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RAS

raider aerospace society

SPACE RAIDERS

Texas Tech University – Space Raiders

USLI Project Proposal 2019 – 2020

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Dictionary of Acronyms

AAA: American Automobile Association
AGL: Above Ground Level
APCP: Aluminum Perchlorate Composite Propellant
CDR: Critical Design Review
CNC: Computer Numerical Control
CG: Center of Gravity
CP: Center of Pressure
DC: Direct Current
EDM: Electrical Discharge Machining
EHS: Environmental Health and Safety
ESC: Electronic Speed Controller
FAA: Federal Aviation Administration
FCC: Federal Communications Commission
FRR: Flight Readiness Review
GUI: Graphical User Interface
HPR: High Power Rocketry
IMMS: Institute of Materials, Manufacturing, and Sustainment
LCO: Launch Control Officer
LED: Light Emitting Diode
LiPo: Lithium Polymer
LPR: Low Power Rocketry
LRR: Launch Readiness Review
LREV: Launch Rail Exit Velocity
MSFC: Marshall Space Flight Center
NAR: National Association of Rocketry
NASA: National Aeronautics and Space Administration
NFPA: National Fire Protection Agency
PCB: Printed Circuit Board
PDR: Preliminary Design Review

PLA: Polylactic Acid
PLAR: Post Launch Assessment Review
POC: Points of Contact
POT-Rocks: Panhandle of Texas Rocketry
PPE: Personal Protective Equipment
RAS: Raider Aerospace Society
RC: Radio Control
RSO: Range Safety Officer
RX: Receive
SDS: Safety Data Sheet
SL: Sea Level
SO: Safety Officer
STEM: Science, Technology, Engineering, and Math
STP: Standard Temperature and Pressure
TRA: Tripoli Rocket Association
TTU: Texas Tech University
TX: Transmit
UAV: Unmanned Aerial Vehicle
USLI: University Student Launch Initiative

General Information

1.1 School Information

Space Raiders is a special operations division of Raider Aerospace Society. Raider Aerospace Society is a student organization within the Whitacre College of Engineering. Raider Aerospace Society is focused on the study of aeronautical principal whereas Space Raiders, is the special operations division focused on rocket design. We are the premier organization at Texas Tech University focused on aerodynamic studies.

1.2 Leadership Overview

Organization Name:	Space Raiders A division of Raider Aerospace Society
Faculty Advisor:	Andrew Mosedale 806.834.6146 andrew.mosedale@ttu.edu
Team Leader:	Dev Tavares 925.446.7035 dev.tavares@ttu.edu
Team Mentor/Tripoli Contact:	Bill Balash 806.681.6452 billbalash@sbcglobal.net
Safety Officer:	Mohammad Moosajee 832.798.5794 mohammad.moosajee@ttu.edu
Adult Educator:	Barre Wheatley 806.681.4716

	mrbarre1@suddenlink.net

Table 1.1

1.3 Team Structure

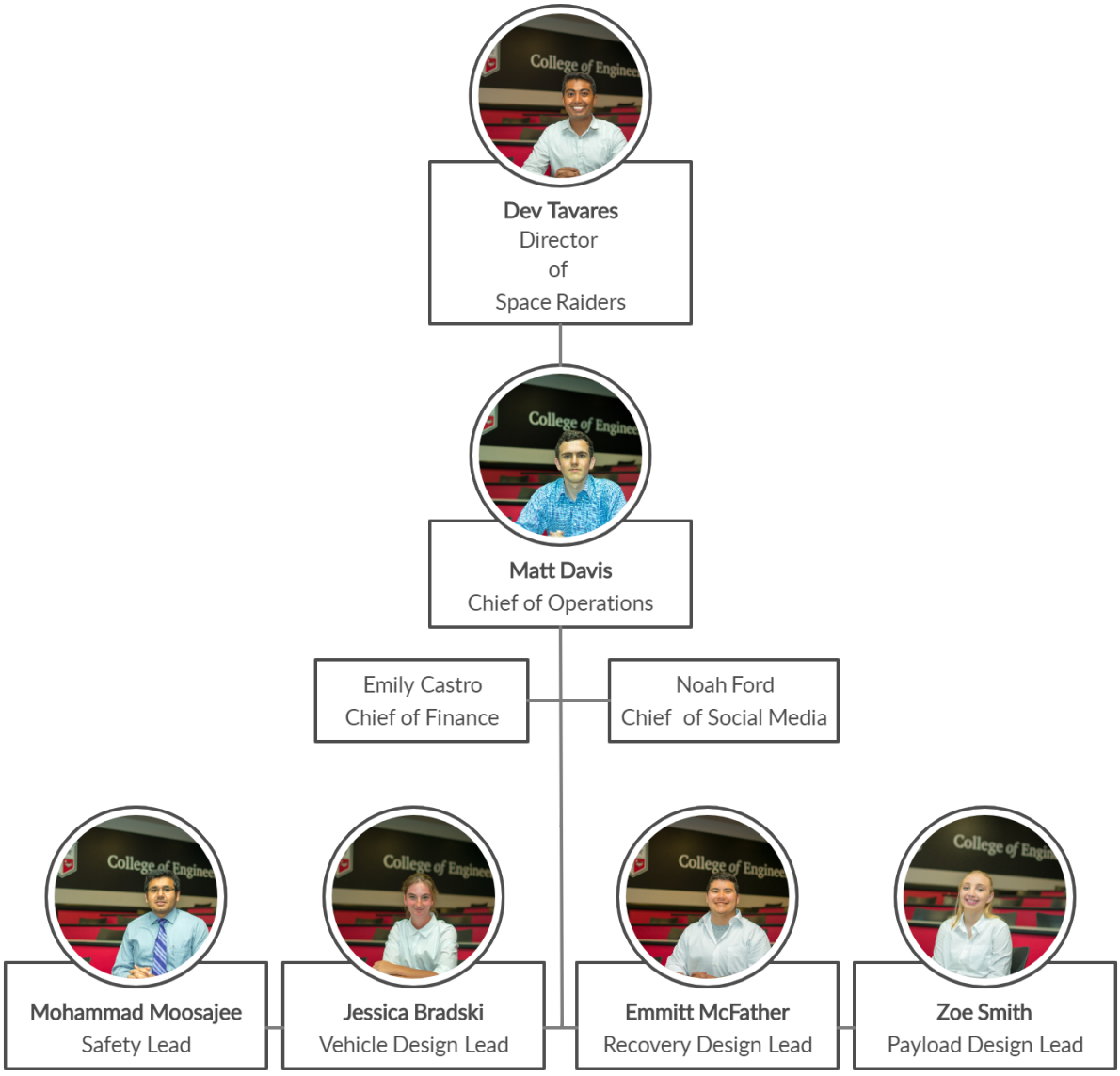


Figure 1.0.1

1.4 Team Organization

Before this Space Raiders team structure section begins, it is important to clarify a crucial point about our student organization. Space Raiders is one of many projects in the greater scope of the Raider Aerospace Society student organization. Raider Aerospace Society is a project-based organization that supports aeronautical related endeavors at Texas Tech University. This includes the USLI project under the team name of Space Raiders and the American Institute of Aeronautics and Astronautics under the team name of Pegasus.

Our team is comprised of the team structure in Section 1.3. The Director of Space Raiders, Dev Tavares, will lead the USLI Project and will be responsible for all of his subordinates. Dev Tavares will also keep close counsel with his direct subordinates, which include the Chief of Operations, Chief of Finance, and Chief of Social Media.

The Chief of Operations role is under the leadership of Matthew Davis. The job requires him to act as an intermediary between the director of Space Raiders and the individual subsystem leads to alleviate pressure from the director himself. He will be responsible for gathering updates from the respective leads and presenting a summarized version to the director.

The role of the Chief of Finance belongs to Emily Castro. Her job is to manage the budget of the project and reach out to obtain funds. The chief of finance will play a pivotal role in creating a budgetary plan of action. This will be crucial for the project plan within the proposal.

The Chief of Social Media is Noah Ford. He maintains our presence on social media platforms, updating our website, and create outreach events. His role will be pivotal in both member recruitment and retention over the course of the project. This role will also control the STEM engagement for the project.

As for the Sub-System Leads, we have categorized them into four separate teams. Those teams are Safety, Vehicle, Recovery, and Payload Designs. They are led by Mohammad Moosajee, Jessica Bradski, Emmitt McFather, and Zoe Smith, respectively. These teams will be responsible for the safety and technical design of the proposal. They will describe their plans in more detail in those sections.

1.5 Compliance of General Requirements

Requirement*	Compliance
1.1. Students on the team will do 100% of the project including design, construction, written reports, presentations, and flight preparation. An exception to this includes assembling the motors, handling black powder or any variant of ejection charges, and preparing and installing electric matches (to be done by the team's mentor). Teams will submit new work. Excessive use of past work will merit penalties.	We are a part of the RAS student organization which is comprised only of students from Texas Tech University. Therefore, it can be guaranteed that 100% of the project design, construction, reports, presentations, and flight preparations will be completed by Texas Tech students. The extent of the adult mentor's influence will be purely guidance on the project and giving input from their experience and insight.
1.2. The team will provide and maintain a project plan to include, but not limited to the following items: project milestones, budget and community support, checklists, personnel assignments, STEM engagement events, and risks/mitigations.	This requirement is fulfilled by sections 6.1, 6.2, 1.4, 5.1, and 3.2, respectively.
1.3. Foreign National (FN) team members must be identified by the Preliminary Design Review (PDR). They may or may not have access to certain activities during launch week due to security restrictions. In addition, FN may be separated from their team during certain activities on-site at Marshall Space Flight Center.	Currently we are in the recruiting phase of our year and will finalize our team roster by the PDR.
1.4. The team must identify all team members attending launch week activities by the Critical Design Review (CDR). Team members will include: 1.4.1. Students actively engaged in the project throughout the entire year. 1.4.2. One mentor (see requirement 1.13).	Currently we are in the recruiting phase of our year and will finalize our team roster by the PDR.

1.4.3. No more than two adult educators.	
1.5. The team will engage a minimum of 200 participants in educational, hands-on STEM activities, as defined in the STEM Engagement Activity Report by FRR. To satisfy this requirement, all events must occur between project acceptance and the FRR due date, and the STEM Engagement Activity Report must be submitted via email within two weeks of the completion of the event. A sample of the STEM Engagement Activity Report can be viewed on page 35.	We are currently working diligently with the Engineering Outreach department at TTU to develop and present at multiple STEM outreach events.
1.6. The team will establish a social media presence to inform the public about team activities.	We will link our social media handle in each of our email signature blocks, starting with the proposal.
1.7. Teams will email all deliverables to the NASA project management team by the deadline as specified in the handbook for each milestone. In the event that a deliverable is too large to attach to an email, the inclusion of a link to download the file will be sufficient.	Our proposal will be submitted by September 16th to both of the emails listed in the RFP. The file for the proposal will be linked as an attachment to the email.
1.8. All deliverables must be in PDF format.	The proposal will be converted from a Google Docs file to .pdf before delivery.
1.9. In every report, teams will provide a table of contents including major sections and their respective sub-sections.	Our comprehensive table of contents will be at the beginning of the document after the cover page.
1.10 In every report, the team will include the page number at the bottom of the page.	The page numbers will begin after our cover page and be located in the bottom middle of the page.
1.11. The team will provide any computer equipment necessary to perform a video teleconference with the review panel. This includes but is not limited to, a computer, a video camera, a speaker telephone, and a sufficient Internet connection. Cellular phones should be used for speakerphone capability only as a last resort.	SR will be fully prepared for all video teleconferences with supporting equipment including but not limited to, a webcam, a computer with solid internet connection, a microphone, and a speaker.
1.12. All teams will be required to use the	We will utilize the proper launch hardware to

launch pads provided by Student Launch's services provider. No custom pads will be permitted on the launch field. At launch, 8-foot 1010 rails and 12-foot 1515 rails will be provided. The launch rails will be canted 5 to 10 degrees away from the crowd on launch day. The exact cant will depend on launch day wind conditions.	make use of the Student Launch Services Provider's launch system. Furthermore, we will calculate our apogee based on the cant angle of the launch system.
1.13. Each team must identify a "mentor." A mentor is defined as an adult who is included as a team member. He or she will be supporting the team (or multiple teams) throughout the project year, and may or may not be affiliated with the school, institution, or organization. The mentor must maintain a current certification, and be in good standing, through the National Association of Rocketry (NAR) or Tripoli Rocketry Association (TRA) for the motor impulse of the launch vehicle. He or she also must have successfully flown and recovered (using electronic, staged recovery) a minimum of 2 flights in this or a higher impulse class prior to PDR. The mentor is designated as the individual owner of the rocket for liability purposes and must travel with the team to launch week. One travel stipend will be provided per mentor regardless of the number of teams he or she supports. The stipend will only be provided if the team passes FRR and the team/mentor attend launch week in April.	Our Tripoli mentor is defined within the leadership overview chart section 1.2. Bill Balash is a level 3 certified member of the Tripoli Rocketry Association.

*Requirements as defined by 2020 NASA Student Launch Handbook and Request for Proposal

Table 1.2

Facilities and Equipment

2.1 Facilities

2.1.1 Advanced Prototyping and Manufacturing Facility

The Advanced Prototyping and Manufacturing Facility will be our main on-campus place of work. This is where we can manufacture some of our parts. The Advanced Prototyping and Manufacturing Facility will also be referenced as the mechanical engineering shop, machine shop, or the shop. This facility is occupied with lathes, mills, welders, CNC machines, 3D printers, along with other state-of-the-art equipment. The machine shop is staffed with a senior technician, safety officer, two other technicians, and a student body of helpers. In order to gain access to the shop, students are required to have two shop certifications. The two shop certification forms needed are the General Basic Shop and Safety Training and the Advanced Mill and Lathe Training which can be accessed through the Environmental Health and Safety Department (EHS). These shop certifications are also required to gain access to our other workspace, the Reese Technology Center, which is described in the subsequent section. Every member of our team is required to acquire both certifications.

We will primarily be using the CNC machine to precision cut the bulkheads down to size. We would also like to create either a fin jig for the placement of our fins or CNC the slits into the rocket tubing itself.

2.1.2 Reese Technology Center

This is the other workspace that we will use. Reese Technology Center is a workspace located off of the main campus of TTU. The building is owned by the Whitacre College of Engineering at TTU and is used for engineering activities including the Space Raiders project. This is the primary workspace of Space Raiders and where the team will design and perform ground testing for the rocket.

2.2 Personnel and Equipment

Currently, Space Raiders is comprised of 10 members. We plan to bring in a team of between 20 and 30 members after recruitment. As stated above, we have a well-structured list of chair members who will be running the majority of operations such as vehicle design, payload, and more importantly, safety.

The USLI subgroup would not be active without the general guidelines of safety. As stated before, the USLI team will be using the Reese Technology Center. The facility provided the team with rules and procedures to ensure the safety of our members. Some of these rules include general equipment behavior, cleanup and awareness, clothing standards, shop maintenance, and chemical use.

Some of the equipment provided includes non-powered tools and power tools. The non-power tools consist of screwdrivers, hand saws, hammers, and pliers. Power tools such as table and circular saws, impact drivers, drills, routing tools, and a power sander will be used as well.

In order to be active in the construction of our project, students must take the RoboRaider's safety exam. This will help the students understand the basic rules and operations of power tools. Our safety lead, Mohammed Mooseajee, will make sure everyone participating in building at the Reese Technology Center takes the exam to prevent injury and liability.

2.3 Software

2.3.1 Arduino

Arduino is an open-source hardware and software company that the team will be using to program the payload and drone components. This software is relatively easy to learn for members who are new programmers or have experience with arduinos. By doing this, we can have multiple people working on different sections of code.

2.3.2 Autodesk AutoCAD

AutoCAD is a computer aided design software that allows the user to construct an engineering drawing of any part he or she desires. It can be used in civil engineering, mechanical engineering, and architecture. We will be using this software to render 2-D

drawings of the payload and vehicle design. Rather than drawing the parts on paper, it is best to use AutoCAD to present our data, report dimensions, and include pictures of the drawings in future reports.

2.3.3 Autodesk Inventor

This is a CAD software that we will use to model our parts and assemblies. This software can also be used to run finite element analysis (FEA) on the rocket and payload. This will be a crucial factor in the design process of the USLI because the team will need to know where the major stress candidates are located. This will help the team choose different materials or modify existing ones. In our current and future documentation, we will present some of the drawings, parts, and assemblies to help the audience visualize the design.

2.3.4 Google Drive

Google Drive will be used to store all documents, spreadsheets, and files for the project. As a team that focuses on collaboration, the ability to share files with many members is essential. This storage will also aid in sustainability of the project and the organization as a whole.

2.3.5 OpenRocket

OpenRocket is a java-based rocket simulator that allows the user to design and animate the launch before flight. This will be used to design specifics for the rocket on a user friendly GUI. OpenRocket can also be used to calculate common rocketry statistics that most programs don't offer. This is for the ease of our rocket-specific project.

2.3.6 MATLAB

MATLAB will be our language of choice when writing common scripts and possibly the code for the electronics and payload (although we are still considering other languages as options for this). We chose MATLAB because our university teaches students using MATLAB and therefore it is commonly known among our members. This will ease in their understanding.

2.3.7 Slack

Slack will be our main method of communication between team members and officers. The team has determined that Slack is a more professional and organized application to communicate with one another. It contains the main thread of Space Raiders general chat and subthreads such as RAS and Safety. Through the use of subthreads, we are able to organize, and distribute relevant information accordingly.

Safety

3.1 Purpose

Safety is of the utmost importance to our team because we want to ensure that while everyone is gaining the experience of designing and manufacturing of the rocket, they are doing so in a proper and safe manner. To avoid injuries and operate in a professional work environment, it is important that we establish a precedent in safety for the present and future of the project itself and for the future of the student organization. We understand the significant risks associated if any negligence is shown while handling materials, chemicals, rocket motors, electrical components, etc. We understand that, if misused, some materials can be toxic, carcinogenic, explosive and or in some cases, fatal.

3.2 Risk Assessment

For our safety risk assessment, we will use a traditional risk assessment matrix to identify the probability and severity of hazards that we might encounter during the project. Table 3.1 defines the probability codes, Table 3.2 defines the severity codes, Table 3.3 presents the description of the severity/probability combined codes, and Table 3.4 presents the overall matrix drawing from definitions in the prior three tables. These tables and the subsequent matrix will be used to later identify safety hazards throughout our proposal, but are defined here.

Probability Levels Table

Description	**Percentage**
A - Frequent	85%> chance of occurance
B - Probable	50% to 85% chance of occurance
C - Occasional	15% to 50% chance of occurance
D - Remote	1% to 15% chance of occurance
E - Improbable	<1% chance of occurance

Table 3.1

Severity Definition Table

Description	**Personnel Health**	**Equipment Health**	**Mission Health**
1 - Catastrophic	Loss of life/severe injury	Destruction of equipment	Possibly irrecoverable setback/Major reconstruction, mission success could be lost
2 - Critical	Severe injury	Major damage of equipment	Reconstruction required, but mission success is still possible
3 - Marginal	Moderate injury	Moderate damage of equipment	Moderate reconstruction, mission success is probable
4 - Negligible	Minor injury	Minor damage of equipment health	Minor reconstruction, mission success not affected

Table 3.2

Risk Assessment Levels Table

Total Risk	**Acceptance Level**
High Risk	Unacceptable
Medium Risk	Undesired. Will require rigorous documentation and mitigation to obtain approval through proper safety channels
Low Risk	Acceptable. Documentation required and approval through proper safety channels
Minimal Risk	Acceptable. Light documentation, approval through safety channels.

Table 3.3

Risk Assessment Matrix

Probability vs Severity	**1 - Catastrophic**	**2 - Critical**	**3 - Marginal**	**4 - Negligible**
A - Frequent	1A	2A	3A	4A
B - Probable	B	2B	3B	4B
C - Occasional	1C	2C	3C	4C
D - Remote	D1	D2	D3	D4
E- Improbable	E1	E2	E3	E4

Table 3.4

3.2.1 Critical Points

This will outline a table of the most hazardous points during the project, their hazard, description of hazard, risk assessment classification (RAC), and prevention methods.

Hazard	**Description**	**RAC**	**Prevention**
Manufacturing of G10 fiberglass fins	During the manufacturing of fiberglass, there is a risk of eye, skin, and respiratory irritation.	1C	Wear the proper PPE of a respirator and clothing concealing all exposed skin along with working in a well ventilated workspace. Another option is to let the staff from the mechanical engineering shop handle the manufacturing.
Epoxying the airframe	When applying the epoxy to the airframe, we must avoid contact between epoxy and skin to avoid skin irritation and skin injuries.	4B	We will wear the proper PPE of gloves, long sleeves, pants, and closed toed shoes to avoid contact between the epoxy and skin.
Electrical Shock in ebay/Payload assembly	Exposed wiring along the ebay and payload can create a risk of electrical shock that can range from minor to severe injury.	1C	Grounding strips will be required for all members handling mission critical electronics. The electrical wiring will be inspected and documented by the electronics team lead to identify and avoid dangerous wires.
Launch Motor Failure	Failure to launch due to motor failure could be caused by manufacturing, the buying of faulty motors, or improper installation of the motor in the rocket body tube.	1C	The motor will be bought from a reputable company rather than manufactured ourselves. It will be assembled

			with proper precision under the guidance of professionals (being our shop technicians and/or industry advisor).
Pre-detonation of black powder	This is caused by faulty altimeters or wiring which can cause heavy damage in the vehicle and payload device.	2C	We will buy reputable altimeters and provide proper code that will be tested prior to launch.
Failure of detonation of black powder charge	This is caused by faulty altimeters or wiring which can cause heavy damage in the vehicle and payload devices.	3C	We will have a second altimeter to go off in the ebay of the rocket, acting as a backup if the first one fails.
Land-sharking of rocket	This is caused by instability within the rocket and can result in severe injuries to the participants and heavy damage to the vehicle and payload device.	1C	Create a thorough design within CAD software to increase stability and take advice from shop technicians, manufacturers, and faculty advisors.
Entanglement of the drogue and main parachute	This is caused by deployment of drogue and main parachute in rapid succession or the drogue getting stuck within the rocket due to the payload failing to deploy.	2D	Ensure that the drogue launches at apogee and the main much lower. Also includes the use of black powder for payload exit.
Zippering of the rocket in the air	This is caused by failure to properly calculate the forces exerted, greatly damaging the rocket.	2A	We will tape the shock cords to slow the deployment of the parachutes.
Payload jettisoning from CANSAT	This is caused by failure to properly separate the payload from the CANSAT. This can result in severe damages to payload section and slight risk for participants.	2D	Prevented by proper recovery put into place, effective handling, and deployment of payload within CANSAT.
Motor handling errors	This is caused by lack of proper handling and can lead to severe injuries.	1C	Safe handling practices will be implemented by the vehicle team lead

			along with guidance and help from industry advisor

Table 3.5

3.2.2 Hazardous Materials

This section will outline two tables of the most hazardous materials that we might encounter during the duration of this project (two tables for organizational/spatial purposes). The first table will outline the material, use of that material, manufacturer, and link to SDS sheet. The second table will list the material, hazard and its effects, risk assessment classification (RAC), and prevention methods.

Hazardous Materials Table

Material	**Use**	**Manufacturer**	**SDS Sheet**
Epoxy	The bonding of the airframe and the kevlar together	West System	Appendix V 5.1
Black Powder	Recovery Deployment of main and drogue parachute	GOEX Powder	Appendix V 5.2
Lithium Polymer	Used for the batteries within the ebay and payload sections of the rocket	Venom Group	Appendix V 5.3
Cyanoacrylate	Bonding of interior components of the rocket	Arrowhead Forensics	Appendix V 5.4
Fiberglass	Used for the construction fins	Current inc.	Appendix V 5.5
Carbon Fibers	Used to manufacture the airframe	Public Missiles	Appendix V 5.6
Solid Propellant Motor	Used to propel the rocket to apogee	Cesaroni	Appendix V 5.7
Kevlar Sock	Used as structural support for the	Giant Leap Rocketry	Appendix V 5.8

	airframe		

Table 3.6

Risks of Hazardous Materials and Prevention

Material	**Hazard**	**RAC**	**Prevention**
Epoxy	Appendix V 5.1	4B	Work in a well ventilated area with proper PPE.
Black Powder	Appendix V 5.2	2C	Work alongside Tripoli Rocketry Association mentor, Bill Babash, on charge sizing and placement.
Lithium Polymer	Appendix V 5.3	1C	Take proper precautions while charging and while placing battery in the rocket as defined by manufacture.
Cyanoacrylate	Appendix V 5.4	1C	Work in a well ventilated area with proper PPE.
Fiberglass	Appendix V 5.5	1C	Work in a well ventilated area with proper PPE.
Carbon Fibers	Appendix V 5.6	1C	Work in a well ventilated area with proper PPE.
Solid Propellant Motor	Appendix V 5.7	3C	Work alongside Tripoli Rocketry Association member, Bill Balash, while handling and installing motor, and preparing electronic ignition system.

Kevlar Sock	Appendix V 5.8	1C	Use proper PPE while installing Kevlar sock to prevent skin irritation.

Table 3.7

3.3 Facilities and Equipment

We plan to use our on-campus workshop, the Advanced Prototyping and Manufacturing Facility, as a facility to design and manufacture parts required to create rockets. The IMMS Test and Evaluation Capabilities is another facility used by Space Raiders to create, test, evaluate, and demonstrate the parts of rocket. The Advance Prototyping and Manufacturing Facility and the IMMS are open from 08:00 AM to 05:00 PM, 5 days a week.

