Preface

The following RSO Guidelines are not meant to add to, subtract from, or supercede any of the Tripoli Safety Codes. This document is meant only to be a guide to help persons in the position of Range Safety Officer to perform a thorough inspection and promote safe practices.

INTRODUCTION

The goal of the Range Safety Officer (RSO) is to minimize the risks to personnel and property involved in the handling, preparation, and launch operations of model and high power rocket launches.

The flight safety goals are to review the intended flight of all vehicles, and attempt to prevent any incidents that might endanger human life, cause damage to property, or result in embarrassment to Tripoli and rocketry at large. Although the risk of such an incident can never be completely eliminated, the flight should be carefully reviewed to minimize the risks involved while enhancing the probability for attaining a successful launch.

The RSO is responsible for assuring that the Tripoli safety policy and RSO procedures are not violated during operations and to ensure that acceptable risks are understood and are within reasonable limits.

The Flight Safety Review is to be performed by a Range Safety Officer prior to any launch at a sanctioned Tripoli event. This review assesses the quantitative and qualitative aspects of the proposed vehicle flight. 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.

Safety is the responsibility of all Tripoli Rocketry Association members. This idea must be instilled into all flyers and exemplified by Range Safety Officers. A concerted effort by all persons involved will minimize the risks inherent in performing rocket related activities.

RSO REQUIREMENTS

The RSO must be a current member of Tripoli Rocketry Association in good standings, certified level two or above, experienced in high power rocketry, and knowledgeable about rocket theory, hobby rocket motors and the high power rocketry safety regulations (Tripoli Safety Code, NFPA 1127, etc.).

The RSO should be familiar with the FAA Certificate of Waiver holder and must be approved to act on that persons behalf in the RSO capacity. Any discrepancies regarding the Range or Flight Operations should be brought to the attention of the Waiver Holder who will have the final decision making authority.

RSO PROCEDURES

CARDINAL PRINCIPLE: Limit the exposure to hazardous situations to a minimum number of persons for a minimum time, consistent with safe and efficient operations.

The RSO shall carry out the Cardinal Principle through their monitoring and execution of the Range Operations and Flight Operations outlined below. The FAA Certificate of Waiver holder, who has the ultimate authority to stop any or all launches, should address any questions or concerns.

Large Launch Provision

Should the size and scope of a particular launch be greater than the abilities of a single RSO to perform both the Range Operations and Flight Operations, these duties may be split amongst several persons. A single individual that is assigned Range Operations will be responsible for all of the duties that fall thereunder and should be the waiver holder if possible. This person will then be known as the Launch Safety Officer (LSO). Accordingly, an RSO or group of RSO's shall be assigned Flight Operations. They will be responsible for all of the duties that fall thereunder.

Range Operations

The RSO/LSO is responsible for determining the status of range operations. Before any launch begins, or in the event of a breech, the following criteria must be assessed. If not met, it is up to the RSO/LSO to halt any further launches until a safe condition is returned.

Site

The RSO shall make a cursory examination of the Range area to ensure that adequate barriers, markings, and safety measures exist to prevent unauthorized person from entering into the range and alert authorized person as to any hazardous situations.

The RSO shall make themselves aware of the largest motor that can be supported by the site area given the table in the High Power Rocketry Safety Code.

The RSO has the authority to open and close the range to any and all personnel

Airspace

Where applicable (i.e. when entering controlled airspace):

1. The RSO must have knowledge that a current Certificate of Waiver issued by the U.S. Department of Transportation is in force and applies to the sections of the Federal Aviation Regulations that will be bypassed.
2. The RSO should have knowledge of the Special Provisions of the Certificate of Waiver and that they are being adhered to.
3. The RSO must have knowledge that a Notice to Airman has been issued for the date and times of the launch.
4. The RSO must not allow launches when aircraft are within a three-mile radius of the projected flight path.

Weather

The RSO must have clear and convincing evidence that the following constraints are not violated.

