety Team's discretion.

### 6.4 Launch Mishap

A launch mishap occurs when a flight attempt results in a CATO event, or any other condition rendering it potentially unsafe to continue the salvo without pause. In the event a launch mishap occurs, it automatically triggers the start of a hold period lasting no less than two minutes, during which time the LCO and RSO will take the following actions. The RSO may revise this guidance as needed based on his/her past personal experience or observations on events unfolding in "real world".

1. *The LCO will safe the Launch Control Unit.*
2. *The RSO will begin using the resources at his/her disposal – to include Spaceport America Emergency Services Personnel – to assess the condition of the launch areas, and whether any unsafe conditions continue posing either hazards to personnel or risks to further flight attempts.*
3. *The RSO will provide initial guidance to the LCO over the long range radio communications network, updating later as needed. At a minimum this guidance should include the RSO’s anticipated hold duration, specifically whether this is more or less than two minutes.*
4. *The LCO will announce the start of the hold over Public Address and Giant voice Systems, and for personnel in the Rocket Assembly and Spectator Area(s) to listen for more information while resuming normal activity – reminding these personnel that only during the verbal "five count" announcement are those able asked to stop what they're doing, and observe the flight.*
5. *The LCO will instruct the MCO over the long-range radio communication network to advise deployed rocket recovery teams on the status of the mishap and any impacts it will have on their activities (if any).*
6. *The LCO will complete the Post Flight Record's "LCO Description of Launch Attempt", located on the reverse side of the Flight Card while awaiting further instructions from the RSO.*
7. *When he/she determines the affected launch Area(s) are secure, the RSO will instruct the LCO to resume the salvo in one of the following ways.*
    a. *If the hold has not exceeded five minutes, the LCO may resume the salvo by beginning at Step 1 of the Final Countdown Process defined in Section 6.2 of this document.*
    b. *If the hold has exceeded five minutes, the LCO should resume the salvo by starting at Step 7of the Launch Readiness Poll Process defined in Section 6.1 of this Document.*

Depending on available time, resources, and the overall severity/impact of the launch mishap the RSO should strive to collect additional records of the incident (e.g. photographic/video records, eyewitness accounts, physical evidence, etc.) which may benefit any subsequent investigation. The primary purpose of investigating mishaps is to

determine the cause, identify corrective actions and take preventative measures in future rocket launch operations. Removing and protecting personnel from danger shall always take priority over any investigative concerns.

## 7.0 Procedures for Rocket Recovery

The Flier, LCO, and MCO shall engage in the following processes facilitating the safe location and recovery of rockets after any flight attempt not resulting in a "Pad Abort", CATO, or any “Other” scrub event. In addition to promoting the safety of those participating in the search and recovery of the rocket, these processes also assure information relevant to scoring the IREC is recorded, and competitors receive all the credit they deserve for their flight attempt. Although they are not included in the formal process, either the Launch Director or RSO may command the interruption or termination of any recovery operations in progress for any reason.

### 7.1 Flight card Retrieval and Recovery Check-in

At the conclusion of the salvo during which the flight occurred a Mission Manager will retrieve from the LCO the documentation of all rockets not remaining in the Launch Area for re-attempt in the next salvo, and bring them to a designated Mission Control Center (MCC).The LCO will instruct the Fliers of these rockets to report to MCC with the team members who will participate in the recovery operation.

The number of individuals permitted on a recovery team is no less than two and no more than four per 100 lbs (~45 kg) of equipment being recovered. In situations where multiple, independent elements are being recovered separately (e.g. booster stages or deployable payloads) the Mission Managers may require a separate team be formed to recover each element, or for multiple excursions to be made. The Mission Managers will append one or more *Continuation Sheets* to the Flier's document set to facilitate multiple teams being formed or multiple excursions. The Flier may request a modification to these general provisions from the MCO based on their unique situation. In the event the MCO refuses such a request, the Flier may make a one-time only appeal to the Launch Director. The Launch Director's decision, once made, is final and supersedes all others.

