KSU-HPRC Launch ChECKLISTS

KSU-HPRC-CL 12 April 2017

The Kent State University High-Power Rocket Club began in 2016 and is open to all students. The club is an Integrated Product Team comprised of diverse members with varying technical majors, assembled with the intent to design and build high-power rockets for professional competition**.**The purpose of this student organization is to advance the arts, sciences, and technology of aeronautics and astronautics, to develop the professionalism and leadership of those engaged in these pursuits, and to promote community outreach of the sciences.

**Table of Contents**

Safety Briefing

Safety Items Checklist

Pre-Launch Checklist

Launch Pad and Flight Arming Checklist

Recovery Checklist

**Appendices**

Appendix A: Rocket Descriptions and Dimensions

Appendix B: Motor Specifications

Appendix C: NAR Minimum Safe Distance Chart

Appendix D: Tripoli Minimum Safe Distance Chart

Appendix E: Form ALT-2-LOG

Appendix F: KSU-HPRC Launch SOP

Appendix G: Avionics Coupler Reassembly Procedures

Appendix H: Motor Assembly Procedures

Appendix J: Unit Conversion Chart

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**Safety Items Checklist**

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Yes No N/A

1. Appropriate permissions have been obtained. ◻ ◻ ◻

*(I.e. Fire Marshall, Local Police, Land Owner, etc.)*

2. FAA has been contacted & clearance has been obtained. ◻ ◻ ◻

*(Contactor must log date-time group in Flight Log Book)*

3. *NOTAM* has been issued. ◻ ◻ ◻

*(NOTAM issuer and date-time group must be logged in Flight Log Book)*

4. *METAR* has been obtained and logged in Flight Log Book. ◻ ◻ ◻

5. *Risk Assessment Worksheet* completed and available. ◻ ◻ ◻

6. Launch area cleared IAW NAR &/or Tripoli regulations. ◻ ◻ ◻

7. *Safety briefing* has been completed. ◻ ◻ ◻

8. All appropriate safety equipment is on site. ◻ ◻ ◻

*(I.e. Fire Extinguishers, First Aid Kits, PPE, etc.)*

9. Current *Launch SOP* is located within this manual, *(KSU-HPRC-CL)*. ◻ ◻ ◻

*(Must contain a current list of emergency contact numbers for the appropriate launch site)*

10. *Pre-Launch* and *Launch Pad & Flight Arming Checklists* complete. ◻ ◻ ◻

11. Safe to proceed with launch(es). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ◻ ◻ ◻

*(Can ONLY be* ***signed off by Mentor or Safety Officer****, Program Manager ONLY in case of previous two being unavailable at launch)*

*(NOTES)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_End of Safety Checklist*

**Pre-Launch Checklist**

Date-Time Group: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Flight#

1 2 3 4 5 6

1. All data has been downloaded from previous flight and recorded. N/A ◻ ◻ ◻ ◻ ◻

2. ***Avionics Coupler Reassembly Procedures*** completed *(Appendix G)*. ◻ ◻ ◻ ◻ ◻ ◻

*(****WARNING****: Safety glasses are required while attaching electric matches or ejection charges)*

3. Second person to ensure chute charges are attached properly. ◻ ◻ ◻ ◻ ◻ ◻

4. Droque chute reset into lower rocket body. ◻ ◻ ◻ ◻ ◻ ◻

5. Main chute reset into upper rocket body. ◻ ◻ ◻ ◻ ◻ ◻

6. Droque and main chute ‘D-rings’ reattached to avionics coupler. ◻ ◻ ◻ ◻ ◻ ◻

7. Avionics coupler reinstalled into upper and lower rocket bodies. ◻ ◻ ◻ ◻ ◻ ◻

8. Shear pins installed into lower rocket body and avionics coupler. ◻ ◻ ◻ ◻ ◻ ◻

9. Shear pins installed into upper rocket body and nose cone. ◻ ◻ ◻ ◻ ◻ ◻

10. Rivets reinstalled into upper rocket body and avionics coupler. ◻ ◻ ◻ ◻ ◻ ◻

11. Remove and replace rubber bands on drag system. ◻ ◻ ◻ ◻ ◻ ◻

12. Final Safety of Flight check completed. ◻ ◻ ◻ ◻ ◻ ◻

*(To be completed ONLY by Safety Officer, Mentor, or Project Manager)*

*13.* Safety Briefing completed. ◻ ◻ ◻ ◻ ◻ ◻

*(For all participants and spectators. Necessary ONLY prior to first flight or between launches where greater than 30 minutes’ time has elapsed)*