1. Do not launch if ground level winds exceed 20 mph.
2. Do not launch if the planned flight path will carry the vehicle through any clouds
3. Do not launch if any type of lightning is detected within 10 miles of the launch site

Time Interval Determination Method

· Visual conformation of lightning flash

· Count number of seconds until you hear thunder

· Divide the result by five (5)

· Result is in miles

GOOD SENSE RULE: Even when constraints are not violated, if any other hazardous weather conditions exist, the RSO may hold at any time based on the instability of the weather.

Launch Systems

The RSO shall familiarize themselves with the types of launch pads available ensuring that they do not approve any flight for which there isn't a sufficient pad.

The RSO shall make a cursory examination of the Range area to ensure that the pads available have been placed appropriately according to the Safety Code.

The RSO should become familiar with the launch control systems and ensure that sufficient safety interlocks are in place to prevent accidental ignitions.

Emergency

The RSO shall confirm that adequate safety equipment is on site including a portable fire extinguisher, first aid kit, and cellular communications.

The RSO shall have available to them contact number for local fire departments, police, emergency medical, and power authority personnel.

Flight Operations

The RSO is to perform a Flight Safety Review (FSR) of all rockets intended for launch. Upon completion of the FSR the RSO will make a flight readiness decision. If the flight is approved this

should be indicated by the RSO initialing the flight card. If minor modifications will bring the rocket to flight ready status the flyer should be informed of the required modifications and asked to return only after taking appropriate corrective actions. If a situation arises that the RSO is unfamiliar with and/or feels uncomfortable making a judgment call on, it is their obligation the find one or more experienced Tripoli members on the field to consult with. As always, the final decision rests with the Certificate of Waiver Holder.

Flight Safety Review

Safety First –
At all times prior to a safe firing position on the rod, rail, tower, or other suitable ground support facility, the igniter **shall not** be inside the motor, and all ejection charge related **electronics must be off**!

Exception: Igniters used in the initiation of upper stages and those of complex clusters may be inserted early but must be shunted to avoid accidental ignition.

Flyer –

By asking to see a current membership card:

Verify that the individual flying the rocket is a current member in good standing of Tripoli Rocketry Association or the National Association or Rocketry.

Verify the certification level of the individual and that they are flying within their certification level or attempting a new certification level.

Observe that the individual does not appear impaired by the use of drugs or alcohol. Under no circumstances should someone who has participated in the consumption of alcoholic beverages be allowed to enter the range or launch a rocket.

Flight Card –

Verify that an applicable flight card exists, is filled out in a legible manner, and indicates all of the pertinent flight data including but not limited to flyer name and TRA number, physical vehicle parameters, motor configuration, and recovery systems.

Special attention should be given to flights that are indicated as Heads-up or Certification. In the case of a Level 3 certification attempt, verify the presence of associated TAP member.

History –

Ask the flyer if they have flown this particular rocket and motor combination. If they have, ask for the results of that flight. If not, ask if they have flown a similar rocket/motor combination and the outcome.

Use the results of this line of questioning to determine into how much detail the remainder of the FSR will go.

IMPORTANT: By no means does a response of “I’ve flown it just like this perfectly before” exempt the flyer from the remainder of the FSR.

Propulsion –

Verify that the motor used is a currently certified motor or that it is on the consumer list.

Verify that the total installed power does not exceed the limitations of the field.

Verify, as best possible, that the vehicle is capable of withstanding the forward thrust that will be produced by the motor.

Verify that the initial thrust of the motor chosen will provide at least a 5:1 thrust-to-weight ratio. This can be done by one of three ways:

1. The flyer can provide documentation that shows the initial thrust produced by the motor. This can then be compared to the GLOW (Gross Lift Off Weight) of the rocket as presented.

2. The peak thrust of the motor can be assumed to be at least equal to the average thrust as indicated in the motor designation. In this case, the average Newtons produced by the motor should be converted to pounds and compared to the GLOW of the rocket as presented.