The only personnel allowed into our physical facilities are qualified and have obtained the proper certification courses through TTU EHS and signed the TTU USLI Safety Agreement. The administrators who provide oversight within these facilities are TTU Campus Staff. The equipment that we have access to are:

- 3D Printers
- Manual Lathes
- Drill Presses
- Bench Grinder
- Hand Tools
- Soldering Irons
- Oscilloscope
- Wire EDM Machine
- CNC Lathes and Mills
- Manual Mills
- Belt Sanders
- Band Saw
- Cordless Drills
- Multimeters
- Precision Measurement Tools
- Drop Saw

3.4 Personal Protective Equipment

We plan to use the maximum amount of PPE that is required for any certain application. The PPE that we will be utilizing:

- Safety Glasses
- Hearing Protection
- Long-Sleeved Shirts
- Air Filtering Masks
- Hair Ties
- Leather Work Gloves
- Long Pants
- Closed-Toe Shoes
- Fume Hood

By using the appropriate PPE, injury and hazard prevention will be outstanding. Safety glasses will prevent foreign dust and fumes from the eye. Sound will be trapped and may become intensified, therefore hearing protection will be required. Long-sleeved shirts prevent chemical splashes and debris from impacting the skin. When painting and working with harmful chemicals, air filtering masks are required to prevent inhalation of these substances. The team will be working in a machine shop, therefore there is always the possibility of fires and spills. Hair ties will help avoid the possibility of hair burns. Work gloves will add an extra layer of protection from sharp tools and fires. Wearing long pants is a common PPE in any work environment. They are universal in preventing many hazards such as chemical splashes, burns, and cuts. Closed-toe shoes are also a common PPE for any laboratory or shop setting. They will help students avoid falling of sharp tools or other foreign substances that can cause damage to the feet. Finally, the fume hood will help ventilate the work environment. This is very crucial to keeping the workplace clean and safe from harmful fumes.

3.4.1 Points of Contact

Matt Rowe
Environmental Protection Manager/Occupational Safety Manager
Environmental Health and Safety
matt.rowe@ttu.edu

Roy Mullins
Engineering Safety Officer
Reese Technology Center
Texas Tech University

3.5 Safety Plan Overview

We plan to implement many safety measures this year in order to meet and exceed the standards put in place by USLI. The person coordinating this will our safety officer, Mohammad Mosajee, who will implement a safety-first culture into our organization.

The safety plan will be broken down into the safety monitoring of :

a. Design of the vehicle and payload
b. Construction of the vehicle and payload
c. Assembly of the vehicle and payload

d. Ground testing of the vehicle and payload
e. Sub-scale launch test(s)
f. Full-scale launch test(s)
g. Launch Day
h. Recovery Activities
i. STEM Engagement Activities

3.5.1 Design of the Vehicle and Payload Safety Overview

The goal of the safety official and team during the design of the vehicle and payload is to attempt to identify possible hazards from the design. The safety team should take note of the specific materials being used to make the rocket and create necessary precautions for the manufacturing and assembly of the rocket. The safety team should also outline the manufacturing processes that will be required and create appropriate procedures to execute those manufacturing processes.

3.5.2 Construction of the Vehicle and Payload Safety Overview

The construction of the vehicle and payload requires many safety guidelines and rules. Prior to the construction of the vehicle and payload, all members will complete a safety training course that covers proper rules and procedures necessary to mitigate risk and identify hazards. During the construction of the vehicle and payload, all members will wear proper PPE: safety glasses, gloves, proper clothing and closed toed non-synthetic (canvas, leather, etc.) shoes. Additionally, all team members will follow a predetermined list of rules and procedures prior to beginning construction in order to ensure a smooth and hazard-free process.

3.5.3 Assembly of the Vehicle and Payload Safety Overview

The assembly of both vehicle and payload requires several safety guidelines and rules. Prior to assembly of the launch vehicle, all members will complete a safety training course. During assembly, all members assembling the launch vehicle and payload will follow a set list of procedures to go through and follow to ensure proper assembly of all parts as well as placement of payload inside launch vehicle.

3.5.4 Ground Testing of the Vehicle and Payload Safety

Testing of blast charges will be conducted under the supervision of a NAR supervisor. Blast charge testing will take place at Cal Farley Boys Ranch in Amarillo, TX. Recovery testing and additional vehicle and payload testing will be conducted at Reese Technology Center.

3.5.4.1 Pre-Launch Briefing

All Space Raiders members who wish to attend launches must attend a pre-launch briefing in order to ensure the safety of the entire team. The Safety Officer will brief everyone on pre-launch procedures as well as launch procedures and guidelines established by NAR. Anyone who does not comply will be dismissed from the launch site.

3.6 Motor Safety and Handling

The three motors being considered for the rocket currently use propellants that do not contain titanium sponges. We will comply with the minimum distance table for L-class motors, using 100 feet for our minimum diameter of cleared area. Furthermore all testing of motors will be conducted as a part of a full-scale launch, under the direct supervision of our Tripoli mentor.

3.7 Legal Compliance

Space Raiders and RAS members will comply with all RAS, Whitacre College of Engineering, TTU, NASA USLI, State, FAA, FCC, and Federal rules and regulations in relation to all activities involved with the 2020 NASA USLI competition season.

Technical Design

4.1 Project Requirements

Our design criteria for this year's project is a large step forward in terms of our team's past projects. We would like to build a rocket capable of reaching an altitude of 1 mile, all while carrying a payload consisting of a CANSAT that will deploy at apogee and guide itself down to the designated landing zone. Upon landing, either a drone or rover will deploy to complete the mission. Our main goals for this year are to gain experience working with composites and to design an advanced payload delivery system capable of delivering a mission-critical piece of equipment. We also want to recover our launch vehicle in an airworthy condition and film our launch in full 5.7K resolution 360° video.

4.2 Project Prohibitions

Vehicle Prohibitions

a. The launch vehicle will not utilize forward canards. Camera housings will be exempted, provided the team can show that the housings has minimal aerodynamic effect on the rocket's stability.
b. The launch vehicle will not utilize forward firing motors.
c. The launch vehicle will not utilize motors that expel titanium sponges.
d. The launch vehicle will not utilize hybrid motors.
e. The launch vehicle will not utilize friction fitting for motors.
f. The launch vehicle will not exceed Mach 1 at any point during the flight.
g. Vehicle ballast will not exceed 10% of the total unballasted weight of the rocket as it would sit on the pad (i.e. a rocket with an unballasted weight of 40 lbs on the pad may contain a maximum of 4 lbs of ballast).

h. Transmission from onboard transmitters will not exceed 250 mW of power (per transmitter).
i. Transmitters will not create excessive interference. Teams will utilize unique frequencies, hand-shake/passcode systems, or other means to mitigate interference caused to or received from other teams.
j. Excessive or dense metal can not be utilized in the construction of the vehicle. The use of light-weight metal will be permitted, but limited to the amount necessary to ensure the structural integrity of the airframe under the expected operating stresses.

4.3 Vehicle Design Overview

The launch vehicle will be divided into four individual sections that will make up the airframe. Within the four independent sections, the rest of the components are housed. These include the nose cone, payload bay, drogue recovery bay, ebay section, main recovery bay, and the motor bay. An overview of the launch vehicle's layout and components is shown in Figure 4.3.1.

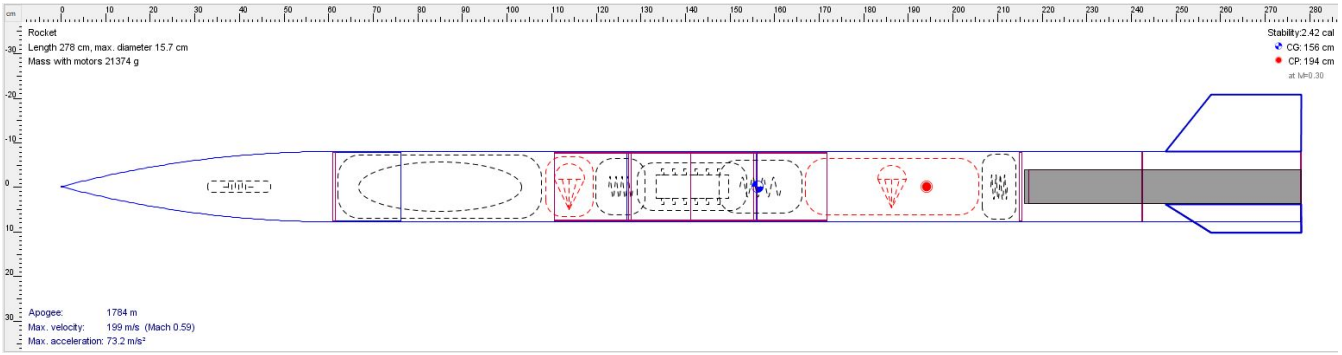


Figure 4.3.1

4.3.1 Dimensions and Weight

The airframe has an outer diameter of 6.17 in and an inner diameter of 6 inches. The length of the rocket is estimated to be 132 inches, with a total weight of approximately 21780 grams (48.01 lb). The airframe provides plenty of space that allows for the payload to be safely transported, deployed, and recovered (Section 4.5).

The individual sections within the airframe and their respective lengths are as follows: The nose cone contains a camera (24 in). The payload bay contains the payload and its recovery system, and the drogue recovery bay contains the drogue chute (26 in).

The ebay contains electronics, altimeters, and a GPS tracking device (11.5 in). The main recovery bay contains the main chute, and the motor bay contains the motor and its retention systems (48 in). Two launch rail buttons are placed at the CG and CP respectively, at a minimum of 12 inches apart to aid stability at launch.

4.3.2 Nose Cone

The nose cone will be an Ogive shape. We choose this shape as it produces a better flight profile for our projected velocity compared to a nose cone with a parabolic shape. The length of the nose cone is 24 inches, the base diameter is 6.17 inches, and the wall thickness is 0.079 inches. The first part of the nose cone which is 2.6 inches in diameter, will be made of a clear acrylic material, bonded to fiberglass which will make up the rest of the nose cone. A camera will be housed inside the clear section of the nose cone for inflight recording. A 12 inch long and 6 inch diameter coupler will be used to attach the nose cone to the fore section of the airframe.

The construction of this nose cone would include taking the fiberglass nose cone of the base diameter of 6.17 inches and cutting it with a bandsaw down to appropriate size where there is a 2.6 inch diameter hole left for the acrylic to be bonded onto the fiberglass using epoxy and proper supporting material. The reason for this process taking place is due to the lack of 6 inch base diameter acrylic nose cones.

The camera stored inside of the acrylic nose cone will be the Insta 360 One X camera sponsored by Insta360. The camera weighs 115g including the battery and has the dimensions of 4.53 in x 1.89 in x 1.10 in. This will allow us to capture flight footage in a 360° view with a resolution of 5.7K fully stabilized.

Figure 4.3.2

4.3.3 Airframe

The first airframe material we are considering is carbon fiber. Carbon fiber is an excellent option due to its high strength to weight ratio and stiffness to weight ratio. Carbon fiber is an optimal choice for our project due to those properties; however, it has its disadvantages as well. If we decide to buy carbon fiber tubing, it will be expensive, and if we decide to buy cheaper carbon fiber sheets rather than the tubing, the manufacturing of the sheets will be difficult to fit our tight parameters on the rocket.

Another airframe material that we are considering is phenolic tubing wrapped in a kevlar sock. The phenolic would a much more cost-efficient purchase when compared to the carbon fiber. While the phenolic is a brittle material, the kevlar sock and the epoxy should reinforce the material to provide additional strength to the material, thereby reducing the risk of failure and increasing safety. Our team also has past experience with the manufacturing of this phenolic tubing wrapped in kevlar sock. This will help reduce manufacturing time because the team knows the processes used to manufacture this and has prior tooling for epoxying the tubing.

4.3.4 Bulkheads

The bulkheads that we are considering this year are A-grade plywood with a thickness of ½ in. We are considering this due to its strength and cost effectiveness for the project. Due to this being the better quality of plywood, it should be able to withstand the load put onto it by the ejection charges. We plan to use plywood for three of the four bulkheads within our rocket. For the fourth bulkhead, we are considering using a fiberglass bulkhead of .13 in in thickness. This fourth G10-fiberglass bulkhead will be the bulkhead separating the nose cone and payload sections of the rocket. The reason for this thinner and weaker bulkhead (relative to the A-grade plywood) is because there is less stress that will be acted on that bulkhead, allowing us to cut down weight in this bulkhead while still keeping some strength in that bulkhead.

The bulkheads will be made using a CNC machine to obtain a precise diameter for an appropriate fitting into the airframe.

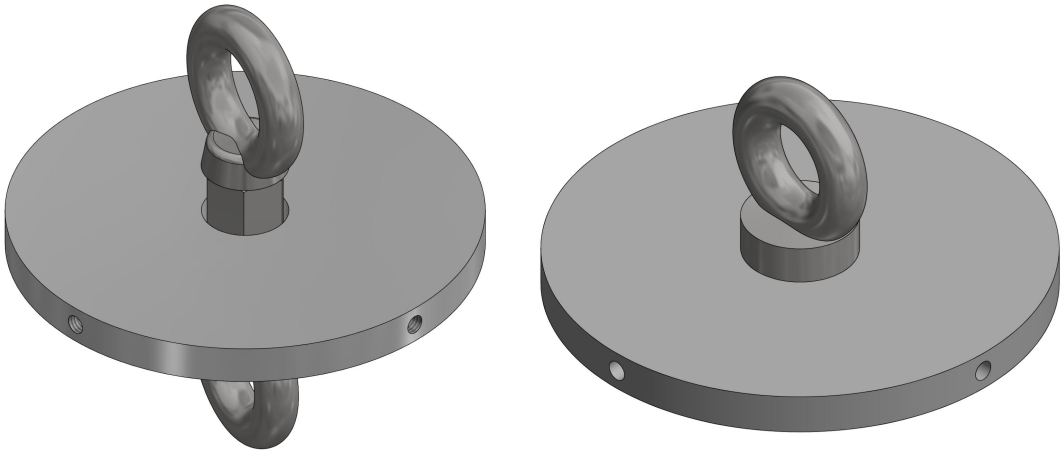


Figure 4.3.4

4.3.5 Motor

We are considering multiple motors to account for potential design changes to the rocket. The three motors we are considering for the vehicles propulsion system are the Cesaroni L-1395, Cesaroni L-1115 and Cesaroni L1355-SS. These Cesaroni motors are all L-class, 4 grain, reloadable, solid propellant motors that provide the ideal characteristics to achieve our apogee goal under a variety of scenarios. These three motors have identical dimensions of 75.00 x 621.00 mm (2.95 x 24.45 in). These motors most appropriately satisfy the specified design parameters outlined by the USLI handbook with the rocket's current configuration. These motors meet all of the necessary design/flight criteria, bringing the rocket within the required apogee range.

The Cesaroni L-1395 has a mass of 4320.0 grams (9.52 lb) and delivers a maximum thrust of 1779.90 N (400.48 lb) for a burn time of 3.51 seconds, yielding an apogee of 5854 feet. This motor uses blue streak as propellant.

The Cesaroni L-1115 has a mass of 4404 grams (9.71 lb) and delivers a maximum thrust of 1713.25 N (385.48 lb) with a burn time of 4.48 seconds, bringing the rocket to an apogee of 5976 feet. This greater burn time and the motors ability to achieve a higher apogee is why this motor is being considered; in the event of the rocket's design weight increasing, this motor will be able to attain an equally appropriate apogee. This motor uses classic propellant.

The Cesaroni L-1355-SS has a mass of 4962 grams (10.94 lb) and delivers a maximum thrust of 1792.20 N (402.9 lb) for a burn time of 3.0 seconds, launching the rocket to an apogee of 4257 feet, with the rocket's current weight configuration. This motor is being considered in the event that the vehicle design changes decrease the

overall weight of the rocket. The lesser burn time of this motor accompanying a lessened vehicle weight would deliver the rocket to the appropriate apogee. This motor uses smokey sam propellant.

4.3.5.1 Motor Casing

The proposed Cesaroni 75mm 4 grain L-Class motors utilizes Cesaroni Pro 75 4G reloadable motor casings. This commercial off-the-shelf casing is rated to withstand the forces generated by the motor grain and contain the pressure generated by the propellant grains as it burns.

4.3.5.2 Motor Retention

Retention methods of the Cesaroni L-1395 motor could include but is not limited to, a motor casing, motor mount tube, centering rings, epoxy, thrust plate, nuts and bolts, motor retainer and encapsulating foam. We are explicitly not utilizing any form of friction fitting methods to retain the motor.

The motor casing is capable of containing the pressure of the motor, preventing damage to the vehicle body. The engine casing and motor are 2.953 inches (75 millimeters), which fit into the interior airframe diameter of 6 inches (15.2 centimeters). Centering rings made of plywood prevent the motor from radially shifting inside the airframe body. The centering rings fasten to the airframe body via epoxy.

The thrust plate prevents the plywood centering rings from splitting due to the force of the motor. The thrust plate secondly prevents the motor from moving axially within the body of the airframe. A motor retainer fastened to the bottom of the thrust plate via a screw-on system prevents the motor from falling out of the airframe.

Encapsulating foam is being considered. It would be applied within the voids between the centering rings, motor mount tube, and interior vehicle walls to provide additional stability.

The application and implementation of various retention methods significantly reduces the likelihood of potential motor-related incidents, preventing a negative impact on vehicle performance and mission assurance. Ensuring that the motor is safely retained in the vehicle body ensures that no person or property is harmed as a result of motor retention failure.

4.3.5.3 Centering Rings

We are proposing using three centering rings which are ⅛ in in thickness and 6 inches in diameter. The centering rings will be placed at the top, middle, and bottom of the motor. We are considering using different types of wood such as bass wood or plywood. The centering rings will be laser cut to ensure proper dimensioning and shape.

4.3.6 Fins

The fins on the rocket will be a trapezoidal shape. We chose the trapezoidal shape because it has low induced drag. There will be 3 fins which have the following measurements: root chord is 11.97 inches, tip chord is 7.97 inches, height is 5 inches, sweep length is 4.02 inches, sweep angle is 4.02 inches, and the fillet radius is 0.25 inches. The fillet will be done with carbon fiber; this improves the aerodynamics of the rocket and increases the fins' stability. We have changed our design from 4 fins to 3 fins in order to keep the rocket from becoming overly stable. We are considering carbon fiber to be one of the materials we would use due to its high strength to low weight ratio. We would be manufacturing the carbon fiber fins using a CNC router.

Another fin material we are considering is G-10 fiberglass. G-10 fiberglass is a strong, lightweight, and affordable material. If we were to choose this material for the fins, they would also be manufactured using a CNC machine.

4.3.7 Rail Buttons

Two rail buttons will be used to keep the launch vehicle vertical until it has reached an acceleration of a minimum of 52 fps at launch rail exit. The rail buttons will fit a 12 foot 1515 launch rail per the NASA Student Launch Handbook. The first launch rail button will be placed at the center of gravity 62.20 in from the top of the rocket. The second launch rail button will be placed at the center of pressure 87.51 inches from the top of the rocket. The launch rail buttons will be a minimum of 12 inches apart.

4.3.8 Projected Altitude

Based on projected weight, rocket dimensions and motor selection, our projected altitude is approximately 5605 ft for L-115 motor and 5853 feet for the L1395 motor. The difference in altitude is to accommodate for vehicle variance. In order to calculate what our launch vehicles projected altitude would be, we used Open Rocket simulations.

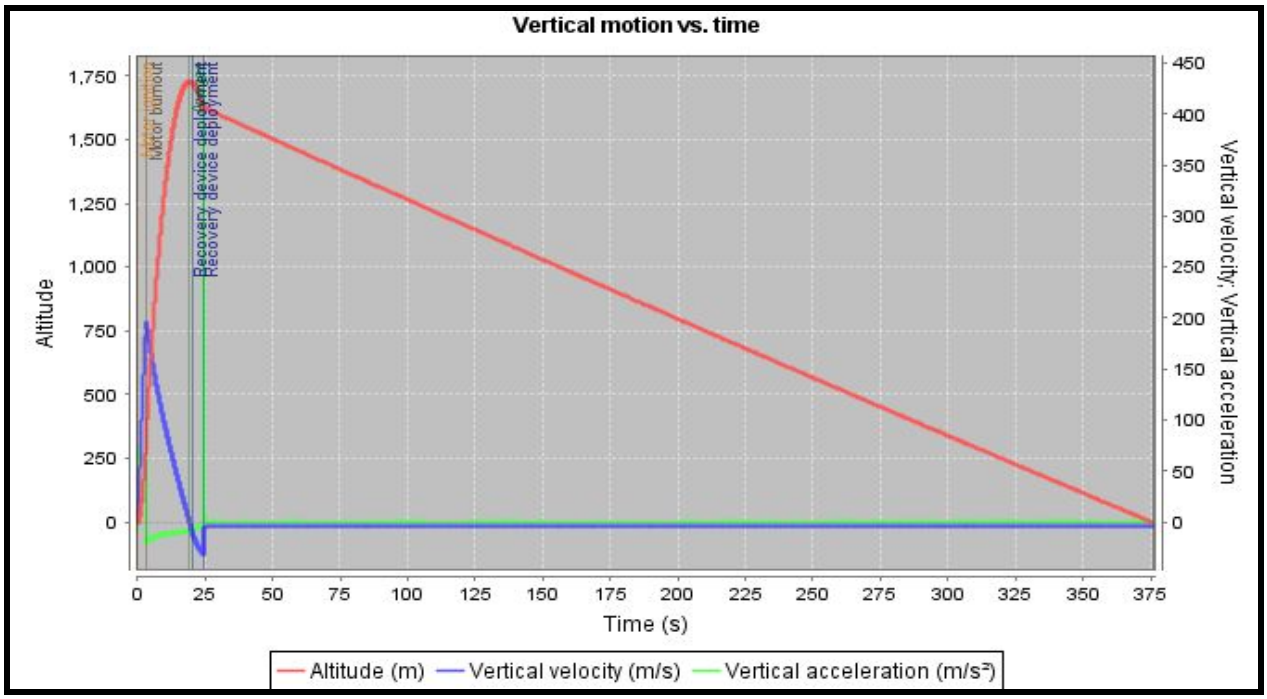


Figure 4.3.3

4.4 Recovery Design Overview

4.4.1 Recovery System Requirements

1. The launch vehicle will stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee, and the main parachute is deployed at a lower altitude. Tumble or streamer recovery from apogee to main parachute deployment is also permissible, provided that kinetic energy during drogue stage descent is reasonable, as deemed by the RSO.

a. The main parachute shall be deployed no lower than 500 feet.
b. The apogee event may contain a delay of no more than 2 seconds.
c. Motor ejection is not a permissible form of primary or secondary deployment.

2. Each team must perform a successful ground ejection test for both the drogue and main parachutes. This must be done prior to the initial subscale and full-scale launches.
3. Each independent section of the launch vehicle will have a maximum kinetic energy of 75 ft-lbf at landing.
4. The recovery system will contain redundant, commercially available altimeters. The term “altimeters” includes both simple altimeters and more sophisticated flight computers.
5. Each altimeter will have a dedicated power supply, and all recovery electronics will be powered by commercially available batteries.
6. Each altimeter will be armed by a dedicated mechanical arming switch that is accessible from the exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.
7. Each arming switch will be capable of being locked in the ON position for launch (i.e. cannot be disarmed due to flight forces).
8. The recovery system's electrical circuits will be completely independent of any payload electrical circuits.
9. Removable shear pins will be used for both the main parachute compartment and the drogue parachute compartment.
10. The recovery area will be limited to a 2,500 ft. radius from the launch pads.
11. Descent time will be limited to 90 seconds (apogee to touch down).
12. An electronic tracking device will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.

a. Any rocket section or payload component, which lands untethered to the launch vehicle, will contain an active electronic tracking device.
b. The electronic tracking device(s) will be fully functional during the official flight on launch day.

13. The recovery system electronics will not be adversely affected by any other on-board electronic devices during flight (from launch until landing).

a. The recovery system altimeters will be physically located in a separate compartment within the vehicle from any other radio frequency transmitting device and/or magnetic wave producing device.
b. The recovery system electronics will be shielded from all onboard transmitting devices to avoid inadvertent excitation of the recovery system electronics.
c. The recovery system electronics will be shielded from all onboard devices which may generate magnetic waves (such as generators, solenoid valves, and Tesla coils) to avoid inadvertent excitation of the recovery system.
d. The recovery system electronics will be shielded from any other onboard devices which may adversely affect the proper operation of the recovery system electronics.

4.4.2 Recovery and Descent

The Recovery System will be composed of a dual deployment system including both a drogue and main parachute. To slow descending velocity, a blackpowder charge ignition will eject a drogue parachute at apogee, separating the rocket into the front and rear sections. During the descent, another black powder ignition charge will eject a main parachute, separating the ebay from the motor bay in the rear section and lowering the rocket safely to the ground.