1. *Upon arriving at the MCC, the Flier will be given their documentation to fill out the "Recovery Personnel Information" and "Measured Apogee as reported by telemetric data (if available)" on the Post Flight Record.*
2. *Once all individuals in the recovery team are present at the MCC, the Mission Manager will verify the completeness of the Post Flight Record with the team members and queue the team for the next available Communications & Tracking Pack. (The recovery team members are asked to remain at the MCC while waiting for authorization to depart.)*
3. *Once issued, the Mission Managers will record the Communication & Tracking Pack's "Radio #" and "Issued Condition" on the Post Flight Record's "Radio Information".*
4. *When authorized to depart, the Mission Managers will record and initial the team's departure time on the Post Flight Record's "Acknowledgement of Recovery Team Departure". The MCO will also convey any possibly useful information on the rocket's location collected by launch organizers.*

No Flier will be permitted to depart the Launch Site – including all areas under the direct supervision of launch organizers – in search of their rocket without the MCO's authorization. Furthermore, no individual will be permitted to engage in recovery operations without proper attire defined in Section 8.8 of this document. Similarly, no recovery team will be granted authorization to depart with carrying a water supply based on guidance recorded in Section 8.7 of this document.

### 7.2 Departure from the MCC and General Communications

Shortly after departing from the MCC, the recovery team will make an initial radio call to the MCO to verify the Communications & Tracking Pack is functioning properly. The MCO will respond that both communications and

tracking features are functioning nominally, otherwise the team is required to return to the MCC. Every radio call to the MCC shall include the following information.

- *Unique Identification:* The calling team's issued Communication & Tracking Pack's "Radio #"
- *Walk Direction:* The calling team's current direction of travel using eight-point cardinal coordinates (The MCO will assist the team in orienting themselves prior to their departure from the MCC.)
- *Health & Status:* Any other comments relevant to the team's progress and capacity to proceed

Every 15 minutes, or as requested by the MCO, the recovery team shall initiate a radio call to the MCO with the above information. Any failure to do so may be interpreted by the MCO as an emergency, who may deploy Spaceport America Emergency Services Personnel to the team's last reported location and compel their return.

The recovery team is under the MCO's control the entire time they are engaged in recovery operations and shall comply with all his/her instructions. Failure to do so may be interpreted by the MCO as an emergency, who may deploy Spaceport America Emergency Services Personnel to the team's last reported location and compel their return.

### 7.3 Emergency communications

If an emergency occurs at any time, the affected team shall initiate a radio call to the MCO immediately – beginning with the words "BREAK - BREAK - BREAK" and followed by the following information.

- *Unique Identification:* The calling team's issued Communication & Tracking Pack's "Radio #"
- *Estimated Bearing:* The calling team's estimated bearing relative to the MCC using eight-point cardinal coordinates (The MCO will assist the team in orienting themselves prior to their departure from the MCC.)
- *Nature of the Emergency:* A summary of the team's situation to assist first responders (If the situation makes it unsafe for the team to return from their current location, the MCO may deploy Spaceport America Emergency Services Personnel.)

### 7.4 Returning to the MCC And Post Flight Processing

The recovery team shall return directly to the MCC either after locating their rocket, or after being compelled to return by the MCO.

1. *Once the recovery team locates the rocket, they shall initiate a regular radio call to the MCO as described in Section 7.2 of this document.*
2. *Once the recovery team has secured the rocket and is ready to return to the MCC, they shall initiate a regular radio call to the MCO as described in Section 7.2of this document.*
3. *The recovery team will continue to make the regular 15-minute check-in calls described in Section 7.2of this document as they make their way back to the MCC.*
4. *Upon arriving at the MCC the Recovery Team will return the Communication & Tracking Pack and present their rocket for post-flight evaluation.*
5. *A Mission Manager will record and initial the team's return time on the Post Flight Record's "Acknowledgement of Recovery Team Return", as well as note the condition of the Communication & Tracking Pack's condition.*
6. *With the team's assistance, the Mission Manager will record the "Measured Apogee as reported by the on-board official altitude logging system" (if available). (Booster stage apogees are not used in IREC scoring but may be optionally recorded as "additional comments".)*
7. *A Mission Manager will make a determination on whether or not the rocket is "excessively damaged" in accordance with Section 2.7.14 and Appendix A of the IREC Rules & Requirements Document and make any "additional comments" they believe pertinent to the post flight record. (The Flier may dispute the*

*Mission Manager's determination by making a one-time only appeal to the Head Judge. The Head Judge's decision, once made, is final and supersedes all others.*

8. *Once the recovery team and the Mission Manager agree all information has been recorded, the team may depart, while the MCO maintains custody of the stapled document set.*

If the recovery team was unable to locate the rocket on the first attempt, the MCO may append one or more *Continuation Sheets* to the Flier's document set to log subsequent attempts.