*Continued on Next Page*

14. Okay to proceed to ***Launch Pad & Flight Arming Checklist***. ◻ ◻ ◻ ◻ ◻ ◻

*(Decision made by Mentor ONLY. RSO, Safety Officer or Project Manager if Mentor not available, in that order)*

*End of Pre-Launch Checklist*

**Launch Pad & Flight Arming Checklist**

Date-Time Group: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Flight#

1 2 3 4 5 6

1. Assemble motor IAW ***Motor Assembly Procedures*** *(Appendix H).* ◻ ◻ ◻ ◻ ◻ ◻

2. Install motor and ensure the retainer is securely fastened. ◻ ◻ ◻ ◻ ◻ ◻

*(MUST have appropriately certified motor handler present)*

3. Place rocket on launch pad and ensure both launch lugs are in place. ◻ ◻ ◻ ◻ ◻ ◻

4. Ensure launch angle is appropriate for objectives and conditions. ◻ ◻ ◻ ◻ ◻ ◻

5. Turn avionics cameras to ‘ON’. ◻ ◻ ◻ ◻ ◻ ◻

6. Turn avionics pitot system battery switch to ‘ON’ using screwdriver. ◻ ◻ ◻ ◻ ◻ ◻

7. Turn avionics coupler Primary Strattologger switch to ‘ON’. ◻ ◻ ◻ ◻ ◻ ◻

*(Ensure the self-check sequence indicates proper operation)*

8. Turn avionics coupler Secondary Strattologger switch to ‘ON’. ◻ ◻ ◻ ◻ ◻ ◻

*(Ensure the self-check sequence indicates proper operation)*

9. Install motor ignition and secure wire to side of rocket with tape. ◻ ◻ ◻ ◻ ◻ ◻

10. Attach electrical leads to ignition wires. ◻ ◻ ◻ ◻ ◻ ◻

*End of Launch Pad & Flight Arming Checklist*

**Recovery Checklist**

Date-Time Group: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Flight#

1 2 3 4 5 6

1. Competition data download completed. ◻ ◻ ◻ ◻ ◻ ◻ *(If applicable)*

2. Rocket released by competition officials for reset. ◻ ◻ ◻ ◻ ◻ ◻ *(If applicable)*

3. ALT-2 batter power level checked, verified greater than 45%. ◻ ◻ ◻ ◻ ◻ ◻

4. ALT-2 Data Log completed. ◻ ◻ ◻ ◻ ◻ ◻

5. ALT-2 Reset to ‘LAUNCH’. ◻ ◻ ◻ ◻ ◻ ◻

6. Camera SD cards have been downloaded and/or replaced. ◻ ◻ ◻ ◻ ◻ ◻

*(ONLY necessary if greater than five consecutive flights between downloads. If replaced, SD cards must be marked with flight info and date)*

7. Primary and Secondary Strattologger batteries replaced. ◻ ◻ ◻ ◻ ◻ ◻

*(If applicable; Required between competition flights)*

*End of Recovery Checklist*

**Safety Briefing**

\* Today’s launch is being conducted for (familiarization, testing, competition).

\* The motor(s) being used today are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

\* Minimum clearance distance for today’s launch is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

\* ONLY designated Launch Pad and Flight Arming personnel will be allowed to be in the launch area during launch periods unless otherwise asked or requested.

\* ALL checklists will be followed and each step verified.

\* ALL appropriate PPE will be used during pre-launch, launch, and post-launch phases.

\* Weather for today’s launch is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

\* ALL directions given by RSO and Mentor will be followed.

\* In case of ignition failure, the RSO and Mentor will be lead and conduct troubleshooting procedures.

\* Today’s overseeing authority is (NAR/Tripoli)

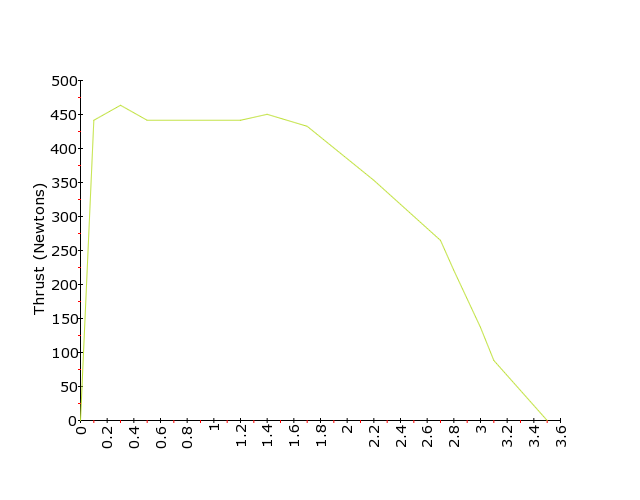
\* Buddy teams will be used at all times during all launch procedures and while the range is hot.