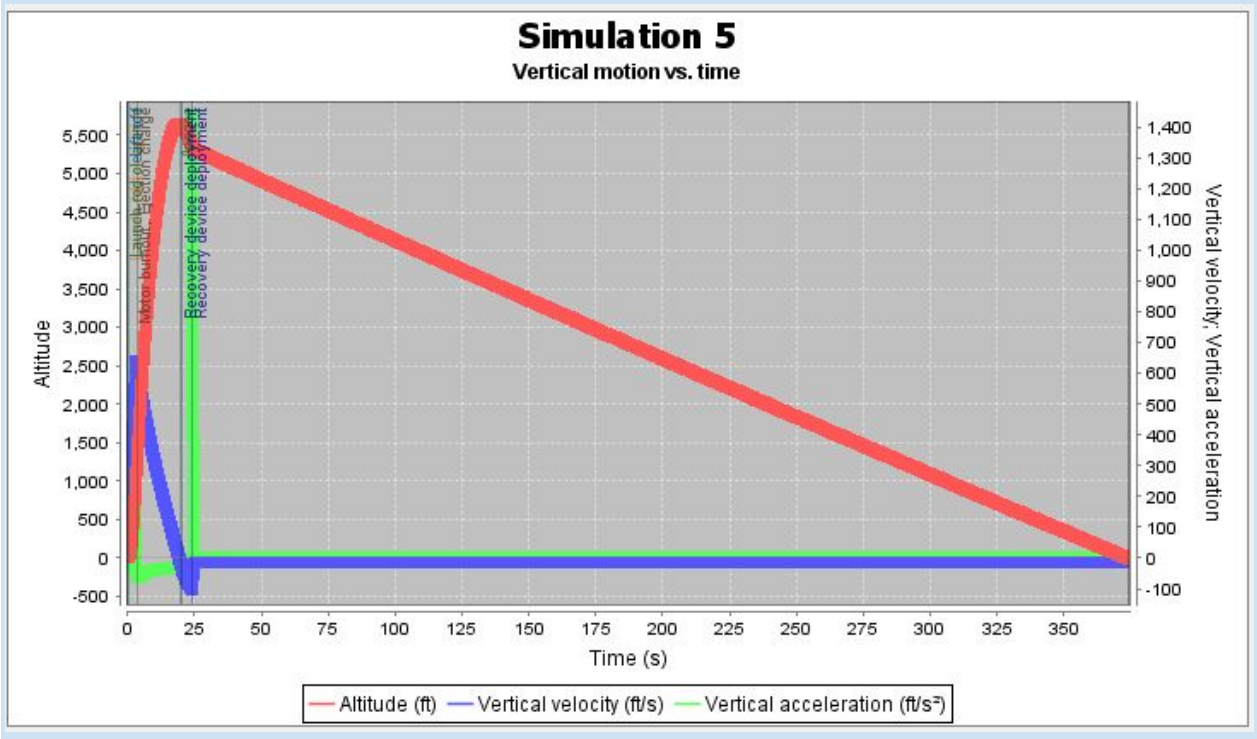


Figure 4.4.1

Stages of Flight:

Stage 1: The rocket launches and ascends

Stage 2: At apogee, the drogue parachute is ejected, separating the front from the rear section.

Stage 3: The front and rear sections fall while connected by the drogue parachute and shock cords.

Stage 4: During the descent, the main parachute is ejected, separating the ebay and motor bay in the rear section.

Stage 5: The front and rear section components fall safely to the ground in compliance with kinetic energy and recovery area radius requirements.

4.4.3 Altimeters

The ebay will consist of two altimeters, each run by its own 9V battery. Each altimeter will contain two precalculated black powder charges to be ignited by electronic matches. The purpose of the altimeters is to function as pressure gauges, record pressure difference, and ignite the set of parachute ejection events. The primary altimeter will serve as the initial ignition for the drogue and main parachutes while the secondary altimeter will serve as a backup in the event that the primary charges fail to eject the parachutes (firing within 2 seconds of the primary altimeter). The altimeters will be protected from interference by aluminum foil secured to the faces of bulkheads on either side of the ebay section.

4.4.4 Parachutes

One drogue and one main parachute will be used in the recovery system for the rocket. The drogue parachute diameter will be 14 ft and the main parachute diameter will be 14 ft. Both parachutes will be made out of nylon and secured to the rocket through the use of eye bolts and shock cords. At apogee, the drogue parachute will eject from the space between the payload and ebay sections. There will be a bulkhead with an eye bolt located below the drogue parachute. The drogue parachute and eyebolt will be connected by a 30 ft kevlar shock cord. During descent, the main parachute will eject from the space between the ebay and motor sections. The main parachute will be connected to the rocket via two kevlar shock cords, one short and one long. The10 ft short shock cord will connect the main parachute to the eyebolt in the bulkhead above the motor while the 40 ft long shock cord will connect the main parachute to the eyebolt in the bulkhead under the ebay section.

4.4.4.1 Parachute Ejection and Drift

The drogue parachute will be released at apogee (5,853 ft) and the main parachute will be released during the descent. The calculated drift from apogee will be presented in the next USLI documentation. The calculated velocity for the rocket’s descent is 11.26 ft/s.

4.4.4.2 Shear Pins

The purpose of the shear pins is to mark and create separation points in the rocket. When a predetermined amount of force is detected inside the rocket due to parachute expansion, the pins will break and separate the rocket sections. The shear pins are designed to be the weakest part of the rocket, to make separation easy and the descent safe. Each shear pin will be made from nylon material.

4.4.4.3 Charges

Black powder charge ignition will ensure that both parachutes are fully ejected. The first charge will go off at apogee to separate the drogue, nose cone, and payload from the rest of the rocket. The second charge will go off about 5 seconds after apogee to release the main parachute, ensuring the safe descent of the rocket. The purpose of the delay is to prevent the entanglement of the shockcords and to make sure the rocket has built up enough velocity to descend without a large amount of drift. To ensure the safety of the team and others, the blackpowder charges/parachute ejection will be tested on the ground before launch.

4.4.4.4 Shock Cords

Kevlar shock cords will connect the parachutes to the eye bolts in the bulkheads of the rocket. Each shock cord will be double the length of the body of the section from which it is exiting.

4.4.4.5 Calculations

	Variable	Units
Coefficient of drag	c_D	-
Weight	W	lb_m
Gravity	g	$^{lb_m \cdot ft}/_{lb_f \cdot s^2}$
Kinetic energy	KE	$ft \cdot lb_f$
Parachute area	A_p	ft^2
Drag force	F_D	lb_f
Density of air	ρ	$^{lb_m}/_{ft^3}$
velocity	v	$^{ft}/_{s}$

Table 4.1

Velocity:

The velocity after apogee can be calculated by rearranging the equation for kinetic energy:

$$KE = \frac{1}{2} \cdot m \cdot v^2$$

The rearranged equation:

$$v = \sqrt{\frac{2 \cdot KE \cdot g}{W}}$$

After plugging in the known values, the maximum descent velocity is calculated to be 11.26 ft/s.

Parachute Area:

After the maximum velocity has been calculated, the area of the parachute can be calculated by rearranging the equation for drag force:

$$F_D = \frac{1}{2} \cdot c_D \cdot \rho \cdot v^2 \cdot A_p$$

The rearranged equation:

$$A_p = \frac{2 \cdot W \cdot g}{c_D \cdot \rho \cdot v^2}$$

After plugging in the known values, using an air density of 0.07184 lb_m/ft^3, and a coefficient of drag value of 1.75, the main parachute needs to have at least a 14 ft diameter.

4.5 Payload Design

4.5.1 Payload requirements

Teams will design a system capable of being launched in a high power rocket, landing safely, and recovering simulated lunar ice from one of several locations on the surface of the launch field. The method(s)/design(s) utilized will be at the teams' discretion and will be permitted so long as the designs are deemed safe, obey FAA and legal requirements, and adhere to the intent of the challenge.

An additional experiment (limit of 1) is allowed, and may be flown, but will not contribute to scoring. If the team chooses to fly an additional experiment, they will provide the appropriate documentation in all design reports so the experiment may be reviewed for flight safety.

4.5.2 Lunar Ice Sample Recovery Mission Requirements Defined by NASA	**Verification**
The launch vehicle will be launched from the NASA-designated launch area using the provided Launch pad. All hardware utilized at the recovery site must launch on or within the launch vehicle.	The payload will be launched within the launch vehicle.
Five recovery areas will be located on the surface of the launch field. Teams may recover a sample from any of the recovery areas. Each recovery site will be at least 3 feet in diameter and contain sample material extending from ground level to at least 2 inches below the surface. The recovered ice sample will be a minimum of 10 milliliters (mL). Once the sample is recovered, it must be stored and transported at least 10 linear feet from the recovery area.	The payload team will follow these rules when designing the payload vehicle to capture the ice sample.
Teams must abide by all FAA and NAR rules and regulations.	We will ensure we follow and abide by all FAA and NAR rules and regulations.

Black Powder and/or similar energetics are only permitted for deployment of in-flight recovery systems. Any ground deployments must utilize mechanical systems.	We will ensure black powder and/or similar energetics are only used for deployment of in-flight recovery systems. We will also ensure if we choose ground deployment will use a mechanized system to extract the payload.
Any part of the payload or vehicle that is designed to be deployed, whether on the ground or in the air, must be fully retained until it is deployed as designed.	We will ensure the payload and CANSAT will be fully retained until the designed deployment.
A mechanical retention system will be designed to prohibit premature deployment. The retention system will be robust enough to successfully endure flight forces experienced during both typical and atypical flights. The designed system will be fail-safe Exclusive use of shear pins will not meet this requirement	We will ensure the CANSAT has a mechanical retention system designed to prohibit premature deployment, will be robust enough to endure flight forces during both typical and atypical flight, and will be fail-safe.
Any experiment element that is jettisoned during the recovery phase will receive real-time RSO permission prior to initiating the jettison event.	Our deployment method is purely mechanical as it is pulled out of the airframe by the drogue chute.
Unmanned aerial vehicle (UAV) payloads, if designed to be deployed during descent, will be tethered to the vehicle with a remotely controlled release mechanism until the RSO has given permission to release the UAV.	Our CANSAT will house either our UAV or rover until it reaches the ground, at which point it mechanically deploys.
Teams flying UAVs will abide by all applicable FAA regulations, including the FAA's Special Rule for Model Aircraft (Public Law 112-95 Section 336; see https://www.faa.gov/uas/faqs).	Our team will review all relevant laws and regulations during the design phase to remain in compliance with all laws and regulations.

Any UAV weighing more than .55 lbs. will be registered with the FAA and the registration number marked on the vehicle.	Our team will review all relevant laws and regulations during the design phase to remain in compliance with all laws and regulations.

Table 4.2

4.5.2 Operation

Utilizing three separate system configurations for remote activation, separation, and flight operation, the Unmanned Aerial Vehicle (UAV) achieves general autonomous completion performance. A remote console communicates to the CANSAT to remote activate the mechanism to open the CANSAT and release the UAV.

Effective system integration is achieved through cohesion of payload housing design and launch vehicle limitations in accordance with safety requirements. This includes multiple flight control redundancies and the limited use of less-tolerable electrical and mechanical hardware. The overall system structure can be categorized into three separate groups: mechanical hardware, electrical hardware, and software.

4.5.3 Hardware

4.5.3.1 Mechanical

Based on specifications provided by the vehicle team, the UAV must not exceed 5 inches (12.7 cm) in diameter while inside the CANSAT. The CANSAT and recovery system must not exceed 6 inches (15.24cm) in diameter while inside the launch vehicle. The amount of space allotted to the CANSAT containing payload as well as its recovery system lengthwise is 18 inches (45.72 cm). The body of the UAV is made of lightweight material so that the vehicle weighs approximately 1.4 lbs (635.029 grams). To better save space in the CANSAT housing, the rotor arms are folded parallel to launch vehicle making a pyramid shape around center of UAV, utilizing the extra space. Once the rocket lands, an electronically controlled mechanical system releases the vehicle housing on the payload section as the fairing.

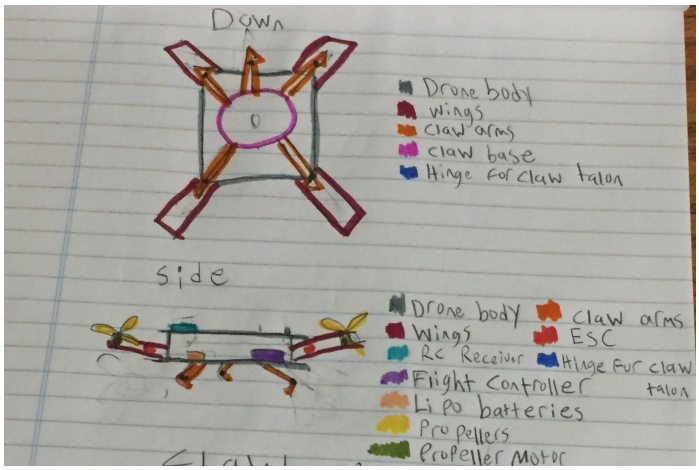


Figure 4.5.2

4.5.3.2 CANSAT Mechanical Components and Operation

The payload will be delivered via a CANSAT deployed at apogee. This system will then initiate a guided decent with control surfaces aided by computer vision software, a collection of avionic sensors, and other telemetry gathering methods. An alternative method of jettisoned-payload control would be a manned-guided descent utilizing radio control and a first-person vision link to the CANSAT. These methods will ensure minimal drift of the payload due to wind and maximize mission assurance by ensuring deployment of our mission solution as close to the ice-collection area as possible. At a specified altitude, the CANSAT will deploy a parachute and touch down in close proximity to the ice-collection area and initiate its collection sequence.

The proposed design utilizes, but is not limited to, grid fins as a method for attitude control. The grid fins will be controlled by a microcontroller which will process the telemetry data being fed to it and process the necessary attitude corrections for precise guidance. If required, this system should be able to transition over to manned control in the event of a system anomaly.

The proposed materials and construction of the CANSAT are a combination of aramid and carbon fiber composites, utilizing sandwich cores where possible and necessary, with minimal use of metal. This combination of materials will allow us to achieve maximum weight savings, minimize risk to ground crew, allow for the manipulation of radio transparency, while ensuring maximum structural strength and rigidity.

Our proposed primary recovery solution utilizes a single main parachute deployed via conventional pyrotechnic charge detonated by a commercial off the shelf altimeter with redundancy. The CANSAT will contain a radio transponder/tracker in compliance with competition, NAR, and Tripoli guidelines and rules.

The proposed design for the CANSAT allows for it open via remote initiation and allow for egress of the mission solution to the ice-collection area.

Upon egressing the CANSAT, the UAV will release the 4 sections of arms down by a spring release system. This allows the UAV to make up a compact space and also always deploy in correct orientation regardless of the direction the CANSAT falls.

4.5.3.3 Electrical

Operation of the payload requires a remote activation method from the ground to begin the separation and start-up process. This transmission is achieved through the implementation of an RF (radio frequency) transmitter in the remote console and a receiver in the launch vehicle. The transmission on the 433 MHz band follows the Federal Communication Commission's (FCC) regulations in Title 47 Part 15 on unlicensed and amateur radio transmissions. It is also used under a limited effective radiated power (ERP) to prevent interference on that band. The receiver is located within the nose cone of the rocket, just above the payload section. Fiberglass, being RF transparent, allows easy receiver to controller connection to be achieved for the fairing and payload separation procedure.

General UAV flight operations are being performed in a fundamental configuration of autonomy using a Arduino Nano and Arduino Uno to send basic direction information to a flight controller. This flight controller then interprets the data and varies speed and maneuvering control by sending a pulse width modulated (PWM) signal to each of the four motors' electronic speed controllers (ESC). The power source for the drone's internal electronics is a +2000mAh lithium-polymer (Li-Po) battery able to supply a continuous current upwards of 10A.

The chosen motors, Energy Propel 2216-20A Brushless Motor w/ESC, have an approximate diameter of 0.87in (22mm), plus/minus some variation for future need, with an approximate maximum power output of 370W in quadcopter configuration.

4.5.4 Software

The UAV will be programmed in Arduino and will be controlled by an RC receiver. The UAV's electronic speed control (ESC), flight control, and RC receiver will be programmed using Arduino's software.

4.5.4.1 Ice Sample Capture

Attached to the UAV on bottom is a mechanical claw powered by gravity to grip around ice sample. The final product will be 3D printed PLA plastic or use balsa wood with rubber ends to grasp around ice sample. We will be looking into making the ice sample capture autonomous by using ultrasonic sensors and mechanizing the claw open and closure.

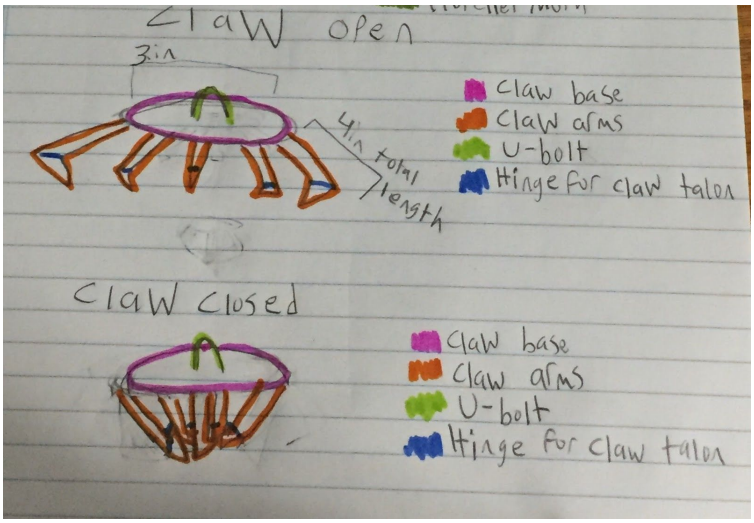


Figure 4.5.2

4.5.4.2 Return:

After capture, the UAV will be driven and flown to return to payload site where the payload deployment and CANSAT will remain.

4.5.4.3 Landing

The landing procedure begins with similar alignment and set-up as take-off. The pilot will slowly make the descent until a soft landing has occurred. The vehicle will then power off the motors and wait for the next flight instruction.

4.6 Technical Design Compliance*

Requirement	Compliance
2.1 The vehicle will deliver the payload to an apogee altitude between 3,500 and 5,500 feet above ground level (AGL). Teams flying below 3,000 feet or above 6,000 feet on Launch Day will be disqualified and receive zero altitude points towards their overall project score.	We are projected to hit a target altitude of approximately 5605 ft which is within the range parameters given for launch day.
2.2 Teams shall identify their target altitude goal at the PDR milestone. The declared target altitude will be used to determine the team's altitude score during Launch Week.	The targeted altitude goal for our rocket is approximately 5605 ft.
2.3 The vehicle will carry one commercially available, barometric altimeter for recording the official altitude used in determining the Altitude Award winner. The Altitude Award will be given to the team with the smallest difference between their measured apogee and their official target altitude on launch day. This altimeter may also be used for deployment purposes	The ebay will consist of two altimeters each run by its own 9V battery.
2.4. The launch vehicle will be designed to be recoverable and reusable. Reusable is defined as being able to launch again on the same day without repairs or modifications.	We intend for our recovery system to work as stated with the drogue and main parachutes carrying the rocket bodies down. The descent of the rocket is calculated to be 11.26 ft/s, which will keep the rocket body reusable upon landing.

2.5. The launch vehicle will have a maximum of four (4) independent sections. An independent section is defined as a section that is either tethered to the main vehicle or is recovered separately from the main vehicle using its own parachute. 2.5.1. Coupler/airframe shoulders which are located at in-flight separation points will be at least 1 body diameter in length. 2.5.2. Nosecone shoulders which are located at in-flight separation points will be at least ½ body diameter in length.	The rocket will have 4 separate sections. It will have the parload, recovery, ebay, and motor sections.
2.6. The launch vehicle will be capable of being prepared for flight at the launch site within 2 hours of the time the Federal Aviation Administration flight waiver opens.	The altimeters and batteries will be tested prior to launch to ensure that they will last up to five hours, and the payload will have an onboard switch to activate the payload remotely.
2.7. The launch vehicle and payload will be capable of remaining in launch-ready configuration on the pad for a minimum of 2 hours without losing the functionality of any critical on-board components, although the capability to withstand longer delays is highly encouraged.	The altimeters and batteries will be tested prior to launch to ensure that they will last up to five hours, and the payload will have an onboard switch to activate the payload remotely.
2.8. The launch vehicle will be capable of being launched by a standard 12-volt direct current firing system. The firing system will be provided by the NASA-designated launch services provider	We will utilize launch systems provided by NASA.
2.9. The launch vehicle will require no external circuitry or special ground support equipment to initiate launch (other than what is provided by the launch services provider).	All the circuitry components will be confined to the rocket.
2.10. The launch vehicle will use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), Tripoli Rocketry Association (TRA), and/or	The current motors that we are running our simulations on are for the L-115 and the L1395 which are both commercially available and are using approved propellant according to the NAR and TRA. The final motor choice will be decided by the CDR.

the Canadian Association of Rocketry (CAR). 2.10.1. Final motor choices will be declared by the Critical Design Review (CDR) milestone. 2.10.2. Any motor change after CDR must be approved by the NASA Range Safety Officer (RSO) and will only be approved if the change is for the sole purpose of increasing the safety margin. A penalty against the team's overall score will be incurred when a motor change is made after the CDR milestone, regardless of the reason	
2.11. The launch vehicle will be limited to a single stage.	The launch vehicle will be confined to a single stage.
2.12. The total impulse provided by a College or University launch vehicle will not exceed 5,120 Newton-seconds (L-class). The total impulse provided by a High School or Middle School launch vehicle will not exceed 2,560 Newton-seconds (K-class).	We are currently planning on utilizing a L-Class motor.
2.13. Pressure vessels on the vehicle will be approved by the RSO and will meet the following criteria: 2.13.1. The minimum factor of safety (Burst or Ultimate pressure versus Max Expected Operating Pressure) will be 4:1 with supporting design documentation included in all milestone reviews. 2.13.2. Each pressure vessel will include a pressure relief valve that sees the full pressure of the tank and is capable of withstanding the maximum pressure and flow rate of the tank. 2.13.3. The full pedigree of the tank will be described, including the application for which the tank was designed and the history of the tank. This will include the number of pressure cycles put on the tank, the dates of pressurization/depressurization, and the name of the person or entity administering each pressure event.	We will not incorporate any pressure vessels in our design.
2.14. The launch vehicle will have a minimum static stability margin of 2.0 at the point of rail exit. Rail exit is defined at the	According to our current OpenRocket design we have a stability margin of 2.42, which is over the required 2.

point where the forward rail button loses contact with the rail.	
2.15. Any structural protuberance on the rocket will be located aft of the burnout center of gravity.	The only structural protrusion on our rocket is our fins, which will be located at the bottom of the airframe, behind the CP.
2.16. The launch vehicle will accelerate to a minimum velocity of 52 fps at rail exit.	Our current design and motor selection maintain a minimum of 65 fps LREV.
2.17. All teams will successfully launch and recover a subscale model of their rocket prior to CDR. Subscales are not required to be high power rockets. 2.17.1. The subscale model should resemble and perform as similarly as possible to the full-scale model, however, the full-scale will not be used as the subscale model. 2.17.2. The subscale model will carry an altimeter capable of recording the model's apogee altitude. 2.17.3. The subscale rocket must be a newly constructed rocket, designed and built specifically for this year's project. 2.17.4. Proof of a successful flight shall be supplied in the CDR report. Altimeter data output may be used to meet this requirement.	We will be constructing our sub-scale and testing it prior to November. It will be considered a L1 class HPR. The design will reflect the flight charistics of the full-scale rocket. We will also include altimeter data in the CDR as well as a video link of the launch in the email containing the CDR.
2.18. All teams will complete demonstration flights as outlined below. 2.18.1. Vehicle Demonstration Flight - All teams will successfully launch and recover their full-scale rocket prior to FRR in its final flight configuration. The rocket flown must be the same rocket to be flown on launch day. The purpose of the Vehicle Demonstration Flight is to validate the 8 launch vehicle's stability, structural integrity, recovery systems, and the team's ability to prepare the launch vehicle for flight. A successful flight is defined as a launch in which all hardware is functioning properly (i.e. drogue chute at apogee, main chute at the intended lower altitude, functioning tracking devices, etc.). The following criteria must be met during the full-scale demonstration flight: 2.18.1.1. The	We will complete all testing well before the deadlines to make sure all relevant flight data is available to input inthe FRR and/or FRR addendum.

vehicle and recovery system will have functioned as designed. 2.18.1.2. The full-scale rocket must be a newly constructed rocket, designed and built specifically for this year's project. 2.18.1.3. The payload does not have to be flown during the full-scale Vehicle Demonstration Flight. The following requirements still apply: 2.18.1.3.1. If the payload is not flown, mass simulators will be used to simulate the payload mass. 2.18.1.3.2. The mass simulators will be located in the same approximate location on the rocket as the missing payload mass. 2.18.1.4. If the payload changes the external surfaces of the rocket (such as with camera housings or external probes) or manages the total energy of the vehicle, those systems will be active during the full-scale Vehicle Demonstration Flight. 2.18.1.5. Teams shall fly the launch day motor for the Vehicle Demonstration Flight. The team may request a waiver for the use of an alternative motor in advance if the home launch field cannot support the full impulse of the launch day motor or in other extenuating circumstances (such as weather). 2.18.1.6. The vehicle must be flown in its fully ballasted configuration during the full-scale test flight. Fully ballasted refers to the same amount of ballast that will be flown during the launch day flight. Additional ballast may not be added without a re-flight of the full-scale launch vehicle. 2.18.1.7 After successfully completing the full-scale demonstration flight, the launch vehicle or any of its components will not be modified without the concurrence of the NASA Range Safety Officer (RSO). 2.18.1.8. Proof of a successful flight shall be supplied in the FRR report. Altimeter data output is required to meet this requirement. 2.18.1.9. Vehicle Demonstration flights must be completed by the FRR submission deadline. No exceptions will be made. If the Student Launch office determines	

that a Vehicle Demonstration Re-flight is necessary, then an extension may be granted. THIS EXTENSION IS ONLY VALID FOR RE-FLIGHTS, NOT FIRST TIME FLIGHTS. Teams completing a required re-flight must submit an FRR Addendum by the FRR Addendum deadline. 2.18.2. Payload Demonstration Flight - All teams will successfully launch and recover their full-scale rocket containing the completed payload prior to the Payload Demonstration Flight deadline. The rocket flown must be the same rocket to be flown on launch day. The purpose of the Payload Demonstration Flight is to prove the launch vehicle's ability to safely retain the constructed payload during flight and to show that all aspects of the payload perform as designed. A successful flight is defined as a launch in which the rocket experiences stable ascent and the payload is fully retained until it is deployed (if applicable) as designed. The following criteria must be met during the Payload Demonstration Flight: 2.18.2.1. The payload must be fully retained until the intended point of deployment (if applicable), all retention mechanisms must function as designed, and the retention mechanism must not sustain damage requiring repair. 2.18.2.2. The payload flown must be the final, active version. 9 2.18.2.3. If the above criteria are met during the original Vehicle Demonstration Flight, occurring prior to the FRR deadline and the information is included in the FRR package, the additional flight and FRR Addendum are not required. 2.18.2.4.Payload Demonstration Flights must be completed by the FRR Addendum deadline. NO EXTENSIONS WILL BE GRANTED.	
2.19. An FRR Addendum will be required for any team completing a Payload Demonstration Flight or NASArequired	We will complete all testing well before the deadlines to make sure all relevant flight data is available to input inthe FRR and/or FRR

Vehicle Demonstration Re-flight after the submission of the FRR Report. 2.19.1. Teams required to complete a Vehicle Demonstration Re-Flight and failing to submit the FRR Addendum by the deadline will not be permitted to fly the vehicle at launch week. 2.19.2. Teams who successfully complete a Vehicle Demonstration Flight but fail to qualify the payload by satisfactorily completing the Payload Demonstration Flight requirement will not be permitted to fly the payload at launch week. 2.19.3. Teams who complete a Payload Demonstration Flight which is not fully successful may petition the NASA RSO for permission to fly the payload at launch week. Permission will not be granted if the RSO or the Review Panel have any safety concerns.	addendum.
2.20. The team's name and launch day contact information shall be in or on the rocket airframe as well as in or on any section of the vehicle that separates during flight and is not tethered to the main airframe. This information shall be included in a manner that allows the information to be retrieved without the need to open or separate the vehicle.	We will include labels with team information in all sections next to the flight separation points.
2.21. All Lithium Polymer batteries will be sufficiently protected from impact with the ground and will be brightly colored, clearly marked as a fire hazard, and easily distinguishable from other payload hardware.	We will create special mounting hardware that will protect the Li-Po batteries from sudden shock during the flight.