## 8.0 General Provisions for Operating on Spaceport America Property

The following sections overview a combination of required codes of conduct, through which participants retain the privilege of being authorized access to the Spaceport during the Launch, and best practices intended to promote the safety of those individuals possibly unfamiliar with living and working in a high-desert environment.

### 8.1 Items and Individuals Prohibited on Spaceport America Property

The possession of weapons, open or concealed, is prohibited within the Spaceport. Although smoking is normally permitted within designated areas, these designated smoking areas may be closed during New Mexico State Forestry Division directed "burn bans". All alcoholic beverages are prohibited, and any open container will result in the person's immediate removal from the Spaceport. Participants are permitted to use only gas grills – not charcoal – for cooking. Animals other than official service animals are prohibited. Finally, children under the age of six are discouraged from attending events on the Spaceport due to potentially harsh conditions and rough terrain.

### 8.2 Bathroom facilities and Trash Disposal on Spaceport America Property

SA Cup participants may not camp onsite at the Spaceport America, Vertical Launch Area (VLA) Chemical latrine facilities (aka “porta-potties”) sufficient for roughly 2,000 attendees will be provided and serviced every day. All attendees are responsible for preventing littering. All trash will be disposed of in provided waste receptacles or bagged by the participants themselves, and disposed of at the Spaceport’s Common Trash Disposal Facility.

### 8.3 Vehicle use on Spaceport America Property

Spaceport America Cup participants are permitted to use all classes of vehicle on designated roads, trails, and aprons, as well as designated parking, camping, observation, and rocket assembly areas. This includes vehicle use to access the designated launch area(s). Furthermore, limited use of all-terrain-vehicles (ATV), “quad-bikes”, “4-wheelers” and similar may be implemented for recovery operations off designated roads and trails with the permission of launch organizers. This permission will be granted on a case by case basis at the launch itself. No vehicle may operate in excess of 30 mph while on the Spaceport, and should not exceed 5 mph when in close proximity to personnel or their equipment. Persons found to be operating vehicles in an unsafe manner will have their on-site vehicle use privileges revoked, and may be subjected to immediate removal from the Spaceport, depending on the frequency and severity of infraction.

### 8.4 Cellular Communications

While on the Spaceport, participants at the Spaceport America Cup should plan on experiencing degraded cellular telephone network reception – or none at all. Participants are highly encouraged to bring their own handheld radios to coordinate their operations. Similarly, participants are highly encouraged to bring their own portable FM radios, which will receive general announcements broadcast over the Public Address System in addition to the Giant Voice speakers.

### 8.5 Radio Frequency Management

There is no comprehensive frequency management plan at the SA Cup; however, two or three Family Radio Service (FRS) and Amateur Radio Service (HAM) Channels will be reserved for use by launch organizers to coordinate

operations and make announcements over the Giant Voice System. These Channels will be announced at the event and posted on a public bulletin board (e.g. whiteboard) outside a designated MCC. Student Teams should de-conflict each other's operations by using the public bulletin board to post the frequencies being used by their personnel as well as their project hardware – also including their Team ID, campsite location, and any other means by which other Student Teams may contact them. Participants using spectrum reserved for the General Mobile Radio Service (GMRS) or HAM should hold appropriate licenses – as applicable – to broadcast on these frequencies.

### 8.6 Wildlife Encounters

The Southern New Mexico desert is home to a diverse and exotic wildlife population. While many of these creatures are mostly harmless, others – most notably rattlesnakes – can pose a noteworthy risk to humans if not treated with the proper respect. Although the commotion of human activity will tend to drive these creatures away, and it is unlikely any given attendee will encounter one, there are non-zero odds of potentially hazardous wildlife being sighted during the launch. Attendees are required to give such creatures a wide berth.

### 8.7 Extreme Temperature

June temperatures in the Southern New Mexico desert average roughly 95° F, and maximum daily temperatures during the launch will regularly exceed 100° F. The Occupational Health and Safety Administration (OSHA) recommends workers in such conditions drink water at a rate no less than 32 oz per person per hour (a total of 3-4 gal per person per day). Any attendee who observes another individual exhibiting signs of heat exhaustion, or feels such symptoms him/herself, shall report this to on-site medical staff immediately. Although on-site medical personnel will never refuse a request for drinking water, all attendees are required to provide their own potable water supply which meets or exceeds OSHA recommendations.

### 8.8 Recommended and Required Dress

Fliers will dress appropriately for the harsh desert environment – including sun exposure, terrain, and wildlife – by using the following guidance.