*End of Safety Briefing*

**Appendix A: Rocket Descriptions & Dimensions**

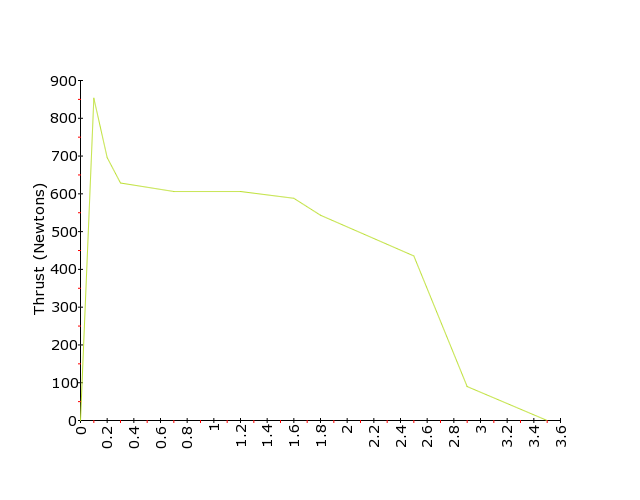
**Appendix B: Motor Specifications**

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| --- | --- |
| ***J-415-WL*** | |
| Manufacturer | Aerotech |
| Designation | J415W |
| Casing | RMS 54/1280 |
| Outside Diameter | 0.054 m |
| Total Length | 0.326 m |
| Total Impulse | 1201 N-s |
| Average Thrust | 343 N |
| Peak Thrust | 552 N |
| Burn Time | 3.50 s |
| Propellant Mass | 0.660 kg |
| Motor Mass | 1.199 kg |
| Propellant Type | White Lightning |



**Appendix B: Motor Specifications**

|  |  |
| --- | --- |
| ***K-550-WL*** | |
| Manufacturer | Aerotech |
| Designation | K550W |
| Casing | RMS 54/1706 |
| Outside Diameter | 0.054 m |
| Total Length | 0.410 m |
| Total Impulse | 1594 N-s |
| Average Thrust | 456 N |
| Peak Thrust | 853 N |
| Burn Time | 3.50 s |
| Propellant Mass | 0.880 kg |
| Motor Mass | 1.515 kg |
| Propellant Type | White Lightning |



**Appendix C: NAR Minimum Safe Distance Chart**

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| --- | --- | --- | --- | --- |
| Installed Total Impulse [Ns] | Equivalent High Power Motor Type | Minimum Diameter of Cleared Area [Ft.] | Minimum Personnel Distance [Ft.] | Minimum Personnel Distance (Complex Rocket) [Ft.] |
| 0-320.00 | H or smaller | 50 | 100 | 200 |
| 320.01-640.00 | I | 50 | 100 | 200 |
| 640.01-1,280.00 | J | 50 | 100 | 200 |
| 1,280.01-2,560.00 | K | 75 | 200 | 300 |
| 2,560.01-5,120.00 | L | 100 | 300 | 500 |
| 5,120.01-10,240.00 | M | 125 | 500 | 1000 |
| 10,240.01-20,480.00 | N | 125 | 1000 | 1500 |
| 20,480.01-40,960.00 | O | 125 | 1500 | 2000 |

NOTE: A Complex Rocket is one that is multi-staged or that is propelled by two or more rocket motors