3. A printout from a flight prediction software package can be presented. In this case the prediction output should indicate the thrust-to-weight of > 5, the initial acceleration of > 5 g’s, or the velocity of the rocket at the end of the rod/rail/tower > 45 f/s. The motor installed and the weight of the rocket must also be indicated and shall be verified to match the presented rocket.Verify that a suitable means of aft retention is used to keep the motor, or motors, in place during the flight and recovery. This is of particular importance in parallel staged cluster flights. In such cases, special attention should be given to providing a positive form of retention that will not allow motors to become dislodged during initial acceleration forces.

If a cluster of motors is being used, the possible failure modes should be explored. If any of the possible scenarios create an extra hazardous situation, additional precautions should be taken.

Verify that a suitable means of ignition has been chosen and will provide a safe and reliable motor ignition. All igniters should be shorted until just prior to connection to launch control equipment. In the event of a hang-fire (failure of the igniter to light the motor), the rocket should not be approached for a minimum of two minutes.

Construction –

Check the structural integrity of the vehicle including the body tubes, nose cone, and fins to ensure that they are adequate to withstand the forces anticipated during the flight and recovery.

Verify the fit of the nose cone. Whenever possible hang the rocket by the nose cone. The vehicle should stay in place. With agitation however, the nose should come free or begin to come free. *Exception*: When shear pins are being employed ask the flyer to explain how they determined the number, size, and type of shear pins to use and what special provisions have been taken in regards to calculation of ejection charges.

Compare the fin material, stiffness, size and attachment method to the projected flight velocity and acceleration to avoid the potential for excessive fin flutter and any structural failures. If a questionable situation arises, consider assigning the flyer to a pad that is further away than the minimum setback. Special consideration should be given the flights that are predicted to exceed mach 1.

Verify that a suitable launch guidance system is employed. Take into consideration the overall dimensions of the vehicle, the total weight of the vehicle, the predicted acceleration, and the current wind conditions. In the case of launch lugs or rail guides, ensure that mounting of the lug or button is sufficient to withstand the loads.

In the case of a two-stage vehicle, check the strength of the inter-stage connection. Verify that is will not buckle under the acceleration loads, and that it will separate as intended.

Stability –

Verify that the rocket is of a stable design.

1. If it has flown in the current configuration with a similar motor and was stable it will likely remain stable.

2. If the design employs canards or unusually small fins be extra careful with the stability verification.

3. Providing the Cp(center of pressure) calculation by Barrowman or other suitable calculation method should be compared to the Cg(center of gravity) as found on the flight ready vehicle. If stability calculations indicate a Cg, its accuracy should always be verified.

4. If no calculations are available or it is an untested design, use past experiences and call upon the expertise of others at the launch in coming to consensus about stability. If the stability is uncertain on an unusual design, ask for proof of stability. Any marginally stable rockets should be treated with extra concern and additional launch safety precautions should be taken.

Recovery –

Verify that the parachutes selected for recovery are rated for the weight of the vehicle and the expected conditions at deployment. Confirm that the parachutes intended for the final descent phase to the ground will not allow a decent rate of >30f/s.

Verify that there is an adequate system in place to contain all of the separable parts of the rocket and parachutes at the forces anticipated during deployment. This includes adequate length of retaining cord, strength of retaining cord, and hard points for recovery system attachment.

Ensure that adequate protection is in place to prevent the hot ejection gases from causing burn damage to retaining cords, parachutes, and other vital components.

If motor delay is used to actuate recovery system, verify that the delay length was properly selected for the motor/rocket system. Do not allow the rocket to fly if the flyer does not know the reason why they have chosen the installed delay.

If electronics are being used to activate the recovery system, verify that an externally controllable method is being used to turn electronics on and that a known good battery is in use.

Summary

An RSO's responsibility is to limit the exposure to hazardous situations to a minimum number of persons for a minimum time, consistent with safe and efficient operations.

In the pursuit of this ideal, we must adhere to the safety code and do our best to make sure that others around us do the same. In doing so, we will make our hobby as safe as possible for those involved and for spectators, thus ensuring the continued growth and enjoyment for all involved.

Never over-rule safety for the sake of friends, fun, or convenience.

Written by Derek Deville under the direction of the Tripoli BOD