- Although daytime in the desert is extremely hot, the temperature may drop as low as roughly 65° F at night. Fliers planning on remaining at the launch site after the sun sets should prepare for this.
- Fliers should protect themselves from sunburn with at least SPF 50 sunscreen, reapplied regularly as directed by the manufacturer.
- Fliers should protect themselves from eye damage due to sun exposure with UV protection sunglasses.
- Fliers should further protect themselves from sunburn and eye damage due to sun exposure with either a wide brimmed or neck shade hat.
- Fliers should protect themselves from thorny desert plant life by wearing long pants with tall socks. Long pants are required dress code for personnel engaged in rocket recovery. (Note: Low humidity in the desert will prevent sweating discomfort.)
- Fliers are required to wear closed toe footwear – which may include closed toe sandals – at all times in the Rocket Assembly and Launch Area(s), as well as while engaged in rocket recovery. Furthermore, personnel engaged in rocket recovery are strongly encouraged – but not required – to wear true hiking boots/shoes. No individual wearing open toe sandals will be permitted to engage in rocket recovery.

## 9.0 Unmanned Aerial System policy

This section pertains to unmanned aerial systems (UAS; aka drone, quadcopter, multi-copter, unmanned aerial vehicle; UAV; radio-controlled airplane or helicopter, etc.) **other than those deployed by rocket flights** at the SA Cup. The latter are considered payloads, and not subject to the contents of this section.

UAS not deployed by rocket flights at the SA Cup (typically flown for the purpose of launch photography/videography, or to assist recovery operations) will adhere to the following rules. The launch organizers reserve the right to deny or terminate the operations of any UAS at any time, if the planned operations or conduct of the operator run counter to the overall goal of promoting flight safety.

Any UAS flight must be covered by at least $1 million general liability insurance (personal injury, death and property damage). This policy must be specific to the drone flight and not included in homeowners or general insurance type policies. Proof of this insurance must be presented to ESRA during registration on Monday, June 19th.

- The UAS shall weigh no more than 55 lb.
- FAA Part 107 licensing requirements are not required as long as the flight is not being performed by a professional drone operator collecting paid for video coverage (such as a media company or similar).
- The UAS shall not be flown over 400 ft above ground level (AGL).
- The UAS shall not be flown outside the event flight waivers without individual flight approvals from Spaceport America.
- UAS operators using first-person-view (FPV) must have a spotter next to them during the entire flight.
- The UAS shall not be flown over any crowd, designated rocket assembly area, or launch area(s), Please refer to the map in Appendix C as the keep out area.
- The UAS shall be launched from the designated ESRA Drone launch pad area. This will ensure that it is away from the crowds and from a location such that a “return-to-home-point” feature will not carry the UAS over any of the aforementioned areas.
- The UAS pilot shall submit for approval in person his/her flight plan(s) to the Launch Director (or his/her delegate) prior to conducting their first flight.
- The UAS pilot’s location while flying within 20 feet of the ESRA Drone launch pad area. This area will be around the ESRA OPS shipping containers.
- The UAS flight operations shall not interfere with rocket launch operations.

- **Appendix A: Acronyms, Abbreviations, and Terms**

| ACRONYMS & ABBREVIATIONS | |
|---|---|
| **AGL** | Above Ground Level |
| **AIAA** | American Institute of Aeronautics and Astronautics |
| **APCP** | Ammonium Perchlorate Composite Propellant |
| **APRS** | Automatic Packet Reporting System |
| **ATV** | All-terrain Vehicle |
| **C2** | Command & Control |
| **CATO** | Catastrophic [Failure] |
| **CFR** | Code of Federal Regulations |
| **CG** | Center of Gravity |
| **CONOPS** | Concept of Operations |
| **COTS** | Commercial Off-the-Shelf |
| **CP** | Center of [Aerodynamic] Pressure |
| **EMS** | Emergency Medical Services |
| **ESRA** | Experimental Sounding Rocket Association |
| **FAA** | Federal Aviation Administration |
| **FRS** | Family Radio Service |
| **FSR** | Flight Safety Review |
| **GMRS** | General Mobile Radio Service |
| **GPS** | Global Positioning System |
| **HAM** | Amateur Radio Service |
| **HPR** | High Power Rocket *or* Rocketry |
| **HTP** | High-test Peroxide |
| **IREC** | Intercollegiate Rocket Engineering Competition |
| **ITAR** | International Traffic in Arms Regulations |
| **LCC** | Launch Control Center |