*Requirements as defined by 2020 NASA Student Launch Handbook and Request for Proposal

Table 4.3

STEM Engagement

5.1 Planned STEM Engagement Activities

As of the writing of this proposal, we have a couple of events planned for STEM Engagement within the community. The team plans to host an educational event at one of our facilities, potentially Reese Technology Center. The team will teach students from the general student body of Texas Tech, members of Raider Aerospace Society and the students in the USLI project about the basics of rocketry to help educate them for future aerospace interests and careers. We estimate that this event will have 50 attendees participating. Another event that the team has planned to participate in is the Texas Tech University Whitacre College of Engineering's "Catch the Engineering Bug." This is an event where the Whitacre College of Engineering invites female students from local middle schools to come to the Texas Tech campus and meet some of the clubs offered and affiliated with the university with the intention of encouraging young women to consider careers in STEM. We estimate that this event will have about 100 attendees participating.

5.1.1 Rocketry Training

The rocketry training educational outreach will be a two day course that teaches the basics of rocketry to any individual who wants to learn from the student body. This will be good to establish a more profound presence of aerospace at our university, since the current status of aerospace affairs at our university is limited to our organization's projects and the overlaps of engineering into the aerospace field. This will continue our goal to promote aerospace at Texas Tech University.

As for specifics, we plan to make a powerpoint presentation to present to a group going over rocket components, materials, and properties. After that we will go out to our facilities at Reese Technology Center and launch an LPR rocket kit to demonstrate the components, materials and properties discussed in class. Ideally, we would be able to get as many of these kits as possible so that the members can get the most experience possible within rocketry therefore igniting the drive in aerospace that we are striving for.

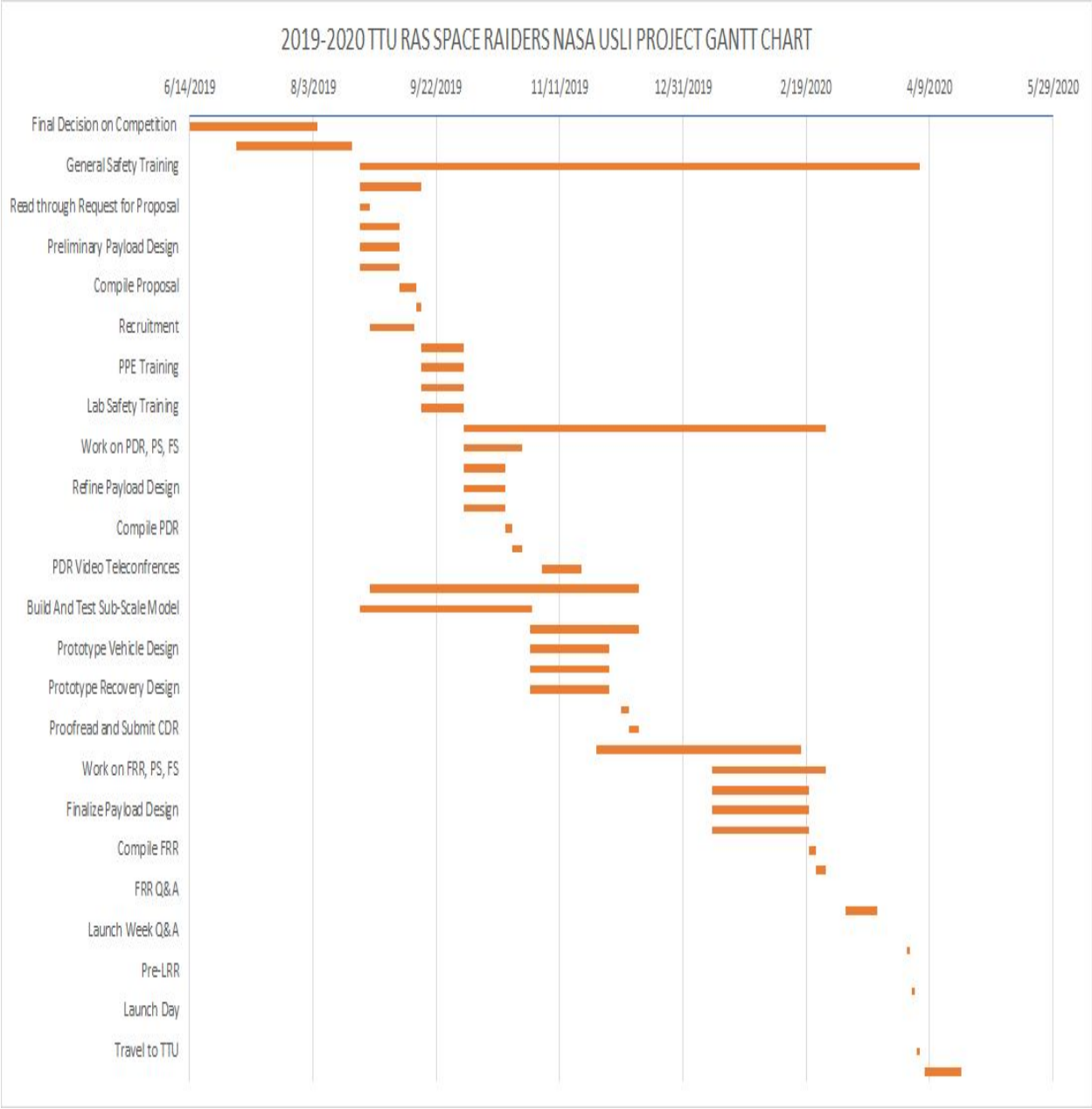
5.1.2 Catch the Engineering Bug

The Space Raiders team will also participate in a Texas Tech University Whitacre College of Engineering event called “Catch the Engineering Bug” which is an event aimed towards increasing the involvement of women in STEM careers and activities, since they are heavily underrepresented within these majors and careers. They accomplish this goal by bringing middle school girls out to a field in the middle of all the engineering buildings at Texas Tech where they will set up the event. The students get to meet with engineering students, play games, eat food, and have a good time. We participate and contribute by showing off our rockets and what we do as an organization to ignite their interest in not just STEM majors, but aerospace as well.

Project Plan

6.1 Schedule

The schedule we had developed for the 2019-2020 competition season is as follows:



TASK	START DATE	END DATE	DURATION
Final Decision on Competition	6/3/2019	8/5/2019	63
Decide Project Leads	7/3/2019	8/19/2019	47
General Safety Training	8/22/2019	4/5/2020	227
Work on Proposal	8/22/2019	9/16/2019	25
Read through Request for Proposal	8/22/2019	8/26/2019	4
Preliminary Vehicle Design	8/22/2019	9/7/2019	16
Preliminary Payload Design	8/22/2019	9/7/2019	16
Preliminary Recovery Design	8/22/2019	9/7/2019	16
Compile Proposal	9/7/2019	9/14/2019	7
Proofread and Submit Proposal	9/14/2019	9/16/2019	2
Recruitment	8/26/2019	9/13/2019	18
Training	9/16/2019	10/3/2019	17
PPE Training	9/16/2019	10/3/2019	17
Hazard Communication and Awareness Training	9/16/2019	10/3/2019	17
Lab Safety Training	9/16/2019	10/3/2019	17
STEM Engagement Activities	10/3/2019	2/27/2020	147
Work on PDR, PS, FS	10/3/2019	10/27/2019	24
Refine Vehicle Design	10/3/2019	10/20/2019	17
Refine Payload Design	10/3/2019	10/20/2019	17
Refine Recovery Design	10/3/2019	10/20/2019	17
Compile PDR	10/20/2019	10/23/2019	3
Proofread and Submit PDR	10/23/2019	10/27/2019	4
PDR Video Teleconfrences	11/4/2019	11/20/2019	16
Identify Members Attending MSFC	8/26/2019	12/13/2019	109
Build And Test Sub-Scale Model	8/22/2019	10/31/2019	70
Work on CDR, PS, FS	10/30/2019	12/13/2019	44
Prototype Vehicle Design	10/30/2019	12/1/2019	32
Prototype Payload Design	10/30/2019	12/1/2019	32
Prototype Recovery Design	10/30/2019	12/1/2019	32
Compile CDR	12/6/2019	12/9/2019	3
Proofread and Submit CDR	12/9/2019	12/13/2019	4
Full Scale Build and Test w/Payload	11/26/2019	2/17/2020	83
Work on FRR, PS, FS	1/12/2020	2/27/2020	46
Finalize Vehicle Design	1/12/2020	2/20/2020	39
Finalize Payload Design	1/12/2020	2/20/2020	39
Finalize Recovery Design	1/12/2020	2/20/2020	39
Compile FRR	2/20/2020	2/23/2020	3
Proofread and Submit FRR	2/23/2020	2/27/2020	4
FRR Q&A	1/31/2020	1/31/2020	0
FRR Video Teleconfrences	3/6/2020	3/19/2020	13
Launch Week Q&A	3/26/2020	3/26/2020	0
Travel to MSFC	3/31/2020	4/1/2020	1
Pre-LRR	4/1/2020	4/1/2020	0
Launch Week Activities	4/2/2020	4/3/2020	1
Launch Day	4/4/2020	4/4/2020	0
Awards Ceramony	4/4/2020	4/4/2020	0
Travel to TTU	4/4/2020	4/5/2020	1
Work on PLAR	4/7/2020	4/22/2020	15
Compile PLAR	4/15/2020	4/18/2020	3
Proofread and Submit PLAR	4/18/2020	4/22/2020	4

6.2 Budget

For the 2019-2020 competition season, we have partitioned our budget into separate sections to more efficiently allocate and track funds. We have separated our budget into 5 sections, Safety, Vehicle, Payload, Recovery, and Transportation. The tables below detail our preliminary budget for each sub-system and our proposed travel budget.

Safety Budget

Expense:	Quantity:	Subquantity:	Unit Cost Estimat	Cost:	Source:
First Aid Kits	2 Kits	2 150 piece kits	$0.00	$0.00	RAS
Fire Extuingsher	1 Extuingsher	1 ABC Class	$0.00	$150.00	RAS
Safety Glasses	24 Pairs	ANSI certified pa	$0.00	$700.00	RAS
Work Gloves	4 Boxes	4 50 pair boxes	$0.00	$903.00	RAS
				Total:	$0

Table 6.1

Vehicle Budget

Quantity:	Subquantity:	Unit Cost Estimate	Cost:	Source:
2 Sections	2 48" pieces Pre- Fab	$538.00	$1,076.00	Mad Cow Rocketry
1 Nose Cone	2.6" ogive cone	$24.99	$24.99	Sunward Products
1 Nose Cone	6" ogive cone	$113.03	$113.03	Apogee Rockets
3 Motors	3 Reload kits	$292.99	$878.97	CSRocketry
1 Retention Kit	Cesseroni Kit	$616.00	$616.00	Apogee Rockets
1 Casing	1 Blue tube casing	$32.04	$32.04	Apogee Rockets
1 4*8 Sheet	A grade wood	$44.75	$44.75	Home Depot
1 Bulkhead	1 bulkhead	$9.80	$9.80	Apogee Rockets
1 sheet	3 CNC rings cut	$14.64	$14.64	Amazon
3 sheets	3 CNC fins cut	$55.79	$111.58	Rock West Composites
1 sheet	3 CNC fins cut	$43.68	$43.68	Apogee Rockets
4 couplers	4 Pre-Fab	$94.95	$379.80	Public Missiles
4 Eye-bolts	4 Pre-Fab	$0.27	$1.08	ASP Rocketry
2 Gallons	1 Epoxy and one Hardener	$69.75	$139.50	Creative Wholesale
			Total:	$3,495.86

Table 6.2

Payload Budget

Expense:	Quantity:	Subquantity:	Unit Cost Estima	Cost:	Source:
CANSAT Electron	10 Components	10 Misc. electronics	$250.00	$250.00	Amazon
CANSAT Body	1 Complete Unit	1 Composite Unit	$250.00	$250.00	Apogee Components
Mission Vehicle	1 Vehicle	1 Composite Vehicle	$250.00	$250.00	Amazon
				Total:	$750

Table 6.3

Recovery Budget

Expense:	Quantity:	Subquantity:	Unit Cost Estima	Cost:	Source:
Parachutes	2 chutes	1 main & 1 drouge	$410.00	$410.00	Apogee Components
Altimeters	2 Altimeters	2 Altimeters	$82.64	$165.28	Apogee Components
				Total:	$575

Table 6.4

Travel To MSFC

Expense:	Quantity:	Subquantity:	Unit Cost Estima	Cost:	Source:
Vehicle	2 Vehicles	1 Van & 1 Truck	0	$0.00	TTU
Trailer	1 Trailer	5 days	$29.99/ day	$150.00	U-Haul
Fuel	300 Gallons	5 days	$2.30/gal	$700.00	AAA
Housing	1 House	5 rooms	$165/ night	$903.00	Airbnb
Food	180 Meals	3/ day	$20/ person/ day	$1,300.00	RAS
				Total:	$3,053

Table 6.5

6.3.1 Finance Introduction

The Space Raiders functions as a sub-committee of the Raider Aerospace Society (RAS) and therefore, is supported by Texas Tech University and is in affiliation with the Whitacre College of Engineering. The Treasurer of SR works directly between the Sub-team leads and the RAS Treasurer to efficiently allocate funds to the team.

6.3.2 Current Funding

Our funds currently consist of member fees, Student Government Association (SGA), fundraisers, and sponsorships. Funds allocated between

both RAS and the Space Raiders finance both learning and ambitious projects in these organizations.

6.3.3 Finance Activities

The RAS Finance Team acquires funds through the following activities: RAS membership dues, sponsorships, fundraisers, grants, TopTier Catering, and GoFundMe donations. The RAS Finance Team strives to be an active presence in the local community to inspire financial contributions to projects.

6.3.4 Finance Goals

Our finance goal is to raise $10,000 to be allocated between both RAS and Space Raiders. Donors that contribute to the goal can follow our progress on both social media as well as our blog posts on our website. The GoFundMe page contains our Financial Mission, which is as follows:

6.3.4.1 Financial Mission

“The Raider Aerospace Society is raising money for our High Powered Rocketry Competitive team, the Space Raiders. After conquering our first award, the team is ready for more action. The Space Raiders are returning for their second time, to the NASA University Student Launch Initiative (USLI) competition. We would like your support to help fund our ambitious. Help us send Texas Tech University's determined Space Raiders once again to Huntsville to launch their rocket.”

6.4 Sustainability

After losing 18 members to graduation this past spring, recruitment has become a primary focus for the beginning of this year. We have recruited new team members through multiple methods, including posting advertisements around campus and informing potential members about our work at the engineering organization fair.

RAS has made many efforts to ensure that the Space Raiders team is financially sustainable. RAS plans to raise $10,000 from a combination of various sources, including membership dues, sponsorships, fundraisers, grants, and GoFundMe donations.

Community outreach is very important to the success of the Space Raiders. We will be holding a two-day course on the basics of rocketry in the coming weeks. All are welcome to this event. We hope this will help to gain recognition and support from the Lubbock community.

Appendix I

Federal Aviation Administration Guidelines

Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; Amateur Rockets

Subpart C— Amateur Rockets

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§101.21 Applicability.

(a) This subpart applies to operating unmanned rockets. However, a person operating an unmanned rocket within a restricted area must comply with §101.25(b)(7)(ii) and with any additional limitations imposed by the using or controlling agency.

(b) A person operating an unmanned rocket other than an amateur rocket as defined in §1.1 of this chapter must comply with 14 CFR Chapter III.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

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§101.22 Definitions.

The following definitions apply to this subpart:

(a) *Class 1—Model Rocket* means an amateur rocket that:

(1) Uses no more than 125 grams (4.4 ounces) of propellant;

(2) Uses a slow-burning propellant;

(3) Is made of paper, wood, or breakable plastic;

(4) Contains no substantial metal parts; and

(5) Weighs no more than 1,500 grams (53 ounces), including the propellant.

(b) *Class 2—High-Power Rocket* means 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.

(c) *Class 3—Advanced High-Power Rocket* means an amateur rocket other than a model rocket or high-power rocket.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

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§101.23 General operating limitations.

(a) You must operate an amateur rocket in such a manner that it:

(1) Is launched on a suborbital trajectory;

(2) When launched, must not cross into the territory of a foreign country unless an agreement is in place between the United States and the country of concern;

(3) Is unmanned; and

(4) Does not create a hazard to persons, property, or other aircraft.

(b) The FAA may specify additional operating limitations necessary to ensure that air traffic is not adversely affected, and public safety is not jeopardized.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

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§101.25 Operating limitations for Class 2-High Power Rockets and Class 3-Advanced High Power Rockets.

When operating *Class 2-High Power Rockets* or *Class 3-Advanced High Power* Rockets, you must comply with the General Operating Limitations of §101.23. In addition, you must not operate *Class 2-High Power Rockets* or *Class 3-Advanced High Power* Rockets—

(a) At any altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails;

(b) At any altitude where the horizontal visibility is less than five miles;

(c) Into any cloud;

(d) Between sunset and sunrise without prior authorization from the FAA;

(e) Within 9.26 kilometers (5 nautical miles) of any airport boundary without prior authorization from the FAA;

(f) In controlled airspace without prior authorization from the FAA;

(g) Unless you observe the greater of the following separation distances from any person or property that is not associated with the operations:

(1) Not less than one-quarter the maximum expected altitude;

(2) 457 meters (1,500 ft.);

(h) Unless a person at least eighteen years old is present, is charged with ensuring the safety of the operation, and has final approval authority for initiating high-power rocket flight; and

(i) Unless reasonable precautions are provided to report and control a fire caused by rocket activities.

[74 FR 38092, July 31, 2009, as amended by Amdt. 101-8, 74 FR 47435, Sept. 16, 2009]

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§101.27 ATC notification for all launches.

No person may operate an unmanned rocket other than a Class 1—Model Rocket unless that person gives the following information to the FAA ATC facility nearest to the place of intended operation no less than 24 hours before and no more than three days before beginning the operation:

(a) The name and address of the operator; except when there are multiple participants at a single event, the name and address of the person so designated as the event launch coordinator, whose duties include coordination of the required launch data estimates and coordinating the launch event;

(b) Date and time the activity will begin;

(c) Radius of the affected area on the ground in nautical miles;

(d) Location of the center of the affected area in latitude and longitude coordinates;

(e) Highest affected altitude;

(f) Duration of the activity;

(g) Any other pertinent information requested by the ATC facility.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008, as amended at Doc. No. FAA-2007-27390, 74 FR 31843, July 6, 2009]

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§101.29 Information requirements.

(a) *Class 2—High-Power Rockets.* When a Class 2—High-Power Rocket requires a certificate of waiver or authorization, the person planning the operation must provide the information below on each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 2 rocket expected to be flown:

(1) Estimated number of rockets,

(2) Type of propulsion (liquid or solid), fuel(s) and oxidizer(s),

(3) Description of the launcher(s) planned to be used, including any airborne platform(s),

(4) Description of recovery system,

(5) Highest altitude, above ground level, expected to be reached,

(6) Launch site latitude, longitude, and elevation, and

(7) Any additional safety procedures that will be followed.

(b) *Class 3—Advanced High-Power Rockets.* When a Class 3—Advanced High-Power Rocket requires a certificate of waiver or authorization the person planning the operation must provide the information below for each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 3 rocket expected to be flown:

(1) The information requirements of paragraph (a) of this section,

(2) Maximum possible range,

(3) The dynamic stability characteristics for the entire flight profile,

(4) A description of all major rocket systems, including structural, pneumatic, propellant, propulsion, ignition, electrical, avionics, recovery, wind-weighting, flight control, and tracking,

(5) A description of other support equipment necessary for a safe operation,

(6) The planned flight profile and sequence of events,

(7) All nominal impact areas, including those for any spent motors and other discarded hardware, within three standard deviations of the mean impact point,

(8) Launch commit criteria,

(9) Countdown procedures, and

(10) Mishap procedures.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008, as amended at Doc. No. FAA-2007-27390, 74 FR 31843, July 6, 2009]

Appendix II *

National Association of Rocketry High Powered Rocketry Safety Code

High Powered Rocketry Safety Code

1. **Certification.** I will only fly high power rockets or possess high power rocket motors that are within the scope of my user certification and required licensing.
2. **Materials.** I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.
3. **Motors**. I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 25 feet of these motors.
4. **Ignition System.** I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the "off" position when released. The function of onboard energetics and firing circuits will be inhibited except when my rocket is in the launching position.
5. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.
6. **Launch Safety.** I will use a 5-second countdown before launch. I will ensure that a means is available to warn participants and spectators in the event of a problem. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table. When arming onboard energetics and firing circuits I will ensure that no person is at the pad except safety personnel and those required for arming and disarming operations. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable. When conducting a simultaneous launch of more than one high power rocket I will observe the additional requirements of NFPA 1127.
7. **Launcher.** I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 5 miles per hour I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor's exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying

Minimum Distance table, and will increase this distance by a factor of 1.5 and clear that area of all combustible material if the rocket motor being launched uses titanium sponge in the propellant.

8. **Size.** My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My rocket will not weigh more at liftoff than one-third of the certified average thrust of the high power rocket motor(s) intended to be ignited at launch.
9. **Flight Safety.** I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond the boundaries of the launch site, and will not put any flammable or explosive payload in my rocket. I will not launch my rockets if wind speeds exceed 20 miles per hour. I will comply with Federal Aviation Administration airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.
10. **Launch Site.** I will launch my rocket outdoors, in an open area where trees, power lines, occupied buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude to which rockets are allowed to be flown at that site or 1500 feet, whichever is greater, or 1000 feet for rockets with a combined total impulse of less than 160 N-sec, a total liftoff weight of less than 1500 grams, and a maximum expected altitude of less than 610 meters (2000 feet).
11. **Launcher Location.** My launcher will be 1500 feet from any occupied building or from any public highway on which traffic flow exceeds 10 vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the **appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site.**
12. **Recovery System**. I will use a recovery system such as a parachute in my rocket so that all parts of my rocket return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.
13. **Recovery Safety.** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places, fly it under conditions where it is likely to recover in spectator areas or outside the launch site, nor attempt to catch it as it approaches the ground.

Installed Total Impulse (Newton-Seconds)	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

*The information here came from the NAR High-Powered Rocketry Safety code

Appendix III

What follows is the RAS safety contract which will be signed by every member prior to beginning any hands on work on the team.

Safety Contract:

Rules and regulations:

Behavior and Conduct:

- Horseplay or aggressive actions towards any and all persons at any fabricating or professional will not be tolerated.
- The consumption, possession and the presence of alcohol pr other illicit substances will not be tolerated at any RAS activity.
- All food and drinks must be kept out of construction zones.
- Access to equipment other than that owned by RAS must be approved by a credible representative of ownership
- Members should NEVER run inside of the workspace building
- NEVER use equipment you are not familiar with and haven't been introduced to by an authorized RAS officer.
- Never work in poor lit areas.
- Keep yourself well balanced and never overreach.
- Never work with material that is broken or unclean.