SOURCE: *National Association of Rocketry: High Power Rocket Safety Code*

**Appendix D: Tripoli Minimum Safe Distance Chart**

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| Rockets Total Installed Impulse [Ns] | Motor Type | Minimum Clear Distance | | | | Minimum Launch Site Dimensions (Diameter or Shortest Dimension), Feet (The Larger of ½ of the Waived Altitude, or) | | Minimum Safe Distance, Commercial Launch | | Minimum Safe Distance, Research Launch | |
| Regular | | Sparky | |
| FT | M | FT | M | FT | M | Non-Complex | Complex | Non-Complex | Complex |
| 0.01-160 | A-G |  |  |  |  |  |  | 30 | 9 | 30 | 9 |
| 160.01-320 | H | 6 | 15 | 75 | 23 | 1500 | 457 | 100 | 30 | 200 | 61 |
| 320.1-640 | I | 50 | 15 | 75 | 23 | 1500 | 457 | 100 | 30 | 200 | 61 |
| 640.01-1280 | J | 50 | 15 | 75 | 23 | 1500 | 457 | 100 | 30 | 200 | 61 |
| 1280.01-2580 | K | 75 | 23 | 113 | 38 | 1500 | 457 | 200 | 61 | 300 | 91 |
| 2580.01-5120 | L | 100 | 30 | 150 | 45 | 1500 | 457 | 300 | 91 | 500 | 152 |
| 5120.01-10240 | M | 125 | 38 | 200 | 61 | 1500 | 457 | 500 | 152 | 1000 | 305 |
| 10240.01-20480 | N | 125 | 38 | 200 | 61 | 2000 | 610 | 1000 | 305 | 1500 | 457 |
| 20480.01-40960 | O | 125 | 38 | 200 | 61 | 3000 | 915 | 1500 | 457 | 2000 | 610 |
| 40960.01-890000 | P-T | 125 | 38 | 200 | 61 | 3000 | 915 | N/A | N/A | N/A | N/A |

\*Distances for commercial Model Rocket Motors. High Power ‘F’ and ‘G’ Motors (exceeding the limits in the definition of Model Rocket Motor) shall be flown at the ‘H’ distance.

SOURCE: *Tripoli Rocketry Association Safe Launch Practices (Table V) July 2013*

**Appendix E: Form ALT-2-LOG**

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| **Date-Time Group:** |  | | |
| **Launch #:** |  | | |
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| Ejection | |  |  |
|  | |  | (Ft./s) |
| Duration | |  |  |

**Appendix F: KSU-HPRC Launch SOP**

**Section 1 - Purpose**

The purpose of this Standard Operating Procedure for the Kent State University High Power Rocket Club is to set practices for safe operation of Model and High Power rocket launches. Safety is the first priority of this organization and all accepted risks shall be calculated and deemed low risk through the use of hazard controls (ie. PPE, minimum safe distances, etc.)

**Section 2 - Definitions & Acronyms**

FAA - Federal Aviation Administration

FSDO - Flight Standards District Office

High Power Rocket - *A rocket exceeds the definition of a model rocket under NFPA 1122 and becomes a High*

*Power rocket under NFPA 1127 if it:*

* *Uses a motor with more than 160 Newton-seconds of total impulse (an “H” motor or larger) or multiple motors that all together exceed 320 Newton-seconds;*
* *Uses a motor with more than 80 Newtons average thrust (see* [*rocket motor coding*](http://www.nar.org/standards-and-testing-committee/standard-motor-codes/)*);*
* *Exceeds 125 grams of propellant;*
* *Uses a hybrid motor or a motor designed to emit sparks;*
* *Weighs more than 1,500 grams including motor(s); or*
* *Includes any airframe parts of ductile metal.*

*In addition, a rocket exceeds the definition of a model rocket under FAA rules (FAR 101.22) if weighs more than 1500 grams (53 ounces).*

METAR - Meteorological Aerodrome (Airport) Report

Model Rocket - See definition of High Power Rocket. Anything not meeting those criteria is a

model rocket

NAR - National Association of Rocketry

NFPA - National Fire Protection Association

NOTAM - Notice to Airmen - a notice filed with the federal aviation authority to alert aircraft pilots of potential hazards along a flight route or at a location that could affect the safety of the flight.

**Appendix F: KSU-HPRC Launch SOP**

**Section 3 - Risk Assessment Process**

Prior to launch a risk assessment worksheet shall be completed by the safety officer and reported to all members of the launch teams. Risk Assessment worksheets shall be retained throughout the duration of the current school year including the summer semester.

**Section 4 - NOTAM Filing Process**

If flight is located at Kent State University the safety officer shall contact the Kent State University Airport manager no less than 4-7 days prior to the established launch date to have a NOTAM issued for the flight.

The contact number for the Kent State University Airport is (330) 672-1943 and the Airport Manager’s name is Dave Poluga.