| | |
|---|---|
| **LCO** | Launch Control Officer |
| **LOX** | Liquid Oxygen |
| **MCC** | Davinci Mission Control Center |
| **MCO** | Davinci Mission Control Officer |
| **N2O** | Nitrous Oxide |
| **NAR** | National Association of Rocketry |
| **OSHA** | Occupational Safety and Heal Administration |
| **PII** | Personally Identifiable Information |
| **PPE** | Personal Protective Equipment |
| **RSO** | Range Safety Officer |
| **RV** | Recreational Vehicle |
| **SA Cup** | Spaceport America Cup |
| **SDL** | Space Dynamics Laboratory |
| **SRAD** | Student Researched & Developed |
| **STEM** | Science, Technology, Engineering, and Mathematics |
| **TBD** | To Be Determined |
| **TBR** | To Be Resolved |
| **TRA** | Tripoli Rocketry Association |
| **UAS** | Unmanned Aerial System |
| **VLA** | Vertical Launch Area |
| **WSMR** | White Sands Missile Range |

| TERMS | |
|---|---|
| **Amateur Rocket** | 14 CFR, Part 1, 1.1 defines an amateur rocket as an unmanned rocket that is "propelled by a motor, or motors having a combined total impulse of 889,600 Newton-seconds (200,000 pound-seconds) or less, and cannot reach an altitude greater than 150 kilometers (93.2 statute miles) above the earth's surface". |
| **Critical [FSR] Issues** | These issues pose major operational and/or flight safety concerns, the correction of which may be difficult and time consuming. A Flier whose FSR Resolution Form lists any "critical" issues may only request re-inspection from a member of the Flight Safety Team. |
| **Excessive Damage** | Excessive damage is defined as any damage to the point that, if the systems intended consumables were replenished, it could not be launched again safely. Intended Consumables refers to those items which are - within reason - expected to be serviced/replaced following a nominal mission (eg propellants, pressurizing gasses, energetic devices), and may be extended to include replacement of damaged fins specifically designed for easy, rapid replacement. |
| **Minor [FSR] Issues** | These issues are easily remedied with quick fixes, which mitigate any associated flight safety concerns the issue had caused. A Flier whose FSR Resolution Form lists only "minor" issues may request re-inspection from either a member of the Flight Safety Team or the Launch Operations Team. |
| **FAA Class 2 Amateur Rocket** | 14 CFR, Part 101, Subpart C, 101.22 defines a Class 2 Amateur Rocket (aka High Power Rocket) as "an amateur rocket other than a model rocket that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less." |
| **Non-toxic Propellants** | For the purposes of the Spaceport America Cup: IREC, the event organizers consider ammonium perchlorate composite propellant (APCP), potassium nitrate and sugar (aka "rocket candy"), nitrous oxide, liquid oxygen (LOX), hydrogen peroxide, kerosene, propane and similar, as non-toxic propellants. Toxic propellants are defined as requiring breathing apparatus, special storage and transport infrastructure, extensive personal protective equipment, etc. |

- **APPENDIX B: FLIGHT SAFETY REVIEW OVERVIEW**

Introduction

Before any Flier may request an LCO Inspection to receive a Flight Card, both the rocket and the Flier must pass a preliminary FSR. The FSR shall only be performed by a member of the Flight Safety Team – consisting of the RSO and his/her appointed Flight Safety Manager(s).

In addition to checking for overall compliance with the *IREC Design Test & Evaluation Guide* – or for proof of design, analysis, testing and/or safety mitigations in instances of deviation from the guide – the FSR considers the rocket's general implementation of best practices and safety guidelines in the areas of rocket structures, payloads, propulsion, flight profiles, and recovery systems. Ultimately, the Flight Safety Review ensures acceptable risks are understood and within reasonable limits.

The Flight Safety Team will nominally complete all FSRs during the Poster Session held throughout the SA Cup Conference day. Any FSRs not completed by the end of the Poster Session will be completed the following day, during launch preparations in the Rocket Assembly Area(s). Upon completion of the FSR the inspector will make a flight readiness status decision of either "nominal", "denied", or "provisional" in accordance with the definitions recorded in Section 1.3 of the *IREC Design Test & Evaluation Guide.* This decision will be recorded on the 3-part (i.e. 3-carbon-copies) FSR Resolution Form. The inspector will provide one copy to the Flier and retain the other two for official record keeping. If the Flier loses their copy of the FSR Resolution Form during the SA Cup, they may request one of the two extra copies from the Flight Safety Team.