- Always consult a RAS officer before using any special equipment or setups.
- Never stand near danger zones or close to anyone operating equipment.

General Equipment Behavior:

- Always keep hands, arms, or legs out of the cutting path of equipment.
- Position your body out of harms way while operating any equipment.
- NEVER use faulty equipment that is subject to replacement.
- NEVER test the sharpness or temperature of a tool with an appendage of a body.
- Equipment will be used solely for its functions and are not to be considered toys.
- The appropriate use of tools for a given action must be considered in order to avoid errors in equipment performance and protection.
- Only authorized members may use both the given equipment of the facility and equipment purchased by the organization.
- Equipment is not to be removed from the premises unless for club events or repairs by an approved source.
- Properly use secure support surfaces while operating any equipment in order to ensure safety to both equipment and adjacent people.
- Always store or secure tools away from potential harm to yourself, other person(s), or the equipment itself.
- Cutting edges must be sharp and within operating conditions.
- Equipment should always be adjusted and calibrated before attempting a given task.
- Always consult a RAS officer before making adjustments or performing maintenance to equipment.
- Never force or apply uneven pressure while performing any tasks with equipment.

Cleanup and Awareness:

- Keep workspaces clean and organized.
- Keep aisles clear of loose materials.
- Never use your hand or body parts to remove scraps or shavings away from the equipment operating area.
- Remove any special attachments from the equipment as well as reset both safety guards and standard settings to equipment.
- Do not leave spills or hazardous materials unattended.
- All equipment and tools will be returned to their designated storage area(s)/container(s).
- Maintain cleanliness of equipment to ensure the equipment functions properly.

Clothing Standards and PPE (Personal Protective Equipment):

- Always use proper personal protective equipment while operating any equipment.
- Closed-toe footwear is always required at RAS events.
- Hair should be secured with proper hair accessories.
- Jewelry must be removed before using any equipment.
- No baggy clothing will be worn while using the equipment.
- Non-Synthetic pants must be worn while using equipment.
- Shirts should be tucked in and long sleeves neatly rolled up.
- Do not wear gloves while operating equipment unless handling rough materials.
- Wear ear protection while around working around loud equipment.
- Use proper ventilation and wear masks to avoid breathing in harmful material debris.

Shop Maintenance:

- If you are not certain on cleaning procedures or cannot identify spilled substances, notify a RAS officer immediately.
- Always know where and how to use fire extinguishers.
- Always keep cabinet doors and drawers closed.
- If you disconnect power to a machine at the circuit breaker, use a Lockout Tag Out system or put up a sign: “DO NOT USE”

Chemical Use and Storage:

Chemicals include but are not limited to:

- Potassium Nitrate
- Ammonium Nitrate
- Potassium Chloride
- Liquid Oxygen
- Oxidizers
- Lithium
- Fluorine
- Methane
- Water
- etc.

- All chemicals must be properly secured and stored when not in use.

- Any chemicals with noxious and flammable fumes must remain in airtight containers until directly in use.
- All flammable materials must be properly stored within an approved fire cabinet.
- While handling any dangerous fumes the proper use of the fume hood, masks, goggles, lab coat, and gloves will be mandatory.
- Chemical expiration must be documented and properly disposed of.
- Disposal of chemicals must be done properly and safely according to TTU EHS standards.

Hand Tools:

Tools include but are not limited to:
Non-powered equipment such as: screwdrivers, pliers, hammers, etc.

Hand tools are to be used in a safe manner at all times and should never be used outside of their designed purpose. Proper maintenance and replacement of hand tools should be exercised by all RAS members.

Power Tools:

Tools include but are not limited to:

- Table saw
- Band saw
- Power drill
- Drill press
- Routing tools
- Sander
- Jigsaw
- Circular saw
- Lathe
- etc.

- Electric Power tools must be grounded or double insulated to prevent electric shock. If the equipment does not meet that standard, it will not be used.
- Double check power tool as been turned off before connecting to a power source to avoid any unintended equipment actions.
- Always make sure equipment has been turned off and unplugged before any adjustments or maintenance is performed.
- Always wait for the machine to reach operating position/speed before use.

- Unplug or turn off any equipment not being used.

Specialized Machine and Equipment
Policies and procedures for any heavy equipment not listed above will be added under this given section as the need arises.

I _____hereby agree to all safety terms and conditions listed above as well as the terms and conditions set forth by NAR, Tripoli, Whitacre College of Engineering, and Texas Tech University's code of conduct and operating procedures. I acknowledge that failure to adhere to RAS safety guidelines or those set forth by Whitacre College of Engineering and Texas Tech University may result in my expulsion from the organization pending a review from the safety team and RAS officer board. In addition to expulsion from RAS, I may face additional review and consequences from Texas Tech University.

Printed Name:_____ R#:_____
Signature:_____ Date:_____

Appendix IV

5.1

WEST SYSTEM® 105 Epoxy Resin Safety Data Sheet According to the Hazard

Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015 Date of issue: 6/1/2015 Revision date: 01/25/2019 Version: 105-2019a

Identification Product name : WEST SYSTEM® 105 Epoxy Resin **Product code** : 105, 105-A, 105-B, 105-C, 105-E, C 105-A, C 105-B, C 105-C, C 105-E

Relevant identified uses of the substance or mixture and uses advised against Recommended use : Resin for coatings or adhesives

Details of the supplier of the safety data sheet

Manufacturer Gougeon Brothers, Inc 100 Patterson Ave. Bay City, MI 48706 - U.S.A. T 866-937-8797 or 989-684-7286 www.westsystem.com

Emergency telephone number Emergency number : CHEMTREC 1 (800) 424-9300
CHEMTREC International +1 (703) 527-3887 24 hr

Classification of the substance or mixture Skin Irrit. 2 Eye Irrit. 2A Skin Sens. 1 Aquatic Chronic 2

Label elements Hazard pictograms (GHS) :
GHS07

GHS09 **Signal word (GHS)** : Warning **Hazard statements (GHS)** : Causes skin irritation. May cause an allergic skin reaction.

Causes serious eye irritation. Toxic to aquatic life with long lasting effects **Precautionary statements (GHS)** : Avoid breathing dust, fume, gas, mist, vapours, spray. Wash hands thoroughly after handling. Contaminated work clothing must not be allowed out of the workplace. Avoid release to the environment. Wear protective gloves, protective clothing, eye protection. If on skin: Wash with

plenty of soap and water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If skin irritation or rash occurs: Get medical advice/attention. If eye irritation persists: Get medical advice/attention. Take off contaminated clothing and wash it before reuse. Collect spillage. Dispose of contents/container to hazardous or special waste collection point, in accordance with local, regional, national and/or international regulation
Other hazards No additional information available **Unknown acute toxicity** Not applicable

Substance Not applicable **Mixtures**

Name Product identifier HPR % Oxirane, 2,2'-[(1-methylethylidene)bis(4,1-phenyleneoxymethylene)]bis-, homopolymer (CAS No) 25085-99-8 60 - 80
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WEST SYSTEM® 105 Epoxy Resin

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Name Product identifier HPR % Benzyl alcohol (CAS No) 100-51-6 10 - 30

Phenol, polymer with formaldehyde, glycidyl ether (CAS No) 28064-14-4 5 - 10

The exact chemical identity and/or exact percentage (concentration) of each ingredient may be held as confidential business information (CBI). Any ingredient not disclosed in this section may have been determined not to be hazardous to health or the environment, or it may be present at a level below its disclosure threshold.

Description of first aid measures First-aid measures after inhalation : If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical advice/attention if you feel unwell. **First-aid measures after skin contact** : In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing before reuse. If skin irritation or rash occurs: Get medical advice/attention. **First-aid measures after eye contact** : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If easy to do, remove contact lenses, if worn. If irritation persists, get medical attention. **First-aid measures after ingestion** : If swallowed, do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical advice/attention if you feel unwell.

Most important symptoms and effects, both acute and delayed Symptoms/injuries after inhalation : Not a normal route of exposure. May cause respiratory tract irritation. **Symptoms/injuries after skin contact** : Causes skin irritation. Symptoms may include redness, edema, drying, defatting and cracking of the skin. May cause an allergic skin reaction. **Symptoms/injuries after eye contact** : Causes serious eye irritation. Symptoms may include discomfort or pain, excess blinking and tear production, with marked redness and swelling of the conjunctiva. **Symptoms/injuries after ingestion** : May be harmful if swallowed. May cause stomach distress, nausea or vomiting.

Indication of any immediate medical attention and special treatment needed Symptoms may not appear immediately. In case of accident or if you feel unwell, seek medical advice immediately (show the label or SDS where possible).

Extinguishing media Suitable extinguishing media : Foam. Carbon dioxide. Dry chemical. **Unsuitable extinguishing media** : Do not use a heavy water stream.

Special hazards arising from the substance or mixture Fire hazard : Products of combustion may include, and are not limited to: oxides of carbon, phenolics. **Reactivity** : No dangerous reaction known under conditions of normal use.

Advice for firefighters Protection during firefighting : Keep upwind of fire. Wear full fire fighting turn-out gear (full Bunker gear) and respiratory protection (SCBA). Cool closed containers exposed to fire with water spray.

Personal precautions, protective equipment and emergency procedures General measures : Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected

personnel.

For non-emergency personnel
No additional information available

For emergency responders No additional information available

Environmental precautions Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

WEST SYSTEM® 105 Epoxy Resin

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Methods and material for containment and cleaning up For containment : Stop leak if safe to do so. Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in a suitable container. Do not flush to sewer or allow to enter waterways. Use appropriate Personal Protective Equipment (PPE). **Methods for cleaning up** : Scoop up material and place in a disposal container. Provide ventilation. Clean contaminated surfaces thoroughly.

Reference to other sections See section 8 for further information on protective clothing and equipment and section 13 for advice on waste disposal.

Precautions for safe handling Precautions for safe handling : Avoid contact with skin and eyes. Avoid breathing dust, fume, gas, mist, vapours, spray. Do not swallow. Handle and open container with care. When using do not eat, drink or smoke. When mixed with epoxy curing agents this product causes an exothermic reaction, which in large masses, can produce enough heat to damage or ignite surrounding materials and emit fumes and vapors that vary widely in composition and toxicity. **Hygiene measures** : Contaminated work clothing should not be allowed out of the workplace. Launder contaminated clothing before reuse. Wash hands before eating, drinking, or smoking.

Conditions for safe storage, including any incompatibilities Storage conditions : Keep out of the reach of children. Keep container tightly closed. Store in a dry, cool and well- ventilated place. Storage temperature : 40°F (4°C) - 120°F (49°C). Keep away from heat and direct sunlight.

Control parameters

Oxirane, 2,2'-[(1-methylethylidene)bis(4,1-phenyleneoxymethylene)]bis-, homopolymer (25085-99-8) Not applicable

Benzyl alcohol (100-51-6) AIHA WEEL TWA (ppm) 10 ppm

Phenol, polymer with formaldehyde, glycidyl ether (28064-14-4) Not applicable

Exposure controls Appropriate engineering controls : Use ventilation adequate to keep exposures (airborne levels of dust, fume,

vapor, etc.) below recommended exposure limits. **Hand protection** : Wear chemically resistant protective gloves. **Eye protection** : Wear eye/face protection. **Skin and body protection** : Wear suitable protective clothing. **Respiratory protection** : In case of insufficient ventilation, wear suitable respiratory equipment. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. **Environmental exposure controls** : Maintain levels below Community environmental protection thresholds. **Other information** : Do not eat, smoke or drink where material is handled, processed or stored. Wash hands carefully before eating or smoking. Handle according to established industrial hygiene and safety practices.

Information on basic physical and chemical properties Physical state : Liquid **Appearance** : Viscous **Colour** : Colourless **Odour** : Mild **Odour threshold** : No data available **pH** : No data available **Melting point** : No data available

WEST SYSTEM® 105 Epoxy Resin

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Freezing point : No data available **Boiling point** : > 400 °F (204 °C) **Flash point** : > 200 °F (93 °C) (estimated based on ingredient data) **Relative evaporation rate (butylacetate=1)** : No data available **Flammability (solid, gas)** : Non flammable. **Vapour pressure** : No data available **Relative vapour density at 20 °C** : Heavier than air (estimated based on ingredient data) **Relative density** : 1.15 **Solubility** : No data available **Partition coefficient n-octanol/water** : No data available **Auto-ignition temperature** : No data available **Decomposition temperature** : No data available **Viscosity, kinematic** : 869.5 mm2/s @ 68 °F (20 °C) **Viscosity, dynamic** : No data available **Explosive limits** : No data available **Explosive properties** : No data available **Oxidising properties** : No data available

Other information Bulk density : 9.6 lb/gal (1.15 kg/L)

Reactivity : No dangerous reaction known under conditions of normal use. **Chemical stability** : Stable under normal storage conditions. **Possibility of hazardous reactions** : No dangerous reaction known under conditions of normal use. A mass of more than one pound of product plus an aliphatic amine will cause irreversible polymerization with significant heat buildup. Strong acids, bases, amines and mercaptans can cause polymerization. **Conditions to avoid** : Heat. Incompatible materials. **Incompatible materials** : Strong acids. Bases. Amines. Mercaptans. **Hazardous decomposition products** : May include, and are not limited to: oxides of carbon, phenolics.

Information on toxicological effects

Oxirane, 2,2'-[(1-methylethylidene)bis(4,1-phenyleneoxymethylene)]bis-, homopolymer (25085-99-8) LD50 oral rat > 15000 mg/kg LD50 dermal rabbit > 23000 mg/kg

Benzyl alcohol (100-51-6) LD50 oral rat 1620 mg/kg LC50 inhalation rat 4.18 mg/l/4h

Phenol, polymer with formaldehyde, glycidyl ether (28064-14-4) LD50 oral rat > 2000 mg/kg LD50 dermal rat 2000 mg/kg

Acute toxicity (oral) : Not classified. **Acute toxicity (dermal)** : Not classified. **Acute toxicity (inhalation)** : Not classified. **Skin corrosion/irritation** : Causes skin irritation. **Serious eye damage/irritation** : Causes serious eye irritation. **Respiratory or skin sensitization** : May cause an allergic skin reaction. **Germ cell mutagenicity** : Not classified. **Carcinogenicity** : Not classified. No ingredient of this product

present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA, NTP or IARC. **Reproductive toxicity** : Not classified. **STOT-single exposure** : Not classified. **STOT-repeated exposure** : Not classified.

WEST SYSTEM® 105 Epoxy Resin Safety Data Sheet

Aspiration hazard : Not classified.

WEST SYSTEM® 105 Epoxy Resin Viscosity, kinematic (calculated value) (40 °C) 869.5 mm2/s @ 68 °F (20 °C)

Symptoms/injuries after inhalation : Not a normal route of exposure. May cause respiratory tract irritation. **Symptoms/injuries after skin contact** : Causes skin irritation. Symptoms may include redness, edema, drying, defatting and cracking of the skin. May cause an allergic skin reaction. **Symptoms/injuries after eye contact** : Causes serious eye irritation. Symptoms may include discomfort or pain, excess blinking and tear production, with marked redness and swelling of the conjunctiva. **Symptoms/injuries after ingestion** : May be harmful if swallowed. May cause stomach distress, nausea or vomiting. **Other information** : Likely routes of exposure: ingestion, inhalation, skin and eye.

Toxicity Ecology - general : Toxic to aquatic life with long lasting effects.

Benzyl alcohol (100-51-6) LC50 fish 1 460 mg/l (Exposure time: 96 h - Species: Pimephales promelas [static]) EC50 Daphnia 1 23 mg/l (Exposure time: 48 h - Species: water flea) LC50 fish 2 10 mg/l (Exposure time: 96 h - Species: Lepomis macrochirus [static])

Persistence and degradability

WEST SYSTEM® 105 Epoxy Resin Persistence and degradability Not established.

Bioaccumulative potential

WEST SYSTEM® 105 Epoxy Resin Bioaccumulative potential Not established.

Benzyl alcohol (100-51-6) Partition coefficient n-octanol/water 1.1

Mobility in soil No additional information available

Other adverse effects

Effect on the global warming : No known effects from this product.

Name Product identifier Ecotoxicity Classification Information Oxirane, 2,2'-[(1-methylethylidene)bis(4,1-phenyleneoxymethylene)]bis-, homopolymer (CAS No) 25085-99-8 Aquatic Chronic Cat. 2

Benzyl alcohol (CAS No) 100-51-6 Not Classified

Phenol, polymer with formaldehyde, glycidyl ether (CAS No) 28064-14-4 Aquatic Chronic Cat. 2

Waste treatment methods Product/Packaging disposal recommendations

: This material must be disposed of in accordance with all local, state, provincial, and federal regulations. The generation of waste should be avoided or minimized wherever possible. **Ecology - waste materials** : Avoid release to the environment.

Department of Transportation (DOT) and Transportation of Dangerous Goods (TDG) In accordance with DOT and TDG Not regulated

Transport by sea In accordance with IMDG UN-No. (IMDG) : 3082

WEST SYSTEM® 105 Epoxy Resin Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Proper Shipping Name (IMDG) : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Epoxy Resin) Class (IMDG) : 9 Packing group (IMDG) : III EmS Number : F-A, S-F Marine Pollutant : Yes

Transport by air In accordance with IATA UN-No. (IATA) : 3082 Proper Shipping Name (IATA) : Environmentally hazardous substance, liquid, n.o.s. (Epoxy Resin) Class (IATA) : 9 Packing group (IATA) : III Marine Pollutant : Yes

Federal regulations

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory.

All components of this product are listed, or excluded from listing, on the Canadian DSL (Domestic Substances List) and NDSL (Non-Domestic Substances List) inventories.

Oxirane, 2,2'-[(1-methylethylidene)bis(4,1-phenyleneoxymethylene)]bis-, homopolymer **(25085-99-8)** EPA TSCA Regulatory Flag XU - XU - indicates a substance exempt from reporting under the Inventory Update Reporting Rule, i.e, Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(C)).

Phenol, polymer with formaldehyde, glycidyl ether (28064-14-4) EPA TSCA Regulatory Flag XU - XU - indicates a substance exempt from reporting under the Inventory Update Reporting

Rule, i.e, Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(C)).
Epichlorohydrin (106-89-8) Listed on the United States SARA Section 302 Subject to reporting requirements of United States SARA Section 313 CERCLA RQ 100 lb SARA Section 302 Threshold Planning Quantity (TPQ)
01/25/2019 EN (English) 6/7
1000 lb
SARA Section 313 - Emission Reporting 0.1 %
International regulations No additional information available
US State regulations
California Proposition 65 - This product contains, or may contain, trace quantities of a substance(s) known to the state of California to cause cancer, developmental and/or reproductive harm
Epichlorohydrin (106-89-8) U.S. - California - Proposition 65 - Carcinogens List
U.S. - California - Proposition 65 - Developmental Toxicity
U.S. - California - Proposition 65 - Reproductive Toxicity - Female
U.S. - California - Proposition 65 - Reproductive Toxicity - Male
Non-significant risk level (NSRL)
Yes No No Yes 9 µg/day
Benzyl alcohol (100-51-6) U.S. - Pennsylvania - RTK (Right to Know) List
Epichlorohydrin (106-89-8) U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List U.S. - Pennsylvania - RTK (Right to Know) - Special Hazardous Substances U.S. - Pennsylvania - RTK (Right to Know) List

WEST SYSTEM® 105 Epoxy Resin

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Issue

date : 6/1/2015 **Revision date** : 01/25/2019 **Version** : 105-2019a **Other information** : None.

NFPA health hazard : 2 **NFPA fire hazard** : 1
NFPA reactivity : 1

HMIS III Rating **Health** : 2 **Flammability** : 1
Physical : 1

Disclaimer: We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind. The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. It is the user's responsibility to satisfy oneself as to the suitability and completeness of this information for the user's own particular use.

WEST SYSTEM® 206 Slow Hardener Safety Data Sheet According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015 Date of issue: 08/15/2016 Revision date: 01/25/2019 Version: 206-2019a

Identification Product name : WEST SYSTEM® 206 Slow Hardener **Product code** : 206, 206-A, 206-B, 206-C, 206-E, C 206-A, C 206-B, C 206-C, C 206-E

Relevant identified uses of the substance or mixture and uses advised against Recommended use : Curing agent for epoxy resins

Details of the supplier of the safety data sheet Gougeon Brothers, Inc 100 Patterson Ave. Bay City, MI 48706 - U.S.A. T 866-937-8797 or 989-684-7286 www.westsystem.com

Emergency telephone number Emergency number : CHEMTREC 1 (800) 424-9300
CHEMTREC International +1 (703) 527-3887 24 hr

Classification of the substance or mixture Acute Tox. 4 (Oral) Skin Corr. 1B Eye Dam. 1 Skin Sens. 1 STOT SE 3 Aquatic Acute 3 Aquatic Chronic 2
Label elements Hazard pictograms (GHS) :
GHS05
GHS09 **Signal word (GHS)** : Danger **Hazard statements (GHS)** : Harmful if swallowed. Causes severe skin burns and eye damage. May cause an allergic skin reaction. May cause respiratory irritation. Harmful to aquatic life. Toxic to aquatic life with long lasting effects **Precautionary statements (GHS)** : Do not breathe dust, fume, gas, mist, vapours, spray. Wash hands thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Contaminated work clothing must not be allowed out of the workplace. Avoid release to the environment. Wear protective gloves, protective clothing, eye protection, face protection. If swallowed: rinse mouth. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. Wash contaminated clothing before reuse. Collect spillage. Store in a well-ventilated place. Keep container tightly closed. Store locked up. Dispose of contents/container to hazardous or special waste collection point, in accordance with local, regional, national and/or international regulation
Other hazards No additional information available **Unknown acute toxicity** No additional information available

GHS07

WEST SYSTEM® 206 Slow Hardener

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Substance Not applicable **Mixtures**

Name Product identifier HPR % Propylene glycol diamine, 2-amino-, diether with Propylene (CAS No) 9046-10-0 30 - 60

Diethylenetriamine-bisphenol A-epichlorohydrin polymer (CAS No) 31326-29-1 10 - 30

Tetraethylenepentamine (CAS No) 112-57-2 10 - 30

Diethylenetriamine (CAS No) 111-40-0 7 - 13

1,2-Ethanediamine, N,N'-bis(2-aminoethyl)-, polymer with methyloxirane (CAS No) 26950-63-0 5 - 10

Triethylenetetramine (CAS No) 112-24-3 1 - 5

The exact chemical identity and/or exact percentage (concentration) of each ingredient may be held as confidential business information (CBI). Any ingredient not disclosed in this section may have been determined not to be hazardous to health or the environment, or it may be present at a level below its disclosure threshold.

Description of first aid measures First-aid measures after inhalation : If inhaled and if breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/physician. **First-aid measures after skin contact** : IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before reuse. Immediately call a POISON CENTER or doctor/physician. **First-aid measures after eye contact** : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If easy to do, remove contact lenses, if worn. Get medical attention immediately. **First-aid measures after ingestion** : If swallowed, do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Immediately call a POISON CENTER or doctor/physician.

Most important symptoms and effects, both acute and delayed Symptoms/injuries after inhalation : May cause respiratory irritation. **Symptoms/injuries after skin contact** : Causes severe burns. Symptoms may include redness, pain, blisters. May cause an allergic skin reaction. **Symptoms/injuries after eye contact** : Causes serious eye damage. Symptoms may include discomfort or pain, excess blinking and

tear production, with possible redness and swelling. May cause burns. **Symptoms/injuries after ingestion** : Harmful if swallowed. May cause burns or irritation of the linings of the mouth, throat, and gastrointestinal tract. May cause stomach distress, nausea or vomiting.

Indication of any immediate medical attention and special treatment needed Symptoms may not appear immediately. In case of accident or if you feel unwell, seek medical advice immediately (show the label or SDS where possible).

Extinguishing media Suitable extinguishing media : Foam. Carbon dioxide. Dry chemical. **Unsuitable extinguishing media** : Do not use a heavy water stream.

Special hazards arising from the substance or mixture Fire hazard : Products of combustion may include, and are not limited to: oxides of carbon, oxides of nitrogen, amines, ammonia, nitric acid, nitrosamines. When mixed with sawdust, wood chips, or other cellulosic material, spontaneous combustion can occur under certain conditions. Heat is generated as the air oxidizes the amine. If the heat is not dissipated quickly enough, it can ignite the sawdust. **Reactivity** : No dangerous reaction known under conditions of normal use.

Advice for firefighters Protection during firefighting : Keep upwind of fire. Wear full fire fighting turn-out gear (full Bunker gear) and respiratory protection (SCBA).

WEST SYSTEM® 206 Slow Hardener

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Personal precautions, protective equipment and emergency procedures General measures : Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel.

For non-emergency personnel No additional information available.

For emergency responders No additional information available.

Environmental precautions Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

Methods and material for containment and cleaning up For containment : Stop leak if safe to do so. Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in a suitable container. Do not flush to sewer or allow to enter waterways. Use appropriate Personal Protective Equipment (PPE). **Methods for cleaning up** : Scoop up material and place in a disposal container. Provide ventilation.

Reference to other sections See section 8 for further information on protective clothing and equipment and section 13 for advice on waste disposal.

Precautions for safe handling Precautions for safe handling : Do not get in eyes, on skin, or on clothing. Do not breathe vapours, mist. Do not swallow. Handle and open container with care. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. When mixed with epoxy resin this product causes an exothermic reaction, which in large masses, can produce enough heat to damage or ignite surrounding materials and emit fumes and vapors that vary widely in composition and toxicity. **Hygiene measures** : Launder contaminated

clothing before reuse. Wash hands before eating, drinking, or smoking.