**Section 5 - Model Rocket & High Power Rocket Launch Procedures**

All launches, model and high power,  shall abide by the field operating associations’ (NAR or Tripoli) model rocket or high power rocket safety code, and all launches shall follow the Kent State University High Power Rocket Club checklists.

The safety officer shall assume responsibility for completing all tasks as assigned in the safety checklist.

Teams will be assigned for each portion of the launch process to include pre-launch,

launch, and recovery. Each of these teams shall assume responsibility for completing all tasks assigned in the checklist of the team they are part of. These individual checklists shall be confirmed by the teams to either the safety officer, or the project leader.

**NAR Minimum Safe Distance Table**

SEE APPENDIX C

**Tripoli Minimum Safe Distance Table**

SEE APPENDIX D

**Section 6 - Notification List / Emergency Contact List**

**Kent State University - High Power Rocket Club**

**Emergency Contact List**

**Appendix F: KSU-HPRC Launch SOP**

**Response Checklist Contact Numbers**

1. **If there is a potential injury, fire, or an immediate threat to**

**life, limb, or property, immediately call 911 9-1-1**

**--If launch is at Kent State University**

1. **Kent State Police and Fire Department 330-672-2212**
2. **Kent State Media Relations 330-672-2797**
3. **Kent City Police Department 330-673-7732**

**--Specifically if incident involves manned aircraft**

1. **Kent State University Airport 330-672-1943**
2. **Ohio Highway Patrol: Canton & Stark Post 330-433-6200**
3. **Cleveland FAA - FSDO 440-686-2001**
4. **Dave Poluga, KSU Airport Manager**  **330-672-1943**

**Record:**

1. **Date, Time & Location**
2. **Collect witness statements**

**Section 7 - Storage, Transport & Handling of Motors**

Rocket reloading kits and pyrotechnic modules to be used in competition will be stored and maintained off-site with our mentor, Mr. Steve Eves. Mr. Eves is a level three Tripoli member and will handle all rocket motors and motor-reloading kits to include transporting and loading. All instructions while at the launch pad will be given by Mr. Eves. He will also be in charge if any motor is armed yet does not fire.

**Appendix F: KSU-HPRC Launch SOP**

**Section 8 - References**

* **Code for High Power Rocketry - Tripoli Rocketry Association \*\***
* **National Association of Rocketry - High Power Rocket Safety Code \*\***
* **National Association of Rocketry - Model Rocket Safety Code**
* **Tripoli Rocketry Association - Safe Launch Practices \*\***
* **National Fire Protection Association 1122 - Code for Model Rocketry**
* **National Fire Protection Association 1127 - Code for High Power Rocketry**
* **14 CFR Part 101 Subpart C - Amatuer Rockets \*\***
* **Hazardous Substances Act**

\*\*Shall be considered part of the SOP and in possession of the club at all launches

*End of KSU-HPRC Launch SOP*

**Appendix G: Avionics Coupler Reassembly Procedures**

1. Ensure all compo0nent mounting hardware are secure.
2. Ensure all batteries are secured and leads are attached.
3. Ensure the camera battery switch is set to OFF.
4. Ensure the Primary and Secondary Strattologger battery switches are set to OFF.
5. Ensure the pitot system battery switch is set to OFF.
6. Feed the Drogue chute electric match or ejection charge through the bottom coupler cap and attach to the Strattologger where indicated.
7. Ensure the excess wire is secured to the sled and place a piece of tape over the wire feed hole.
8. Feed the Main chute electric match or ejection charge through the top

coupler cap and attach to the Strattologger where indicated.

1. Ensure the excess wire is secured to the sled and place a piece of tape over the wire feed hole.
2. Insert the sled into the coupler housing ensuring the ‘top’ of the sled is at the ‘top’ of the housing.
3. Attach the cameras to their appropriate Velcro positions and feed the excess ribbon leads into the top opening of the coupler tube.
4. Feed any excess wire into the top opening of the coupler tube.
5. Place the top cap on the coupler and secure tightly.

*End of Coupler Reassembly Procedures*

**Appendix H: Motor Assembly Procedures**

1. Install motor reload grains into appropriate casing.
2. Install forward closure
3. Fill forward closure ejection port with black powder.
4. Place masking tape over and around the ejection port and black powder.
5. Install motor into rocket
6. Secure casing into rocket with retainer cap.

*End of Motor Assembly Procedures*

**Appendix I: Unit Conversion Chart *(Source: Pinterest)***