- *Nominal:* If the inspector determines the proposed rocket flight is "nominal", he/she will complete the FSR Resolution Form appropriately and initial both its "determination" and "resolution". At this point, the FSR is considered "resolved", and the Flier may continue launch preparations.
- *Provisional:* If the inspector determines the proposed rocket flight may proceed on a "provisional" basis once the Flier corrects one or more issues, he/or she will complete the FSR Resolution Form by listing these issues and categorizing each as either "minor" or "critical". The inspector may also list amended launch condition criteria (e.g. reduced launch elevation or lower permissible ground wind speed) for the Launch Operations Team to implement on this flight attempt. The inspector will only initial the FSR Resolution Form's "determination". The FSR Resolution form shall not be initialed as "resolved", and (if an IREC competitor) the Flier will be considered temporarily disqualified, until all listed issues have been corrected. "Minor" and "critical" issues are defined as follows.
    - *Minor:* These issues are easily remedied with quick fixes, which mitigate any associated flight safety concerns the issue had caused. A Flier whose FSR Resolution Form lists only "minor" issues may request re-inspection from either a member of the Flight Safety Team or the Launch Operations Team.
    - *Critical:* These issues pose major operational and/or flight safety concerns, the correction of which may be difficult and time consuming. A Flier whose FSR Resolution Form lists any "critical" issues may only request re-inspection from a member of the Flight Safety Team.
- *Denied:* If the inspector determines the proposed rocket flight is "denied" based on unacceptable risks, which the Flier stands no reasonable chance of correcting within the time and resource constraints available, he/she will complete the FSR Resolution Form with the rationale for "grounding" and initial both its "determination" and "resolution". At this point, the FSR is considered "resolved", and (if an IREC competitor) the Flier is disqualified. The Flier will make no further launch preparations.

Stability Characteristics

The rocket shall demonstrate overall compliance with the spirit and intent of the *IREC Design Test & Evaluation Guide* – or for proof of design, analysis, testing and/or safety mitigations in instances of deviation from the guide –

guidance pertaining to rocket stability. Similarly, the Flier shall demonstrate a reasonable degree of competence in generally accepted best practices and safety guidelines pertaining to rocket stability.

The following are examples of topics an inspector is almost certain to inquire about during a typical FSR. They are designed to supplement and reinforce guidance recorded in the *IREC Design Test & Evaluation Guide*, and should not be considered comprehensive. There are absolutely no limitations on the depth and breadth of inquiry an inspector may make during an FSR.

- *Flight Simulation:* Upon request, the flier can either provide a hard copy, or demonstrate on a portable computer, a 3-degree-of-freedom (3DoF) simulation (or better) of the rocket's nominal trajectory.
- *Thrust Profile:* The propulsion system provides adequate thrust to assure the rocket achieves stability by the time it leaves the intended launcher.
- *Fin Alignment:* The fins mounted parallel to the roll axis of the rocket, or (if canted or otherwise roll inducing) the Flier demonstrate cognizance of the predicted roll behavior and its effects.
- *Static Margin:* The overall design achieves the required 1.5 calibers of stability or greater.
- *CG/CP Location and Movement:* Upon request, the Flier can identify the location of the rockets center of gravity (CG) and center of pressure (CP) at various phases of flight – demonstrating cognizance of anticipated CG shifting due to consumables depletion (e.g. propellant consumption) and CP shifting due to wave drag effects.
- *Test Criteria:* The Flier has met or demonstrated obviation of all stability related testing or simulation recorded in the *IREC Design Test & Evaluation Guide.*

The remaining examples are relevant to multi-stage rocket propulsion systems.

- *CG/CP Location Before and After Staging:* Upon request, the Flier can identify the location of the rocket's center of gravity (CG) and center of pressure (CP) at various phases of flight – demonstrating cognizance of anticipated CG and CP changes due to each staging event.
- *Staging Event Sequence and Timing:* Any delays implemented between staging events are not so long as to significantly risk the rocket having "arced-over" into an unsafe orientation – typically by "gravity turn".

<u>Construction Techniques</u>

The rocket shall demonstrate overall compliance with the spirit and intent of the *IREC Design Test & Evaluation Guide* – or for proof of design, analysis, testing and/or safety mitigations in instances of deviation from the guide – guidance pertaining to rocket construction and mechanical design. Similarly, the Flier shall demonstrate a reasonable degree of competence in generally accepted best practices and safety guidelines pertaining to rocket construction and mechanical design.