Conditions for safe storage, including any incompatibilities Storage conditions : Keep out of the reach of children. Keep container tightly closed. Store in a dry, cool and well-ventilated place. Storage temperature : 40°F (4°C) - 90°F (32°C). Keep away from heat and direct sunlight.

Control parameters

Propylene glycol diamine, 2-amino-, diether with Propylene (9046-10-0) Not applicable

Diethylenetriamine-bisphenol A-epichlorohydrin polymer (31326-29-1) Not applicable

Tetraethylenepentamine (112-57-2) AIHA WEEL TWA (ppm) 1 ppm

AIHA WEEL TWA (mg/kg) 5 mg/kg (Skin)

Diethylenetriamine (111-40-0) ACGIH ACGIH TWA (ppm) 1 ppm

1,2-Ethanediamine, N,N'-bis(2-aminoethyl)-, polymer with methyloxirane (26950-63-0) Not applicable

Triethylenetetramine (112-24-3) AIHA WEEL TWA (ppm) 1 ppm

AIHA WEEL TWA (mg/m^3) 6 mg/m^3 (Skin)

Exposure controls Appropriate engineering controls : Use ventilation adequate to keep exposures (airborne levels of dust, fume, vapor, etc.) below recommended exposure limits.

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According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Hand protection : Wear chemically resistant protective gloves. **Eye protection** : Wear approved eye protection (properly fitted dust- or splash-proof chemical safety goggles) and face protection (face shield). **Skin and body protection** : Wear suitable protective clothing. **Respiratory protection** : In case of insufficient ventilation, wear suitable respiratory equipment. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. **Environmental exposure controls** : Maintain levels below Community environmental protection thresholds. **Other information** : Do not eat, smoke or drink where material is handled, processed or stored. Wash hands carefully before eating or smoking. Handle according to established industrial hygiene and safety practices.

Information on basic physical and chemical properties Physical state : Liquid **Appearance** : No data available. **Colour** : Colourless **Odour** : Ammonia **Odour threshold** : No data available **pH** : 11 **Melting point** : No data available **Freezing point** : No data available **Boiling point** : > 400 °F (204°C) (estimated based on similar product) **Flash point** : > 200 °F (93°C) (estimated based on similar product) **Relative evaporation rate (butylacetate=1)** : No data available **Flammability (solid, gas)** : Not flammable **Vapour pressure** : < 1 mm Hg @ 20°C (estimated based on ingredient data) **Relative vapour density at 20 °C** : No data available **Relative density** : 1.01 **Solubility** : No data available **Partition coefficient n-octanol/water** : No data available **Auto-ignition temperature** :

No data available **Decomposition temperature** : No data available **Viscosity, kinematic** : 65.6 mm2/s @ 104 °F (40 °C) **Viscosity, dynamic** : No data available **Explosive limits** : No data available **Explosive properties** : No data available **Oxidising properties** : No data available

Other information VOC content : 9.59 g/L (0.08 lb/gal) **Bulk density** : 8.45 lb/gal (1.01 kg/L)

Reactivity : No dangerous reaction known under conditions of normal use. **Chemical stability** : Stable under normal storage conditions. **Possibility of hazardous reactions** : No dangerous reaction known under conditions of normal use. A mass of more than one pound of product plus an epoxy resin will cause irreversible polymerization with significant heat buildup and pressure. **Conditions to avoid** : Heat. Incompatible materials. **Incompatible materials** : Acids. Oxidizing materials. Halogenated compounds. **Hazardous decomposition products** : May include, and are not limited to: oxides of carbon. Oxides of nitrogen. Amines. Ammonia. Nitric acid. nitrosamines. ETHYLENEDIAMINE.

Information on toxicological effects

WEST SYSTEM® 206 Slow Hardener

Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015

Propylene glycol diamine, 2-amino-, diether with Propylene (9046-10-0) LD50 oral rat 2855 mg/kg LD50 dermal rabbit 2890 mg/kg LC50 inhalation rat > 0.74 mg/l/8h

Diethylenetriamine-bisphenol A-epichlorohydrin polymer (31326-29-1) LD50 oral rat 500 mg/kg (ATE) LD50 dermal rabbit 1100 mg/kg (ATE)

Tetraethylenepentamine (112-57-2) LD50 oral rat 1600 mg/kg LD50 dermal rabbit 1260 mg/kg

Diethylenetriamine (111-40-0) LD50 oral rat 1620 mg/kg LD50 dermal rabbit 1090 mg/kg LC50 inhalation rat *0.07 - 0.3 mg/l/4h (aerosol/mist)

1,2-Ethanediamine, N,N'-bis(2-aminoethyl)-, polymer with methyloxirane (26950-63-0) Not applicable

Triethylenetetramine (112-24-3) LD50 oral rat 1716.2 mg/kg LD50 dermal rabbit 805 mg/kg

* LC_{50} data has been generated for this substance by subjecting rats to an airborne aerosol/mist atmosphere in a test chamber. It has not been determined that this data directly correlates to an inherent hazard of this product as would be expected under normal, foreseeable or anticipated conditions of use.

Acute toxicity (oral) : Harmful if swallowed. **Acute toxicity (dermal)** : Not classified. **Acute toxicity (inhalation)** : Not classified. **Skin corrosion/irritation** : Causes severe skin burns **Serious eye damage/irritation** : Causes serious eye damage. **Respiratory or skin sensitization** : May cause an allergic skin reaction. **Germ cell mutagenicity** : Not classified. **Carcinogenicity** : Not classified. No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA, NTP or IARC. **Reproductive toxicity** : Not classified. **STOT-single exposure** : May cause respiratory irritation.

STOT-repeated exposure : Not classified. **Aspiration hazard** : Not classified.

WEST SYSTEM® 206 Slow Hardener Viscosity, kinematic (calculated value)
(40 °C) 65.6 mm2/s @ 104 °F (40 °C)

Potential adverse human health effects and symptoms

Symptoms/injuries after inhalation : May cause respiratory irritation. **Symptoms/injuries after skin contact** : Causes severe burns. Symptoms may include redness, pain, blisters. May cause an allergic skin reaction. **Symptoms/injuries after eye contact** : Causes serious eye damage. Symptoms may include discomfort or pain, excess blinking and tear production, with possible redness and swelling. May cause burns. **Symptoms/injuries after ingestion** : Harmful if swallowed. May cause burns or irritation of the linings of the mouth, throat, and gastrointestinal tract. May cause stomach distress, nausea or vomiting. **Other information** : Likely routes of exposure: ingestion, inhalation, skin and eye.

Toxicity Ecology - general : Toxic to aquatic life with long lasting effects.

Tetraethylenepentamine (112-57-2) LC50 fish 1 420 mg/l (Exposure time: 96 h - Species: Poecilia reticulata [static]) EC50 Daphnia 1 24.1 mg/l (Exposure time: 48 h - Species: Daphnia magna)

Diethylenetriamine (111-40-0) LC50 fish 1 248 mg/l (Exposure time: 96 h - Species: Poecilia reticulata [static]) EC50 Daphnia 1 16 mg/l (Exposure time: 48 h - Species: Daphnia magna) LC50 fish 2 1014 mg/l (Exposure time: 96 h - Species: Poecilia reticulata [semi-static])

Triethylenetetramine (112-24-3) LC50 fish 1 570 mg/l (Exposure time: 96 h - Species: Poecilia reticulata [semi-static]) EC50 Daphnia 1 31.1 mg/l (Exposure time: 48 h - Species: Daphnia magna) LC50 fish 2 495 mg/l (Exposure time: 96 h - Species: Pimephales promelas)

Persistence and degradability

WEST SYSTEM® 206 Slow Hardener Persistence and degradability Not established.

Bioaccumulative potential

WEST SYSTEM® 206 Slow Hardener Bioaccumulative potential Not established.

Tetraethylenepentamine (112-57-2) BCF fish 1 (no bioaccumulation expected) Partition coefficient n-octanol/water < 1

Diethylenetriamine (111-40-0) BCF fish 1 0.3 - 1.7 Partition coefficient n-octanol/water -1.3

Triethylenetetramine (112-24-3) BCF fish 1 (no bioaccumulation expected) Partition coefficient n-octanol/water -1.4

Mobility in soil

WEST SYSTEM® 206 Slow Hardener Ecology - soil No additional information available.

Other adverse effects

Effect on the global warming : No known effects from this product.

Name Product identifier Ecotoxicity Classification Information Propylene glycol diamine, 2-amino-, diether with Propylene (CAS No)

9046-10-0 Acute Aquatic Cat. 3; Chronic Aquatic Cat. 2
Diethylenetriamine-bisphenol A-epichlorohydrin polymer (CAS No) 31326-29-1 Not classified
Tetraethylenepentamine (CAS No) 112-57-2 Acute Aquatic Cat. 2; Chronic Aquatic Cat. 2
Diethylenetriamine (CAS No) 111-40-0 Not classified
1,2-Ethanediamine, N,N'-bis(2-aminoethyl)-, polymer with methyloxirane (CAS No) 26950-63-0 Not classified
Triethylenetetramine (CAS No) 112-24-3 Acute Aquatic Cat. 2; Chronic Aquatic Cat. 2
Other information : Avoid release to the environment.

Waste treatment methods Product/Packaging disposal recommendations

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: This material must be disposed of in accordance with all local, state, provincial, and federal
regulations. The generation of waste should be avoided or minimized wherever possible. Avoid release to the environment.

Department of Transportation (DOT) and Transportation of Dangerous Goods (TDG) In accordance with DOT and TDG
UN-No.(DOT/TDG) : UN2735

WEST SYSTEM® 206 Slow Hardener Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015
Proper Shipping Name (DOT/TDG) : Polyamines, liquid, corrosive, n.o.s. (Polyoxypropylenediamine) Class (DOT/TDG) : 8 Packing group (DOT/TDG) : II Marine pollutant : No
Transport by sea In accordance with IMDG UN-No. (IMDG) : 2735 Proper Shipping Name (IMDG) : POLYAMINES, LIQUID, CORROSIVE, N.O.S. (Polyoxypropylenediamine) Class (IMDG) : 8 Packing group (IMDG) : II EmS Number : F-A, S-B Marine pollutant : Yes
Transport by air In accordance with IATA UN-No. (IATA) : 2735 Proper Shipping Name (IATA) : Polyamines, liquid, corrosive, n.o.s. (Polyoxypropylenediamine) Class (IATA) : 8 Packing group (IATA) : II Marine pollutant : Yes

Federal regulations

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory.
All components of this product are listed, or excluded from listing, on the Canadian DSL (Domestic Substances List) and NDSL (Non-Domestic Substances List) inventories.
Propylene glycol diamine, 2-amino-, diether with Propylene (9046-10-0) EPA TSCA Regulatory Flag XU - XU - indicates a substance exempt from reporting under the Inventory Update Reporting
Rule, i.e, Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(C)).
Diethylenetriamine-bisphenol A-epichlorohydrin polymer (31326-29-1) EPA TSCA Regulatory Flag XU - XU - indicates a substance exempt from reporting under the Inventory Update Reporting
Rule, i.e, Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(C)).
1,2-Ethanediamine, N,N'-bis(2-aminoethyl)-, polymer with methyloxirane (26950-63-0) EPA TSCA Regulatory Flag XU - XU - indicates a substance exempt from reporting under the Inventory Update Reporting
Rule, i.e, Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(C)).
Propylene oxide (75-56-9) Listed on the United States SARA Section 302 CERCLA RQ 100 lb SARA Section 302 Threshold Planning Quantity (TPQ)
01/25/2019 EN (English) 7/8
10000 lb
SARA Section 313 - Emission Reporting 0.1 %
International regulations No additional information available

WEST SYSTEM® 206 Slow Hardener Safety Data Sheet

According to the Hazard Communication Standard (CFR29 1910.1200) HazCom 2012 and the Hazardous Products Regulations (HPR) WHMIS 2015
US State regulations
Propylene oxide (75-56-9) U.S. - California -
U.S. - California - Proposition 65 -
Proposition 65 - Carcinogens List
Developmental Toxicity
01/25/2019 EN (English) 8/8
U.S. - California - Proposition 65 - Reproductive Toxicity - Female
U.S. - California - Proposition 65 - Reproductive Toxicity - Male
Non-significant risk level (NSRL)
Yes No No No
Tetraethylenepentamine (112-57-2) U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK

(Right to Know) List
Diethylenetriamine (111-40-0) U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List
Triethylenetetramine (112-24-3) U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List
Propylene oxide (75-56-9) U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List U.S. - Pennsylvania - RTK (Right to Know) - Special Hazardous Substances U.S. - Pennsylvania - RTK (Right to Know) List

Date of issue : 08/15/2016 **Revision date** : 01/25/2019 **Version** : 206-2019a **Other information** : None.
NFPA health hazard : 3 **NFPA fire hazard** : 1 **NFPA reactivity** : 0
HMIS III Rating **Health** : 3 **Flammability** : 1 **Physical** : 0
Disclaimer: We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind. The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. It is the user's responsibility to satisfy oneself as to the suitability and completeness of this information for the user's own particular use.

5.2

1 SAFETY DATA SHEET-BLACK POWDER

Section 1: Identification Product Identifier: Black Powder (includes all grades) **Manufacturer's Name**: GOEX Powder, Inc.
Informational Telephone Number:1-(318) 382-9300 **Address**: P.O. Box 659
Emerg. Phone Number: 1-(800) 255-3924 (Chem Tel) Doyline, LA 71023-0659 **Recommended Use**: for use in competitive and recreational shooting, muzzleloading hunting and the U.S. Military .
Section 2: Hazard(s) Identification
Hazard category:
Signal Word
Hazard statement Pictogram Division 1.1
Danger
Explosive; mass explosion hazard
Target Organ Warning: Above OSHA levels, chronic exposure may cause skin irritation and damage to the respiratory system, and acute exposure can cause skin, eye, and respiratory irritation.
Section 3: Composition/information on ingredients
Component CAS-Number Weight % Charcoal
16291-96-6
8-18% Sulfur
7704-34-9 Potassium Nitrate
7757-79-1
Section 4: First-aid measures
Ingestion:
* Not a likely route of exposure. If ingested, dilute by giving two glasses of water and induce vomiting.
* Not a likely route of exposure. Flush eyes with water. * Remove patient from area to fresh air. If not breathing, give artificial respiration, preferably by mouth
* wash the affected area with copious amounts of water. Some persons may be sensitive to product. **Injury from detonation:** * Seek prompt medical attention immediately. **Note to Physician:**
* Treat symptomatically.
Section 5: Fire-fighting measures Extinguishing media: * Water may be used as the extinguishing method. DO NOT FIGHT EXPLOSIVES FIRES. Evacuate the

area according to Emergency Response Guide 112 guidelines. Isolate the area and guard against any intruders.

Special Procedures: * Black Powder is extremely flammable and may deflagrate. Get away and evacuate the area. **Unusual Hazards:** * As with any pyrotechnic, if under confinement or piled in slight confinement, Black Powder can explode.

No known toxic fumes are emitted, but good ventilation should still be present.

Flash Point:

not applicable. **Auto ignition Temp:**

NFPA Ratings: Health=1 Flammability=3 Reactivity=1 Advice and PPE for Firefighters: * Fires involving Black Powder should not be fought unless extinguishing media can be

applied from a well protected and distant location from the point of fire. Self-contained breathing apparatus (SCBA) and protective clothing must be worn. Follow Emergency Response Guide 112. Wash all clothes prior to reuse.

9-20% 70-76% Graphite (note: not contained in all grades of black powder)

7782-42-5 <1%

Avoid, when possible and contact a Poison control center for advice on treatment, if unsure. **Eye Contact: Inhalation:**

Skin Contact:

to mouth. If breathing is difficult, give oxygen. Seek prompt medical attention. Avoid when possible.

Approximate range: 392º -867^{0}F /(200º-464ºC)

2 SAFETY DATA SHEET-BLACK POWDER

Section 6: Accidental release measures Personal precautions, protective equipment and emergency procedures: * Non-flammable or flame retardant clothing should be worn when cleaning up spilled material. Material is sensitive to ignition from sources such as heat, flame, impact, friction or sparks. Therefore, non-sparking utensils should be used.

Spill/leak response: * Use appropriate personal protective equipment. Isolate area and remove sources of friction, impact, heat, low level electrical current, electrostatic or RF energy. Only competent, experienced persons should be involved in cleanup procedures.

Environmental precautions: * Clean up spills immediately using non-sparking utensils Do not dispose of in the ground. * Spill residues may be disposed of per guidelines under Section 13: Disposal Considerations.

Section 7: Handling and storage

Storage Conditions: * Store in a cool, dry place in accordance with requirements of 27CFR555.201-555.219 (ATF Subpart K) * Avoid heat, impact, friction and static. Protect against heat effects. Keep away from heat, open flame and ignition sources. * Absolutely no smoking around open powder or packages. Keep away from combustibles. Avoid electrostatic charges. * Store in a cool, dry place Do not store in the same area with highly combustible materials. * Keep containers closed at all times when not being used. Keep out of reach of children. Open and handle container with care. * Follow all local, state and federal laws when storing this product.

Section 8: Exposure controls/personal protection Personal protection for routine use: * Respiratory protection is not normally needed. If significant dusting occurs, a NIOSH approved dust mask should be worn. Good ventilation is recommended when working with Black Powder. Gloves may be worn to protect skin. Safety glasses with side shields are recommended for eye protection. Flame retardant outerwear such as coveralls or lab coat may be worn.

Health Hazards (Acute or chronic): * TLV is unknown for ingestion of dust.

Signs/Symptoms of Exposure: * Burning or itching of the eyes, nose or skin; shortness of breath. **First Aid Procedures:** * Remove the patient from exposure and if skin contact, wash the affected area with water

Section 9: Physical and chemical properties

Physical State:

Granular powder

Solubility: Good in water **pH:** 6.0-8.0 **Vapor Pressure/Density:** not applicable **Appearance:**

Black in color

392º -867º F /200º -464º C **Odor:**

No odor detectable

Boiling Point: Not applicable

Section 10: Stability and reactivity General Information:

Section 11: Toxicological information * LD_{50} Values: unknown * TLV unknown for ingestion of dust. Some persons may be unusually sensitive to the product. * None of the components of Black Powder are listed as a carcinogen by NTP, IARC or OSHA.
Section 12: Ecological information
* Do not dispose of powder or residues into any water streams or bodies of water. Avoid spilling powders onto any soils. Clean up any spills promptly. * No known adverse effects on marine or other aquatic organisms.
Auto-ignition Temp.:

* Loading data and the instructions for loading must be observed. **Hazardous decomposition:** * Detonation produces hazardous overpressures and fragments (if confined). Gases produced may be toxic if exposed in areas with inadequate ventilation. **Conditions to Avoid:** Avoid heat, impact, friction or static. Protect against heat effects. Keep away from heat, open flame and ignition sources. A violent burn or deflagration could occur by above mentioned items. **Substances to Avoid:**
Avoid contact with alkaline substances or strong acids.
* Routes of entry include Skin, Inhalation and Ingestion. (Acute Toxicity=Category 4) per Table A.1.1 of 29CFR1910.1200

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Section 13: Disposal considerations * Care must be taken to prevent environmental contamination from the use of this material. The user has the responsibility to dispose of unused material, residues and containers in compliance with all relevant laws and regulations regarding treatment, storage and disposal for hazardous and non-hazardous waste. Powder can be burned in very small quantities and in very thin layer and must only be ignited from a safe distance. **Waste Disposal:** * Desensitize by diluting in water. Open train burning, by qualified personnel, may be used for disposal of small unconfined quantities. Dispose of in compliance with Federal Regulations under the authority of RCRA (40CFR Parts 260-271).
* Do not dispose of the black powder container into a fire.
Section 14: Transport information Label required: Explosive
Highway:
Class or division: UN Number:
Maritime IMDG
Class or division: UN Number: Shipping Name:
1.1D or 4.1 Flam Solid-(if <100 pounds). UN0027 (NA0027 for 4.1 Flam Solid) **Shipping Name:** Black Powder **Air Transport: Forbidden!**
1.1D UN0027 Black Powder
Section 15: Regulatory information * All products related to Black Powder are reported annually as per Community Right-to Know (Tier II). Black Powder has been approved by PHMSA and copies of the approvals are on file with Environmental, Health and Safety Manager.
Section 16: Other information Prepared By: Mark Wendt, Environmental, Health and Safety Manager email: mwendt@hodgdon.com **SDS Creation Date:**
April 1, 2014 **SDS Print Date:**
April 1, 2014 **Disclaimer:**
The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

5.3

Lithium Polymer Battery Safety Data Sheet

Version: 2.8

Product Name Synonyms

06/26/2019 EN (English US) 1/10

: :
Li-Polymer Battery LiPo – [See APPENDIX A]
Use of the substance/preparation : Lithium polymer rechargeable cells
Company identification : Vertical Partners West
14028 North Ohio Street Rathdrum, ID 83858
Telephone number for information
24 hour emegency contact

: :
1-800-705-0620 (USA)
Chemtrec 1-800-424-9300

2.1. OSHA Regulatory Status The batteries are hermitically sealed articles under normal conditions of use. The products referenced herein are exempt articles and are not subject to OSHA's Hazard Communication Standard requirements for preparation of safety data sheets. This information is provided as a service to our customers.

2.2. Potential health effects **Lithium cobalt oxide:** Odorless blue-black powder - cobalt and cobalt compounds are considered to be possible human carcinogens. By International Agency for Research on Cancer (IARC): May irritate eyes, skin, nose, throat and respiratory system and may cause allergic skin sensitization.

Carbon: Odorless black powder - no cases of carbon being harmful to humans have been reported. World Health Organization (WHO), and International Labour Organization (ILO) have never verified that carbon causes irritation of the skin and mucous membrane, etc.

Electric agent: Black powder (Garlic-Like), Toxicity (Am. Conf. Of Gov. Ind. Hygienists ACGIH 2000 Edition) - Simple Asphyxiant, Flammability limits in air (STP conditions): 2.4-83vol% (The upper limit could reach 100%)

Bond: Odorless white powder - inhalation and skin contact are expected to be the primary routes of occupational exposure to this material. As a finished product, it is a synthetic, high molecular weight polymer. Due to its chemical and physical properties, this material does not require special handing other than the good industrial hygiene and safety practices employed with any industrial material of this type. Under normal processing conditions this material releases fume or vapor. Components of these releases may vary with processing time and temperature. Process releases may produce eye, skin and/respiratory tract irritation and with repeated or prolonged exposures, nausea, drowsiness, headache and weakness. Although unlikely under normal handling conditions, if this material is heated in excess of 600°F (315°C), hazardous, decomposition products will be produced. Hazardous decomposition products include hydrogen fluoride and oxides of carbon, the concentrations of which vary with temperature and heating regimens.

Electrolyte: Colorless liquid - may cause moderate to severe irritation, burning, and dryness of the skin. May cause eye irritation or burning. Breathing of the mists, vapors or fumes may irritate the nose, throat and lungs. Exposure of material with areas which contain water may generate hydrofluoric acid which can cause immediate burns on skin, severe eye burns to the mouth and gastrointestinal tract if inhaled. Direct exposure to areas of the body needs to be treated immediately to prevent injury.

2.3. Potential environmental effects No additional information available.

Name CAS number % Carbon (C) 133-86-4 10-25 Lithium-polymer Cobalt Oxide ($LCoO_2$) 12057-24-8

1308-04-9 20-40 Lithium-Polymr Hexafluorophosphate ($LiPF_6$)

21340-40-3 1.4

Organic Carbonates (EC/EMC/DEC) N/A 8-18 Polyvinylidene Fluoride (PVDF) 24937-79-9 1-5 PP+PE 9003-07-0

9002-8804 4-6 Copper (Cu) 7440-50-8 15-30 Aluminum (Al) 7429-50-5 10-20 Nickel 7440-02-0 0.5-1

4.1. First aid procedures First-aid measures general : The following first aid measures are required in the case of exposure to

interior battery components after damage of the external battery casing. Undamaged, closed cells do not represent a danger to health. First-aid measures after inhalation : Assure fresh air breathing. If breathing difficulty or discomfort occurs and

persists, see a physician. If breathing stops, give artificial respiration and see a physician immediately. First-aid measures after skin contact : Remove contaminated clothing and thoroughly wash with soap and plenty of

water. If irritation persists, consult a physician. First-aid measures after eye contact : Rinse thoroughly with plenty of water for at least 15 minutes. If symptoms

persist contact a physician. First-aid measures after ingestion : Contents of an open battery can cause serious chemical burns of mouth,

esophagus, and gastrointestinal tract. If open battery is ingested, do not induce vomiting or give food or drink. Seek medical attention immediately.

5.1. Extinguishing media **Hazardous combustion:** When burned, hazardous products of combustion including fumes of carbon monoxide, carbon dioxide, and fluorine can occur.
Fire and explosion: This material does not represent an unusual fire or explosion hazard.
Flash point: N/A
Auto ignition: N/A
Flammability limits: N/A
5.2. Extinguishing media Suitable extinguishing media : Carbon dioxide, dry chemical or foam Protection during firefighting : Wear protective clothing and self-contained breathing apparatus to avoid fume inhalation.

6.1. Personal precautions Evacuate personnel to safe areas, ventilate the area. Refer to protective measure listed in section 7 and 8.

6.1.1. For non-emergency personnel Emergency procedures :
Evacuate unnecessary personnel.

6.1.2. For emergency responders Protective equipment : Inhalation of any vapor that may be emitted should be avoided. Wear self-

contained breathing apparatus to avoid fume inhalation. Rubber gloves should be used to handle the contents of crushed or opened batteries.

6.2. Environmental precautions Sweep up and place in a suitable container, dispose of waste according to local, state and federal laws and regulations.

7.1. Handling **Battery charge:** Charge according to manufacturer's specifications.

Battery disassembly: The batteries should never be disassembled, or mechanically abused. Should a battery unintentionally be crushed or opened, thus releasing its content, rubber gloves should be used to handle battery components. The inhalation of any vapor that may be emitted should be avoided.

Short circuiting of a battery: As with any battery, short circuit causes heating. In addition, short circuit reduces the life of the battery and can lead to ignition of surrounding materials. Physical contact with a short-circuited battery can cause skin burns.

Reverse polarity: Avoid reversing the battery polarity of a battery pack, which can cause the battery to be damaged and potentially cause a fire.

7.2. Storage Storage conditions : Store in a cool, dry and ventilated area. Do not place the battery near heating equipment, or expose to direct sunlight for long periods of time. Elevated temperatures can result in shortened battery life and degrade performance.

Personal protective equipment : None required under normal use.

Eye protection : Use ANSI approved chemical work safety goggles or face shield, when handling a leaking or ruptured battery. Skin protection : Use rubber apron and protective gloves if working with or handling a ruptured battery.

Hand protection : In case of spill use PVC, neoprene or nitrile gloves of 15 miles (0.015 inch) or thicker.

Work hygienic practice : Use good chemical hygiene practice. Wash hands after use and before drinking, eating or smoking. Wash hands thoroughly after cleaning-up a battery spill caused by leaking battery. No eating, drinking, or smoking in battery storage area. Launder contaminated cloth before re-use.

Supplementary safety and health data : If the battery case is broken or cells leaking, the main hazard is the electrolyte. The electrolyte is a solution of LiPF6, EC, EMC and DEC.

Physical state : Solid article Freezing point : N/A Boiling point : N/A Density : N/A Vapor pressure : N/A Vapor density : N/A Flash point : N/A Evaporation rate : N/A

10.1.

Stability Stable during normal operating conditions.

10.2. Conditions to avoid Keep away from open flames, hot surfaces, and sources of ignition. Do not puncture, crush, or incinerate.

10.3. Incompatible materials Incompatible with water, moisture, strong oxidizing agents, reducing agents, acids and bases.

10.4. Hazardous decomposition products None, under normal operating conditions. Carbon dioxide and hydrogen fluoride gas may be generated during combustion of battery.

Not applicable under normal conditions of use. Chemicals within the battery have the following properties: Cobalt in lithium cobalt oxide is considered as a class 2B carcinogen by IARC. Organic carbonated (electrolyte) vapors are categorized as corrosive, flammable and irritants.

12.1 Ecotoxicity The batteries when properly used or disposed of do not present environmental hazard. The batteries do not contain mercury, cadmium or lead.

Do not let internal components enter marine environment. Avoid release to waterways, wastewater or groundwater.

13.1. Waste treatment methods Do not incinerate. Waste disposal must be in accordance with any and all applicable regulations. Disposal of lithium rechargeable batteries should be performed by permitted, professional disposal firms knowledgeable in federal, state or local requirements. Lithium batteries should be discharged to 0.00mAh prior to disposal.

14.1. Basic shipping description
UN3480 Lithium ion batteries, Class 9

14.2 Additional information Other information : These batteries must be prepared for transportation as defined by DOT,

IATA, and IMDG regulations based on the mode of transportation. This consignment has passed UN 38.3 test report.

Customer service telephone number for information: 1-800-705-0620

Safety Data Sheet

Section IA Section IB Section II Capacity of Cell/Batteries

Cells: greater than 20 Wh
Batteries: greater than 100 Wh
Cells: no more than 20 Wh
Batteries: no more than 100 Wh
* Cell/Batteries: no more than 2.7 Wh
* Cells: more than 2.7 but no more than 20 Wh
* Batteries: more than 2.7 Wh but not more than 100 Wh **Package Limitation**
PAX: 5 kg
CAO: 35 kg
10 kg Gross * 2.5 kg
* 8 cells
* 2 batteries
*must not be loaded in same package

The transportation of the lithium batteries is regulated by the United Nations ”Model Regulations on Transport of Dangerous Goods”.
Exceptions from shipping requrements for lithium cells and batteries are provided in 49 CFR 173.185.
Shipping of lithium batteries in aircrafts are regulated by the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) requirements. See special provision A88.
Shipping of lithium batteries by vessel are regulated by the International Maritime Dangerous Goods (IMDG).

The information and recommendations set forth are made in good faith and are believed to be accurate at the date of preparation. Venom makes no warranty expressed or implied with respect to this information. Venom does not accept liability for any loss or damage that may occur, whether direct, incidental or consequential, from the use of this information.

Safety Data Sheet

APPENDIX A

ITEM DESCRIPTION ITEM DESCRIPTION

1549 20C 2S 8000mAh 7.4V LiPo Hard Case - UNI 15203 35C 3S 1500mAh 11.1V LiPo – UNI 2.0-L
1551 10C 3S 800mAh 11.1V LiPo - Micro/Molex 15204 50C 4S 7000mAh 14.8V LiPo – UNI 2.0-L
1552 30C 3S 7500mAh 11.1V LiPo - UNI 2.0-L 15307 15C 3S 1200mAh 11.1V LiPo Stick - Airsoft
1553 20C 2S 3200mAh 7.4V LiPo Hardcase - UNI
2.0-L 15308 30C 3S 1500mAh 11.1V LiPo - Airsoft
1554 20C 2S 4000mAh 7.4V LiPo Hardcase - UNI
2.0-L 15309 30C 2S 1200mAh 7.4V LiPo - Airsoft

1555 20C 2S 5000mAh 7.4V LiPo Hardcase - UNI
2.0-L 15310 30C 2S 1500mAh 7.4V LiPo - Airsoft
1556 25C 2S 3300mAh 7.4V LiPo Hard Case - UNI 25001X2 45C 1S 180mAh 3.7V LiPo - JST-MCX x2
1557 25C 2S 4100mAh 7.4V LiPo Hardcase - UNI
2.0-L 25001X4 45C 1S 180mAh 3.7V LiPo - JST-MCX x4
1558 25C 2S 5000mAh 7.4V LiPo Hardcase - UNI
2.0-L 25002 30C 2S 430mAh 7.4V LiPo - JST/JST-PH
1558HXT4 25C 2S 5000mAh 7.4V LiPo Hard Case - HXT4 25003 2S 4000mAh 7.4V Transmitter LiPo - Spektrum
1559 10C 2S 1600mAh 7.4V LiPo Receiver Flat Pack 25004 30C 4S 2200mAh 14.8V LiPo - UNI 2.0
1560 10C 2S 1200mAh 7.4V LiPo Receiver Pack 25005 30C 2S 1300mAh 7.4V LiPo - UNI 2.0
1577 20C 3S 2200mAh 11.1V LiPo - UNI 2.0-L 25007 30C 3S 3200mAh 11.1V LiPo - UNI 2.0
1577HXT 20C 3S 2100mAh 11.1V LiPo - HXT 3.5mm 25008 30C 1S 30mAh 3.7V LiPo - JST-MCX
1580 20C 3S 4000mAh 11.1V LiPo - UNI 2.0-L 25009 30C 1S 70mAh 3.7V LiPo - JST-MCX
1581 20C 3S 5400mAh 11.1V LiPo - UNI 2.0-L 25010 30C 1S 200mAh 3.7V LiPo - JST-MCPX
1582 20C 3S 5000mAh 11.1V LiPo - UNI 2.0-L 25011 30C 1S 250mAh 3.7V LiPo - JST-MCX
1584 25C 1S 150mAh 3.7V LiPo - Blade/MCX 25012 30C 1S 500mAh 3.7V LiPo - Mini Losi/JST
1585 15C 2S 250mAh 7.4V LiPo 25013 30C 4S 3200mAh 14.8V LiPo - UNI 2.0
1587 20C 3S 950mAh 11.1V LiPo - Micro Jet 25014 30C 2S 300mAh 7.4V LiPo - JST/JST-PH
15000 5C 2S 2400mAh 7.4V LiPo
Receiver/Transmitter Flat pack 25015 30C 6S 3200mAh 22.2V LiPo - UNI 2.0
15001 5C 2S 2100mAh 7.4V LiPo
Receiver/Transmitter Hump pack 25016 30C 4S 3600mAh 14.8V LiPo - UNI 2.0
15002 20C 2S 430mAh 7.4V LiPo - JST 25017 30C 5S 3600mAh 18.5V LiPo - UNI 2.0
15003 20C 2S 800mAh 7.4V LiPo - JST 25018 30C 6S 3600mAh 22.2V LiPo - UNI 2.0
15004 20C 4S 2100mAh 14.8V LiPo Starter Box-
Tamiya 25019 30C 4S 5000mAh 14.8V LiPo - UNI 2.0
15005 13C 2S 1320mAh 7.4V LiPo - JST 25020 30C 5S 5000mAh 18.5V LiPo - UNI 2.0
15006 13C 3S 1320mAh 11.1V LiPo - UNI 25021 30C 6S 5000mAh 22.2V LiPo - UNI 2.0
15007 20C 3S 3200mAh 11.1V LiPo - UNI 25023 30C 2S 2000mAh 7.4V LiPo - UNI 2.0
15008 20C 2S 5400mAh 7.4V LiPo - UNI 2.0-L 25024 30C 2S 800mAh 7.4V LiPo - JST
15009 20C 3S 6400mAh 11.1V LiPo - UNI 2.0-L 25025 30C 6S 2500mAh 22.2V LiPo - UNI 2.0
15010 20C 2S 8000mAh 7.4V LiPo - UNI 25026 30C 3S 450mAh 11.1V LiPo - JST

ITEM DESCRIPTION ITEM DESCRIPTION

15011 5C 3S 3000mAh 11.1V Receiver/Transmitter
LiPo MX3 25027 70C 3S 450mAh 11.1V LiPo - JST
15012 5C 3S 2400mAh 11.1V Receiver/Transmitter
LiPo Z1/Helios 25028 30C 3S 1300mAh 11.1V LiPo - UNI 2.0
15013 30C 4S 3200mAh 14.8V LiPo 25031 50C 6S 1300mAh 22.2V LiPo - UNI 2.0
15015 30C 6S 3200mAh 22.2V LiPo 25032 30C 6S 5400mAh 22.2V LiPo - UNI 2.0
15016 25C 4S 3600mAh 14.8V LiPo 25033 50C 3S 2200mAh 11.1V LiPo - UNI 2.0
15017 25C 5S 3600mAh 18.5V LiPo 25034 25C 3S 2300mAh 11.4V LiHV - UNI 2.0
15018 25C 6S 3600mAh 22.2V LiPo 25035 25C 4S 2300mAh 15.2V LiHV - UNI 2.0
15019 25C 4S 5000mAh 14.8V LiPo 25036 25C 4S 3400mAh 15.2V LiHV - UNI 2.0
15020 25C 5S 5000mAh 18.5V LiPo 25042 50C 6S 2500mAh 22.2V LiPo - UNI 2.0
15021 25C 6S 5000mAh 22.2V LiPo 25043 50C 4S 3600mAh 14.8V LiPo - UNI 2.0

15023 20C 2S 2000mAh 7.4V LiPo - UNI 2.0-L 25045 50C 6S 3600mAh 22.2V LiPo - UNI 2.0
15024 20C 3S 1300mAh 11.1V LiPo - UNI 2.0-L 25046 50C 4S 5000mAh 14.8V LiPo - UNI 2.0
15025 25C 6S 2500mAh 22.2V LiPo 25047 50C 5S 5000mAh 18.5V LiPo - UNI 2.0
15026 35C 3S 5000mAh 11.1V LiPo - UNI 2.0-L 25048 50C 6S 5000mAh 22.2V LiPo - UNI 2.0
15027 35C 4S 5000mAh 14.8V LiPo Hardcase ROAR
- UNI 2.0-L 25049 30C 3S 2800mAh 11.1V LiPo - UNI 2.0-A
15031 50C 4S 5000mAh 14.8V LiPo Hardcase ROAR
- UNI 2.0-L 25051 30C 3S 800mAh 11.1V LiPo - JST
15032 50C 2S 4500mAh 7.4V LiPo Saddle Pack
ROAR - UNI 25052X2 45C 1S 250mAh 3.7V LiPo - JST-MCX x2
15033 40C 3S 2200mAh 11.1V LiPo - UNI 25052X4 45C 1S 250mAh 3.7V LiPo - JST-MCX x4
15036 50C 1S 5000mAh 3.7V LiPo Hard Case ROAR
- UNI 25053 30C 3S 2200mAh 11.1V Graphene LiPo - UNI 2.0-A
15037 50C 3S 2200mAh 11.1V LiPo - UNI 25054 30C 3S 3200mAh 11.1V Graphene LiPo - UNI 2.0-A
15038 30C 3S 3200mAh 11.1V LiPo Hard Case ROAR
- UNI 25055 30C 4S 2200mAh 14.8V Graphene LiPo - UNI 2.0-A
15038HXT4 30C 3S 3200mAh 11.1V LiPo Hard Case -
HXT4 25077 30C 3S 2200mAh 11.1V LiPo - UNI 2.0
15042 50C 6S 2500mAh 22.2V LiPo 25084 30C 1S 150mAh 3.7V LiPo - JST-MCX
15043 50C 4S 3600mAh 14.8V LiPo 25087 30C 3S 950mAh 11.1V LiPo - JST
15045 50C 6S 3600mAh 22.2V LiPo 25146 30C 2S 210mAh 7.4V LiPo - JST/JST-PH
15046 50C 4S 5000mAh 14.8V LiPo 25147 30C 2S 300mAh 7.4V LiPo - JST/JST-PH
15047 50C 5S 5000mAh 18.5V LiPo 25148 30C 2S 260mAh 7.4V LiPo - JST/JST-PH
15048 50C 6S 5000mAh 22.2V LiPo 25152 30C 6S 1300mAh 22.2V LiPo - UNI 2.0
15049 40C 4S 3500mAh 14.8V LiPo Hard Case - UNI 25159 30C 3S 3000mAh 11.1V LiPo - UNI 2.0
15056 40C 2S 4000mAh 7.4V LiPo Hardcase ROAR -
UNI 2.0-L 25167 30C 1S 700mAh 3.7V LiPo - Mini Losi/JST
15057 40C 2S 5000mAh 7.4V LiPo Hardcase ROAR -
UNI 2.0-L 25168 30C 1S 250mAh 3.7V LiPo - Mini Losi/JST
15058 50C 2S 5000mAh 7.4V LiPo Hardcase ROAR -
UNI 2.0-L 25169 30C 3S 2200mAh 11.1V LiPo - HXT3.5 Super Tigre

ITEM DESCRIPTION ITEM DESCRIPTION
15059 50C 3S 5000mAh 11.1V LiPo - UNI 2.0-L 25170 30C 3S 1300mAh 11.1V LiPo - HXT3.5 Super Tigre
15060 60C 2S 5000mAh 7.4V LiPo Hard Case ROAR
- UNI 35000 15C 6S 22000mAh 22.2V LiPo
15061 60C 2S 5600mAh 7.4V LiPo Hard Case ROAR
- UNI 35000BMS 15C 6S 22Ah 22.2V LiPo Commercial BMS Battery -
XT150/AS150
15064 60C 2S 3800mAh 7.4V LiPo Hard Case Short
Pack ROAR - UNI 35001 15C 6S 16000mAh 22.2V LiPo

15067 70C 2S 7000mAh 7.4V LiPo Hard Case - UNI 35002 15C 6S 13000mAh 22.2V LiPo
15068 70C 4S 6300mAh 14.8V LiPo Hard Case ROAR
- UNI 35003 15C 6S 8000mAh 22.2V LiPo
15070 70C 2S 5300mAh 7.4V LiPo Hard Case ROAR
- UNI 35004 15C 4S 16000mAh 14.8V LiPo
15071 70C 4S 5300mAh 14.8V LiPo Hard Case ROAR
- UNI 35005 15C 4S 13000mAh 14.8V LiPo
15072 70C 2S 5800mAh 7.4V LiPo Hard Case - UNI 35006 15C 4S 8000mAh 14.8V LiPo
15075 25C 2S 10000mAh 7.4V LiPo - UNI 35007 15C 3S 16000mAh 11.1V LiPo
15079 70C 1S 6300mAh 3.7V LiPo Hard Case - UNI 35008 15C 3S 13000mAh 11.1V LiPo
15080 30C 2S 5000mAh 7.4V LiPo Hardcase - UNI
2.0-L 35009 15C 3S 8000mAh 11.1V LiPo 15081 35C 2S 3800mAh 7.4V LiPo Hard Case ROAR
- UNI 35011 3S 6000mAh 11.1V LiPo - DJI Phantom 2
15083 30C 2S 4200mAh 7.4V LiPo Saddle Pack
ROAR - UNI 35012 30C 1S 150mAh 3.7V LiPo - JST-MCX
15084 40C 2S 5000mAh 7.4V LiPo Hardcase ROAR -
UNI 2.0-L 35013 30C 1S 250mAh 3.7V LiPo
15085 20C 2S 4000mAh 7.4V LiPo - UNI 2.0-L 35014 25C 1S 250mAh 3.7V LiPo
15086 50C 2S 5000mAh 7.4V LiPo Hardcase ROAR -
UNI 2.0-L 35015 30C 1S 400mAh 3.7V LiPo
15087 50C 2S 5600mAh 7.4V LiPo Hard Case ROAR
- UNI 35016 30C 1S 500mAh 3.7V LiPo
15091 35C 2S 10000mAh 7.4V LiPo - UNI 2.0-L 35017 30C 1S 500mAh 3.7V LiPo
15092 35C 2S 5200mAh 7.4V LiPo - UNI 35018 15C 1S 600mAh 3.7V LiPo - JST
15093 35C 2S 8000mAh 7.4V LiPo - UNI 2.0-L 35019 30C 1S 600mAh 3.7V LiPo
15094 35C 3S 3300mAh 11.1V LiPo Hardcase - UNI
2.0-L 35020 30C 2S 800mAh 7.4V LiPo 15096 DJI Phantom Battery by Venom 20C 3S
2200mAh 11.1 LiPo – UNI 2.0 35021 30C 3S 1350mAh 11.1V LiPo 15099 100C 2S 5000mah 7.4v LiPo Hardcase ROAR -
UNI 35022 30C 3S 3300mAh 11.1V LiPo
15105 35C 3S 850mAh 11.1v LiPo - UNI 35023 30C 3S 1400mAh 11.1V LiPo
15106 35C 3S 1000mAh 11.1v LiPo - UNI 35024 15C 3S 2200mAh 11.1V LiPo
15107 35C 2S 2000mAh 7.4V LiPo - UNI 2.0-L 35025 15C 3S 4000mAh 11.1V LiPo
15108 35C 3S 1300mAh 11.1V LiPo - UNI 2.0-L 35026 15C 3S 5400mAh 11.1V LiPo
15112 35C 3S 5000mAh 11.1V LiPo Hardcase - UNI
2.0-L 35027 10C 3S 6000mAh 11.1V LiPo - Yuneec Q500
15113 50C 3S 5000mAh 11.1V LiPo Hardcase - UNI
2.0-L 35028 8C 3S 5100mAh 11.1V LiPo
15116 100C 2S 6000mAh 7.4v LiPo Hard Case ROAR
- UNI 35029 30C 4S 1400mAh 14.8V LiPo
15117 100C 2S 7200mAh 7.4v LiPo Hard Case ROAR

- UNI 35030 15C 4S 3200mAh 14.8V LiPo

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ITEM DESCRIPTION ITEM DESCRIPTION

15118 60C 2S 5500mAh 7.4v LiPo Saddle Pack

ROAR - UNI 35031 15C 4S 4000mAh 14.8V LiPo

15119 100C 2S 5800mAh 7.4v LiPo Saddle Pack

ROAR - UNI 35032 15C 6S 5000mAh 22.2V LiPo

15124 100C 2S 4500mAh 7.4v LiPo Shorty Pack

ROAR - UNI 35033 3S 5500mAh 11.1V LiPo - DJI Phantom 2

15125 65C 2S 4100mAh 7.4v LiPo Shorty Pack ROAR

- UNI 35034 25C 3S 5800mAh 11.1V LiPo

15126 100C 2S 5800mAh 7.4v LiPo Square Pack

ROAR - UNI 35035 20C 3S 1600mAh 11.1V LiPo - Parrot Bebop

15127 60C 2S 5200mAh 7.4v LiPo Square Pack

ROAR - UNI 35036 15C 3S 7100mAh 11.1V LiPo - Blade Chroma

15128 35C 3S 5000mAh 11.1V LiPo Hardcase - UNI

2.0-L 35037 20C 3S 2200mah 11.1V LiPo - Sensefly

15129 50C 3S 5000mAh 11.1V LiPo Hardcase - UNI

2.0-L 35038 20C 3S 5400mAh 11.1V LiPo - XT60

15135 100C 3S 5000mah 11.1v LiPo 35039 50C 3S 1000mAh 11.1V LiPo - UNI 2.0
15136 30C 3S 12000mAh 11.1V LiPo Air Pack Battery 35040 50C 3S 1300mAh 11.1V LiPo - UNI 2.0
15137 30C 3S 16000mAh 11.1V LiPo Air Pack Battery 35041 75C 3S 1300mAh 11.1V LiPo - UNI 2.0
15138 30C 4S 8000mAh 14.8V LiPo Air Pack Battery 35042 50C 4S 1000mAh 14.8V LiPo - UNI 2.0
15139 30C 4S 12000mAh 14.8V LiPo Air Pack Battery 35043 50C 4S 1300mAh 14.8V LiPo - UNI 2.0
15140 30C 4S 16000mAh 14.8V LiPo Air Pack Battery 35044 75C 4S 1300mAh 14.8V LiPo - UNI 2.0
15141 30C 6S 8000mAh 22.2V LiPo Air Pack Battery 35046X2 30C 1S 600mAh 3.8V LiHV – JST-MCPX x2
15142 30C 6S 12000mAh 22.2V LiPo Air Pack Battery 35047 10C 3S 7100mAh 11.1V LiPo - Yuneec Q500
15143 30C 6S 16000mAh 22.2V LiPo Air Pack Battery 35048 20C 3S 2800mAh 11.1V LiPo - Parrot Bebop 2
15144 45C 6S 16000mAh 22.2V LiPo Air Pack Battery 35049 4S 6700mAh 14.8V LiPo - Yuneec Typhoon H
15145 45C 6S 22000mAh 22.2V LiPo Air Pack Battery 35050 15C 3S 800mAh 11.1V LiPo - Blade Inductrix 200
15146 20C 2S 210mAh 7.4v LiPo Air Pack Battery 35051 25C 1S 800mAh 3.7V LiPo - Micro Losi/JST - Ominus
15147 20C 2S 300mAh 7.4v LiPo Air Pack Battery 35052 25C 1S 1000mAh 3.7V LiPo - Micro Losi/JST - Vista

15148 40C 2S 260mAh 7.4v LiPo Air Pack Battery -

JST 35053 50C 3S 850mAh 11.1V LiPo - UNI 2.0 15149 30C 2S 5000mAh 7.4V LiPo Hardcase ROAR -

UNI 2.0-L 35054 50C 3S 1800mAh 11.1V LiPo - UNI 2.0 15150 3S 5500mAh 11.1V Intelligent LiPo - DJI

Phantom 2 35055 75C 3S 850mAh 11.1V LiPo - UNI 2.0

15152 30C 6S 1300mAh 22.2V LiPo - EC3 35056 75C 3S 1000mAh 11.1V LiPo - UNI 2.0

15153 45C 6S 22000mAh 22.2V LiPo Air Pack Battery

- XT150/AS150 35057 75C 3S 1800mAh 11.1V LiPo - UNI 2.0

15154 10C 6S 12000mAh 22.2V LiPo Air Pack Battery 35058 50C 4S 850mAh 14.8V LiPo - UNI 2.0
15155 10C 6S 16000mAh 22.2V LiPo Air Pack Battery 35059 50C 4S 1800mAh 14.8V LiPo - UNI 2.0
15156 10C 6S 22000mAh 22.2V LiPo Air Pack Battery 35060 75C 4S 850mAh 14.8V LiPo - UNI 2.0

15157 10C 3S 6000mAh 11.1V LiPo - Yuneec Q500 35061 75C 4S 1000mAh 14.8V LiPo - UNI 2.0
15158 8C 3S 5100mAh 11.1V LiPo - XT60 35062 75C 4S 1800mAh 14.8V LiPo - UNI 2.0
15159 30C 3S 3000mAh 11.1V LiPo - EC3 35063X2 45C 1S 180mAh 3.7V LiPo - JST-MCX x2

ITEM DESCRIPTION ITEM DESCRIPTION

15160 100C 2S 5000mAh 7.4v Water Cooled LiPo Battery 35063X4 45C 1S 180mAh 3.7V LiPo - JST-MCX x4
15161 50C 2S 5000mAh 7.4v Water Cooled LiPo Battery 35065X2 45C 1S 250mAh 3.7V LiPo - JST-MCX x2
15162 100C 3S 5000mAh 11.1v Water Cooled LiPo Battery 35065X4 45C 1S 250mAh 3.7V LiPo - JST-MCX x4
15163 50C 3S 5000mAh 11.1v Water Cooled LiPo Battery 35066 15C 6S 22000mAh 22.2V LiPo Drone Pro Battery - XT90-S
15164 100C 4S 5000mAh 14.8v Water Cooled LiPo Battery 35068 90C 3S 1300mAh 11.1V Graphene LiPo - UNI 2.0
15165 50C 4S 5000mAh 14.8v Water Cooled LiPo Battery 35069 90C 3S 1500mAh 11.1V Graphene LiPo - UNI 2.0
15166 3S 6000mAh 11.1V Intelligent LiPo - DJI Phantom 2 35070 90C 4S 1300mAh 14.8V Graphene LiPo - UNI 2.0
15167 35C 1S 700mAh 3.7V LiPo - Mini Losi 35071 90C 4S 1500mAh 14.8V Graphene LiPo - UNI 2.0
15168 25C 1S 250mAh 3.7V LiPo - Mini Losi 35072 75C 4S 1500mAh 14.8V LiPo - UNI 2.0
15169 20C 3S 1800mAh 11.1V LiPo - Mini Tamiya 35073 75C 4S 850mAh 14.8V LiPo - XT30
15170 50C 2S 2400mAh 7.4V LiPo - UNI 35074X4 30C 1S 220mAh 3.8V LiHV - JST-MCPX
15171 50C 2S 4200mAh 7.4V LiPo - UNI 35075 20C 3S 4900mAh 11.1V LiPo - Sensefly SQ/Plus
15172 35C 2S 6600mAh 7.4V LiPo - UNI 35076 45C 2S 350mAh 7.4V LiPo - JST
15173 50C 3S 5200mAh 11.1V LiPo - UNI 2.0-L 35077 50C 2S 450mAh 7.4V LiPo - JST
15174 3S 6000mAh 11.1V LiPo - DJI Phantom 2 35078 50C 2S 850mAh 7.4V LiPo – JST
15185 25C 2S 5000mAh 7.6V LiHV Hard Case - UNI 35079 30C 3S 450mAh 11.1V LiPo – JST
15186 25C 3S 5000mAh 11.4V LiHV Hard Case – UNI 35080 70C 3S 450mAh 11.1V LiPo – JST
15187 50C 3S 10500mAh 11.1V LiPo - UNI 2.0-TRX 35081 75C 3S 650mAh 11.1V Graphene LiPo - XT30
15188 50C 3S 5000mAh 11.1V LiPo Hard Case – XT90-S 35082 75C 4S 650mAh 14.8V Graphene LiPo - XT30
15189 50C 4S 9000mAh 14.8V LiPo – UNI 2.0-TRX 35083 75C 5S 1300mAh 18.5V LiPo - UNI 2.0
15190 50C 3S 2200mAh 11.1V LiPo - UNI 2.0-L 35084 90C 5S 1300mAh 18.5V Graphene LiPo - UNI 2.0
15191 30C 2S 4000mAh 7.4V LiPo - UNI 2.0-L 35085 4S 7300mAh 15.2V LiHV - Yuneec H520
15192 25C 2S 5000mAh 7.4V Graphene LiPo Hardcase - UNI 2.0-L 45000 35C 3S 1500mAh 11.1V LiPo - EC3
15193 35C 3S 5000mAh 11.1V Graphene LiPo - UNI 2.0-L 45001 50C 3S 2200mAh 11.1V LiPo - EC3
15194 50C 3S 5000mAh 11.1V Graphene LiPo - UNI 2.0-L 45002 75C 3S 2200mAh 11.1V LiPo Battery - UNI 2.0-A
15202 50C 2S 4600mAh 7.4V LiPo Shorty Hardcase - UNI 2.0-L 45075 75C 3S 1300mAh 11.1V LiPo - Barbwire 2

5.4

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1.
Identification

1.1. Product identifier Product Identity A-3202B, A-2616, A-2601 **Alternate Names** Cyanoacrylate Adhesive

1.2. Relevant identified uses of the substance or mixture and uses advised against Intended use See Technical Data Sheet. **Application Method** See Technical Data Sheet.