The following are examples of topics an inspector is almost certain to inquire about during a typical FSR. They are designed to supplement and reinforce guidance recorded in the *IREC Design Test & Evaluation Guide*, and should not be considered comprehensive. There are absolutely no limitations on the depth and breadth of inquiry an inspector may make during an FSR.

- *Checklist:* Upon request, the flier can provide the inspector with hardcopy checklist procedures for the rocket's assembly and integration for flight – including self-inspection/verification steps which make individual team members accountable to one another for having completed the preceding process(s).
- *Column loading:* The "motor mount" is capable of transferring the anticipated thrust loads to the rest of the rocket structure, and the overall rocket is capable of withstanding these loads.
- *Slip-fit Joints*: Joints intended to separate in flight do not become separated when loaded by their own weight alone, and the Flier demonstrates cognizance of shear pin design (if implemented).
- *Joint Stiffness:* All joints – both separating and non-separating in flight – are "stiff", so as to eliminate any visible airframe bending.

- *Rail Guide Type:* Any Rocket designed for integration with ESRA provided launch rails implements rail guides compatible with 1515 80/20 rail.
- *Rail Guide Attachment:* The rail guides are firmly attached to the rocket without evidence of cracking in the joints, and the aft most rail guide attachment is sufficient to bear the rocket's entire mass when erected.
- *Fin Attachment:* The fins are firmly attached to the rocket without evidence of cracking in the joints. ("Hairline" cracks may be acceptable if the fins are not at all loose or, if the fins are mounted using the "through-the-wall" [TTW] construction technique.)
- *Fin Stiffness:* The fins exhibit no shifting and minimal deflection (ie bending) when handled.
- *Fin "Warp-age":* The fins exhibit little-to-no indication of damage due to moisture penetration or excessive thermal cycling during storage or transport – leading to out of tolerance dimensional changes in the part.
- *Adequate venting:* Airframe compartments not specifically designed to pressurize during flight implement an adequately sized vent hole to relieve altitude induced pressurization.
- *Test Criteria:* The Flier has met or demonstrated obviation of all construction and mechanical design related testing, or simulation recorded in the *IREC Design Test & Evaluation Guide.*

Propulsion Systems

The rocket shall demonstrate overall compliance with the spirit and intent of the *IREC Design Test & Evaluation Guide* – or for proof of design, analysis, testing and/or safety mitigations in instances of deviation from the guide – guidance pertaining to rocket propulsion system(s) design and implementation. Similarly, the Flier shall demonstrate a reasonable degree of competence in generally accepted best practices and safety guidelines pertaining to rocket propulsion system(s) design and implementation.

The following are examples of topics an inspector is almost certain to inquire about during a typical FSR. They are designed to supplement and reinforce guidance recorded in the *IREC Design Test & Evaluation Guide*, and should not be considered comprehensive. There are absolutely no limitations on the depth and breadth of inquiry an inspector may make during an FSR.

- *Checklist:* Upon request, the flier can provide the inspector with hardcopy checklist procedures for the propulsion system's safe handling, assembly, disassembly, and operation (both nominal and off-nominal/contingency flows) – including self-inspection/verification steps which make individual team members accountable to one another for having completed the preceding process(s).
- *Pre-flight and Countdown Procedure:* Upon request, the flier can provide the inspector with hardcopy checklist procedures for any of the propulsion system's unique final on-pad preparations, pre-flight, and launch (both nominal and off-nominal/abort/mishap flows) – including self-inspection/verification steps which make individual team members accountable to one another for having completed the preceding process(s).
- *Total Impulse:* The sum of all rocket stages' impulse either does not exceed 9,208 pound-seconds (40,960 Newton-seconds), or the Flier previously consulted with ESRA on provisions for launching a larger rocket.
- *Motor retention:* The design provides for positive retention of the propulsion system within the airframe – leaving no possibility for the propulsion system to shift from its retaining device(s) and jettison itself.
- *Thrust Structure:* A "structural chain" exists that transfers the propulsion system thrust to various points on the rocket structure and is capable of withstanding these loads.
- *Thrust Curve:* Upon request, the flier can provide the inspector with hardcopy thrust curve data for each individual rocket motor or engine implemented.
- *Test Criteria:* The Flier has met or demonstrated obviation of all construction and mechanical design related testing, or simulation recorded in the *IREC Design Test & Evaluation Guide.*

The remaining examples are relevant to multi-stage rocket propulsion systems.

- *Stage Safing and Arming:* The electronics controlling the various staging events will only be armed once the rocket is erected on the launcher. These same electronics can and will be disarmed prior to lowering the launcher, if the rocket must be removed from the launch pad.
- *Stage Ignition Commit Criteria:* The electronics controlling the various staging events inhibit staging if the rocket's flight profile deviates from predicted nominal behavior.
- *Positive State Indication:* Each independent set of electronics controlling staging events provides a sensory (i.e., visual or auditory) indication of its activation.
- *Special Consideration for "Drag Separation":* The electronics controlling stage ignition in design's implementing "drag-separation" are not located in the separating stage – where premature separation could prevent ignition of the following stage.

Recovery Systems

The rocket shall demonstrate overall compliance with the spirit and intent of the *IREC Design Test & Evaluation Guide* – or for proof of design, analysis, testing and/or safety mitigations in instances of deviation from the guide – guidance pertaining to rocket recovery system(s) design and implementation. Similarly, the Flier shall demonstrate a reasonable degree of competence in generally accepted best practices and safety guidelines pertaining to rocket recovery system(s) design and implementation.

The following are examples of topics an inspector is almost certain to inquire about during a typical FSR. They are designed to supplement and reinforce guidance recorded in the *IREC Design Test & Evaluation Guide* and should not be considered comprehensive. There are absolutely no limitations on the depth and breadth of inquiry an inspector may make during an FSR.

- *Checklist:* Upon request, the flier can provide the inspector with hardcopy checklist procedures for the recovery system's safe handling, assembly, disassembly, and operation (both nominal and off-nominal/contingency flows) – including self-inspection/verification steps which make individual team members accountable to one another for having completed the preceding process(s).
- *Pre-flight and Countdown Procedure:* Upon request, the flier can provide the inspector with hardcopy checklist procedures for any of the recovery system's unique final on-pad preparations, pre-flight, and launch (both nominal and off-nominal/abort/mishap flows) – including self-inspection/verification steps which make individual team members accountable to one another for having completed the preceding process(s).
- *Inspect for Damage:* If previously flown, any used parachutes, shock chords, and suspension lines exhibit no signs of damage which threatens the safe recovery of this rocket.
- *Parachutes and Parafoils:* Any parachutes or parafoils used are rated for the weight of the vehicle and the expected conditions at deployment,
- *Safe Descent Rate:* Parachutes or parafoils intended for the final descent phase to the ground do not allow a decent rate that would represent a safety hazard.
- *Mechanical Attachment:* Shock chords are securely affixed to the rocket structure at sufficiently reinforced locations using hardware of appropriate size/rating for anticipated loads, and any knots will not loosen/slip.
- *Threaded Attachments:* The design implements means for preventing thread walking, stripping, or tear-out.
- *Personnel Safety:* The arming/disarming process does not place the operator in the predicted path of any hot gases, ejecta, or deployable devices which might result from an unintentional triggering event.
- *Activation devices:* The electronics controlling recovery events are activated by externally accessible switches, and do not require any disassembly of the rocket to either activate or deactivate.
- *Positive State Indication:* Each independent set of electronics controlling recovery events provides a sensory (i.e. visual or auditory) indication of its activation.
- *Hot Gas Management:* If applicable, adequate protection is provided to prevent any hot ejection gasses from damaging retaining cords, parachutes, and other vital components.

- *Acceleration Effects on Electronics:* Heavy items – most notably batteries – are adequately supported to prevent them becoming dislodged under anticipated flight loads.

## Conclusion

The Flight Safety Team, acting under the RSO's direction, reserves the right to reduce any determination (e.g. from "nominal" to "provisional", or from "provisional" to "denied") based on real-world events, observations, and interactions during the SA Cup. In the event such a reduction is made, the notifying official will generate a new FSR Resolution form and destroy the Flier's original.

A Flier may whose flight status is "denied" may choose to appeal this determination one time only to the RSO – provided the RSO him/herself was not the original inspector. The RSO's decision, once made, is final and supersedes all others. In the event the RSO chooses to overturn the original inspector's determination, he/she will generate a new FSR Resolution form and destroy the Flier's original.

## Source Material

The *Flight Safety Review Overview* is not an original work. It summarizes best practices recorded in the *TRA Safety Code*. Furthermore, it should be considered as incorporating the *IREC Design, Test, & Evaluation Guide* in its entirety. Users of the *Flight Safety Review* Overview should do so in combination with the *IREC Design, Test, & Evaluation Guide*, whose entire contents constitute inspect-able criteria and possible grounds for unfavorable FSR determinations.

- **APPENDIX C: LAUNCH SITE LAYOUT**