1.3. Details of the supplier of the safety data sheet Company Name
Arrowhead Forensics

11030 Strang Line Road

Lenexa, KS 66215

Contact Telephone No. 1 (913) 894-8388 **Customer Service:**

2. Hazard(s) identification

2.1. Classification of the substance or mixture
Combustible Liquid;H227 Combustible Liquid. Skin Irrit. 2;H315 Causes skin irritation. Eye Irrit. 2;H319 Causes serious eye irritation. Carc. 2;H351 Suspected of causing cancer. STOT SE 3;H335 May cause respiratory irritation.

2.2. Label elements Using the Toxicity Data listed in section 11 and 12 the product is labeled as follows.

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H227 Combustible liquid. H315 Causes skin irritation. H319 Causes serious eye irritation. H335 May cause respiratory irritation. H351 Suspected of causing cancer.

[Prevention]:

P201 Obtain special instructions before use. P202 Do not handle until all safety precautions have been read and understood. P210 Keep away from heat / sparks / open flames / hot surfaces - No smoking. P261 Avoid breathing dust / fume / gas / mist / vapors / spray. P264 Wash thoroughly after handling. P271 Use only outdoors or in a well-ventilated area. P280 Wear protective gloves / eye protection / face protection. **[Response]:**

P302+352 IF ON SKIN: Wash with plenty of soap and water. P304+312 IF INHALED: Call a POISON CENTER or doctor / physician if you feel unwell. P305+351+338 IF IN EYES: Rinse continuously with water for several minutes. Remove contact lenses if present and easy to do - continue rinsing. P308+313 IF exposed or concerned: Get medical advice / attention. P321 Specific treatment (see information on this label). P332+313 If skin irritation occurs: Get medical advice / attention. P337+313 If eye irritation persists: Get medical advice / attention. P340 Remove victim to fresh air and keep at rest in a position comfortable for breathing. P362 Take off contaminated clothing and wash before reuse. **[Storage]:**

P403+235 Store in a well ventilated place. Keep cool.
P405 Store locked up. **[Disposal]:**

P501 Dispose of contents / container in accordance with local / national regulations.

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3. Composition/information on ingredients

This product contains the following substances that present a hazard within the meaning of the relevant State and Federal Hazardous Substances regulations.

Ingredient/Chemical Designations	Weight %	GHS Classification	Notes
Ethyl cyanoacrylate **CAS Number: 0007085-85-0**	**50 - 75**	**Eye Irrit. 2;H319** **STOT SE 3;H335** **Skin Irrit. 2;H315**	**[1]**
Methyl methacrylate polymer **CAS Number: 0009011-14-7**	**- 25**	**Not Classified [1]**	
Hydroquinone **CAS Number: 0000123-31-9**	**0 - 1.0**	**Carc. 2;H351 Muta. 2;H341 Acute tox. 4;H302 Eye Dam. 1;H318 Skin Sens. 1;H317 Aquatic Acute 1;H400**	**[1][2]** **[1][2]**

In accordance with paragraph (i) of §1910.1200, the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret. [1] Substance classified with a health or environmental hazard. [2] Substance with a workplace exposure limit.

[3] PBT-substance or vPvB-substance. *The full texts of the phrases are shown in Section 16.

4. First aid measures

4.1. Description of first aid measures General In all cases of doubt, or when symptoms persist, seek medical attention.

Never give anything by mouth to an unconscious person. **Inhalation** Remove to fresh air, keep patient warm and at rest. If breathing is irregular or stopped, give

artificial respiration. If unconscious place in the recovery position and obtain immediate medical attention. Give nothing by mouth. **Eyes** Immediately flush with plenty of water for at least 15 minutes. Get medical attention. If eyelids are bonded closed, release eyelashes with warm water by covering with a wet pad. Do not force eye open. Cyanoacrylate will bond to eye protein and will cause lachrymatory effect which will help to debond the adhesive. Keep eye covered until debonding is complete, usually within 1-3 days. Medical attention should be sought in case solid particles of polymerized cyanoacrylate may have been trapped behind the eyelid causing abrasive damage. **Skin** Do not pull bonded skin apart. Soak in warm soapy water. Gently peel apart using a blunt instrument. If skin is burned due to the rapid generation of heat by a large drop, seek medical attention. If lips are bonded, apply warm water to the lips and encourage wetting and pressure from saliva in the mouth. Peal or roll lips apart. Do not pull lips apart with direct opposing force.

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Ingestion Ensure breathing passages are not obstructed. The product will polymerize rapidly and bond to the mouth making it almost impossible to swallow. Saliva will separate any solidified product in several hours. Prevent the patient from swallowing any separated mass. **4.2. Most important symptoms and effects, both acute and delayed Overview** Skin contact may cause burns. Bonds skin rapidly. Skin and eye irritant. Vapor is irritating to eyes and mucous membranes. When above TLV. Prolonged overexposure to vapors may produce allergic reactions with asthma like symptoms in sensitive individuals. Possible cancer hazard. Contains an ingredient which may cause cancer based on animal data (See Section 3 and Section 15 for each ingredient). Risk of cancer depends on duration and level of exposure. See section 2 for further details.

Eyes Causes serious eye irritation. **Skin** Causes skin

irritation.

5. Fire-fighting measures

5.1. Extinguishing media Carbon Dioxide, Dry Chemicals, Foam **5.2. Special hazards arising from the substance or mixture** Hazardous decomposition: Irritating organic vapors may be released. Use of a SCBA is recommended. Keep away from heat / sparks / open flames / hot surfaces - No smoking. Avoid breathing dust / fume / gas / mist / vapors / spray. **5.3. Advice for fire-fighters** A self-contained breathing apparatus is required. **ERG Guide No.** 128

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures Put on appropriate personal protective equipment (see section 8). **6.2. Environmental precautions** Do not allow spills to enter drains or waterways. Use good personal hygiene practices. Wash hands before eating, drinking, smoking or using toilet. Promptly remove soiled clothing and wash thoroughly before reuse. **6.3. Methods and material for containment and cleaning up** DO NOT use cloth materials. In case of a leak or spill, flood area with water to polymerize the material. Soak up with inert absorbent. Ventilate area. Prevent product from entering drains.

7. Handling and storage

7.1. Precautions for safe handling Avoid contact with skin and eyes. Avoid breathing vapors. See section 2 for further details. - [Prevention]: **7.2. Conditions for safe storage, including any incompatibilities** Handle containers carefully to prevent damage and spillage. Store in a cool dry area, away from heat, sparks and open flame. Keep containers sealed when not in use. Store out of direct sunlight. Incompatible materials: Polymerized by water, alcohol, amines and alkalis. Store below 72 F. See section 2 for further details. - [Storage]: **7.3. Specific end**

use(s) No data available.

8. Exposure controls and personal protection

8.1. Control parameters

Exposure

CAS No.	Ingredient	Source	Value
9-13-321000 0		A: 1 mg/m3S, Revised 2008,	NIOSH C 2 mg/m3
		Supplier	No Established Limit
0-58-5807000	lyhtE etalyrcaonayc AHSO oN hsilbatsE ed	Limit	
		ACGIH	TWA: 0.2 ppm
		NIOSH	No Established Limit
		Supplier	No Established Limit
0009011-14-7	Methyl methacrylate polymer	OSHA	No Established Limit
		ACGIH	No Established Limit
		NIOSH	No Established Limit
		Supplier	No Established Limit

Carcinogen Data

CAS No.	Ingredient	Source	Value

0000123-31-9 Hydroquinone OSHA Select Carcinogen: No

NTP Known: No; Suspected: No

IARC Group 1: No; Group 2a: No; Group 2b: No; Group 3: Yes; Group 4: No;

0007085-85-0 Ethyl cyanoacrylate OSHA Select Carcinogen: No

NTP Known: No; Suspected: No

IARC Group 1: No; Group 2a: No; Group 2b: No; Group 3: No; Group 4: No;

0009011-14-7 Methyl methacrylate polymer OSHA Select Carcinogen: No

NTP Known: No; Suspected: No

IARC Group 1: No; Group 2a: No; Group 2b: No; Group 3: Yes; Group 4: No;

8.2. Exposure controls Respiratory If workers are exposed to concentrations above the exposure limit they must use the

appropriate, certified respirators. **Eyes**
Protective safety glasses recommended

Skin Use polyethylene gloves and aprons. DO NOT use cotton/cloth gloves. **Engineering Controls** Positive draft exhaust ventilation should be provided to maintain vapor concentration levels

below TLV. Use NIOSH approved respirator if there is potential to exceed exposure limit(s).
Other Work Practices Use good personal hygiene practices. Wash hands before eating, drinking, smoking or

using toilet. Promptly remove soiled clothing and wash thoroughly before reuse.
See section 2 for further details. - [Prevention]:

9. Physical and chemical properties

Appearance Clear Liquid **Odor** Sharp **Odor threshold** Not Measured **pH** Not Measured **Melting point / freezing point** Not Measured **Initial boiling point and boiling range** Greater than 300 F **Flash Point** 160 - 200 F (TCC) **Evaporation rate (Ether = 1)** Not Measured **Flammability (solid, gas)** Not Applicable **Upper/lower flammability or explosive limits Lower Explosive Limit:** Not Measured **Upper Explosive Limit:** Not Measured **Vapor pressure (Pa)** Not Measured

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Vapor Density Not Measured **Specific Gravity** 1.1 **Solubility in Water** deziremyloP yb retaw **Partition coefficient n-octanol/water (Log Kow)** Not Measured **Auto-ignition temperature** Not Measured **Decomposition temperature** Not Measured **Viscosity (cSt)** Not Measured **9.2. Other information**

No other relevant information.

10. Stability and reactivity

10.1. Reactivity Hazardous Polymerization will not occur. **10.2. Chemical stability** Stable under normal circumstances. **10.3. Possibility of hazardous reactions** No data available. **10.4. Conditions to avoid** No data available. **10.5. Incompatible materials** Polymerized by water, alcohol, amines and alkalis. **10.6. Hazardous decomposition products** Irritating organic vapors may be released. Use of a SCBA is recommended.

11. Toxicological information

Acute toxicity

Ingredient Oral LD50, mg/kg

Inhalation Gas LC50, ppm

lyhtE

etalyrcaonayc -)0-58-5807(,00.005,4 taR - Category: 5

Skin LD50, mg/kg

Inhalation Vapor LC50, mg/L/4hr

Inhalation Dust/Mist LC50, mg/L/4hr

No data available

Methyl methacrylate polymer - (9011-14-7) No data available

2,000.10,

No data

No data Rabbit -

available

available Category: 5

No data available

enoniuqordyH

-)9-13-321(,00.023 taR - Category: 4

No data

No data

No data available

available

available

4,800.00, Rat -

No data

No data

No data Category: 5

available

available

available

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Note: When no route specific LD50 data is available for an acute toxin, the converted acute toxicity point estimate was used in the calculation of the product's ATE (Acute Toxicity Estimate).

Classification Category Hazard Description etucA yticixot)laro(--- toN elbacilppA etucA yticixot)lamred(--- toN elbacilppA etucA yticixot)noitalahni(--- toN elbacilppA nikS noitatirri/noisorroc 2 sesuaC niks noitatirri . Serious eye damage/irritation 2 Causes serious eye irritation. yrotaripseR noitazitisnes ---

toN elbacilppA nikS noitazitisnes --- toN elbacilppA mreG llec yticinegatum --- toN elbacilppA yticinegonicraC 2 detcepsuS fo gnisuac .recnac evitcudorpeR yticixot --- toN elbacilppA elgnis-TOTS erusopxe --- toN elbacilppA detaeper-TOTS erusopxe --- toN elbacilppA noitaripsA drazah --- toN elbacilppA

12. Ecological information

12.1. Toxicity Toxic to aquatic life **Aquatic Ecotoxicity**

Ingredient	**96 hr LC50 fish, mg/l**	**48 hr EC50 crustacea, mg/l**	**ErC50 algae, mg/l**
lyhtE etalyrcaonayc -)0-58-5807(toN elbaliavA	Not Available	Not Available	Not Available
Methyl methacrylate polymer - (9011-14-7)	Not Available	Not Available	Not Available
enoniuqordyH			
-)9-13-321(,440.0 suhcnyhrocnO mykiss			
0.13, Daphnia magna			
0.335 (72 hr), Pseudokirchneriella subcapitata			

12.2. Persistence and degradability There is no data available on the preparation itself. **12.3. Bioaccumulative potential** Not Measured **12.4. Mobility in soil** No data available.

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12.5. Results of PBT and vPvB assessment This product contains no PBT/vPvB chemicals. **12.6. Other adverse effects** No data available.

13. Disposal considerations

13.1. Waste treatment methods Observe all federal, state and local regulations when disposing of this substance.

14. Transport information

DOT (Domestic Surface Transportation)

ICAO/IATA

14.1. UN number 3991AN toN detaluger 4333NU **14.2. UN proper shipping name**

IMO / IMDG (Ocean Transportation)

Not regulated Aviation regulated liquids N.O.S.
(Cyanoacrylate ester) **14.3. Transport hazard class(es)**
Combustible liquid, n.o.s., (Cyanoacrylate ester)
Air Class: 9
14.4. Packing group III
toN elbacilppA III EXCEPTIONS: (Not more than
500ml). Unrestricted **14.5. Environmental hazards IMDG** Marine Pollutant: No **14.6. Special precautions for user**

oN rehtruf noitamrofni Please note that Cyanoacrylates are not restricted for domestic ground transportation in non bulk containers (The DOT defines a bulk container as a “Package” containing more than 450 liters. The “Package” is the individual bottle, tube or drum, not a carton containing many bottles.

15. Regulatory information

Regulatory Overview The regulatory data in Section 15 is not intended to be all-inclusive, only selected regulations are represented. **Toxic Substance Control Act (TSCA)**
DOT Hazard Class: Combustible
IMDG: Not Applicable liquid
Sub Class: Not Applicable
All components of this material are either listed or exempt from listing on the TSCA Inventory. **WHMIS Classification** B3 D2A

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US EPA Tier II Hazards Fire: Yes

Sudden Release of Pressure: No **Reactive:** No **Immediate (Acute):** Yes **Delayed (Chronic):** Yes **EPCRA 311/312 Chemicals and RQs:** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute. **EPCRA 302 Extremely Hazardous:**

Hydroquinone **EPCRA 313 Toxic Chemicals:** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute. **Proposition 65 - Carcinogens (>0.0%):** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute. **Proposition 65 - Developmental Toxins (>0.0%):** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute. **Proposition 65 - Female Repro Toxins (>0.0%):** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute. **Proposition 65 - Male Repro Toxins (>0.0%):** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute. **New Jersey RTK Substances (>1%):**

Ethyl cyanoacrylate **Pennsylvania RTK Substances (>1%) :** To the best of our knowledge, there are no chemicals at levels which require reporting under this statute.

16. Other information

The information and recommendations contained herein are based upon data believed to be correct. However, no guarantee or warranty of any kind, expressed or implied, is made with respect to the information contained herein. We accept no responsibility and disclaim all liability for any harmful effects which may be caused by exposure to our products. Customers/users of this product must comply with all applicable health and safety laws, regulations, and orders. The full text of the phrases appearing in section 3 is: H302 Harmful if swallowed. H315 Causes skin

irritation. H317 May cause an allergic skin reaction. H318 Causes serious eye damage.

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H319 Causes serious eye irritation. H335 May cause respiratory irritation. H341 Suspected of causing genetic defects. H351 Suspected of causing cancer. H400 Very toxic to aquatic life.

This is the first version in the GHS SDS format. Listings of changes from previous versions in other formats are not applicable. IMPORTANT: The information presented herein, while not guaranteed, was prepared in good faith and is known to be true and accurate to the best of our knowledge. NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE, OR OF ANY OTHER KIND, EXPRESSED OR IMPLIED, IS MADE REGARDING PERFORMANCE, STABILITY OR OTHERWISE. This information is not intended to be all-inclusive as to the manner and conditions of use, handling and storage. Other factors may involve other or additional safety or performance considerations. While our technical personnel will be happy to respond to questions regarding safe handling and use procedures, safe handling and use remains the responsibility of the customer. No suggestions for use are intended as, and nothing herein shall be construed as a recommendation to infringe any existing patents or violate any federal, state or local laws, rules, regulations or ordinances.

End of Document

5.5

SAFETY DATA SHEET NEMA Grade G-10 / G11

Current, Incorporated

Product Name: NEMA Grade G10 / G11

Manufacturer: Current, Incorporated
30 Tyler Street
Extension East Haven,
CT 06512

Emergency Phone: 203-469-1337
877-436-6542 (Toll
Free)

Description: Fully cured solid composite of epoxy/glass cloth

Product Use: Used for electrical insulation in sensitive electronic equipment

GHS Classification: Not applicable. This material, as sold, is not hazardous under the criteria of the Federal
OSHA Hazard Communication Standard 29CFR
1910.1200

GHS Signal Words with Hazard and Precautionary Statements:
Warning!

Dust generated during machining, grinding or sanding may cause eye irritation. Fumes from decomposition or burning may irritate eyes, nose and respiratory system. Dust generated by secondary operations can be explosive. Avoid eye exposure to dust and fumes. Avoid skin exposure to dust and fumes.

GHS Pictograms: Warning! This product may form combustible dust during processing.

Route of Entry: None for this product as sold. For dust or chips generated during fabrication operations:

eye contact, skin contact, and inhalation.

Section 2. Hazard Identification

Section 1. Identification

Target Organs: None

Skin Contact: Solid sheet may be abrasive to, or cut the skin. Operations such as milling, cutting, grinding, etc. may produce dust or fines that may be irritating.

Eye Contact: No hazard for product as sold. Operations such as milling, cutting, grinding, etc. may produce dust or fines that may be irritating.

Respiratory Contact: Not an expected route of entry. Operations such as milling, cutting, grinding, etc. may produce dust or fines that may be irritating.

Ingestion: Not an expected route of entry.

HMIS (United States) NFPA (United States) WHMIS (Canada): Not classified as hazardous

Health 1

Flammability 0

Reactivity 0

PPE B

Section 3. Composition / Information on Ingredients

Fully cured solid composite of epoxy/glass:

Name CAS #

Fiberglass 65997-17-3

Epoxy Resin 25036-25-3

Section 4. First – Aid Measures

For dust or fumes produced by machining, grinding or sanding:

Skin: Wash skin with soap and water. If redness or itching develops seek medical attention.

Eye: Flush with large amounts of cool water for 15 minutes. If irritation persists, seek medical attention.

Respiratory: Remove to fresh air. Call a physician if necessary.

Ingestion: Not an expected route of entry with normal product use. If large amounts of dust swallowed seek medical attention.

Section 5. Fire-Fighting Measures

Flammability: Not Flammable under normal conditions. Flash Pt.: N/A, Class: Solid

Extinguishing Media: Water, foam, carbon dioxide or dry chemical

Special Fire and Explosion Hazard: None as sold. (Accumulated dust may be explosive. Heat from fire can generate decomposition products that may

cause a health hazard.)

Special Firefighting Procedures: Fire fighters should wear positive-pressure self-contained breathing apparatus (SCUBA) and protective clothing.

Section 6. Accidental Release Measures

Personal Precautions, Protective Equipment and Emergency Procedures:

Material is non-hazardous as sold.

Environmental Precautions:
None

Spills: Material is solid as sold. Contain and manage dust during secondary operations. Sweep up accumulated dust using water spray to suppress. Eliminate all ignition sources.

Section 7. Handling and Storage

Handling Precautions: No specific usage precautions required as sold. Follow normal good hygiene practices.

Storage Precautions: Store in a cool, dry well-ventilated area.

Section 8. Exposure Controls / Personal Protection

Machining, cutting, grinding or sanding fiber glass plastic produces respirable fibrous glass dust regulated by OSHA as noted below. Respirable fiberglass dust may cause cancer.

Component Information Exposure limits

Component Name CAS # TLV, TWA, ACGIH OSHA PEL, TWA

Fiberglass 65997-17-3 10mg/m3 (dust) 15 mg/m3 (total dust)

5 mg/m3
(respirable)

Epoxy Resin 25036-25-3 10mg/m3 (dust) 10mg/m3 (dust)

Eye Protection: Minimize dust generating activities. Wear safety goggles. Do not wear contact lenses.

Skin Protection: Wear gloves to protect from sharp edges and protective clothing.

Respiratory Protection: If personal exposure cannot be controlled by ventilation, wear a particulate respirator

approved by NIOSH/MSHA to protect against
dust.

Other: Emergency eye wash stations should be available if cutting or producing dust.

Section 9. Physical and Chemical Properties

Appearance: Light Green / Light Brown **Lower Explosion Limit:** Not Available

Odor: Odorless Solid **Upper Explosion Limit:** Not Available

Odor Threshold: Not Applicable **Vapor Pressure:** Not Applicable

pH: Not Applicable **Vapor Density:** Not Applicable

Melting Point: Not Available **Relative Density:** Not Available

Freezing Point: Not Applicable **Solubility:** Not Soluble

Boiling Point and Range: Not Applicable **Auto-Ignition Temperature:** Not Available

Flash Point and Method: Not Applicable **Decomposition Temperature:** Not Available

Evaporation Rate: Not Applicable **Viscosity:** Not Applicable

Flammability: Not Flammable **Specific Gravity;** ~ 1.93

Partition Coefficient (n-Octanol / Water): Not Applicable

Section 10. Stability and Reactivity

Reactivity: Product is non-reactive

Chemical Stability: Stable under normal conditions

Possibility of Hazardous Reactions: Thermal decomposition may produce oxides of carbon.

Conditions to Avoid: Protect from heat, sparks and flame

Materials to Avoid: Avoid contact with strong acids and bases.

Hazardous Decomposition Products: Carbon dioxide, carbon monoxide, bromine and other hazardous gases

may be generated under normal processing conditions.

Hazardous Polymerization: Will not occur.

Section 11. Toxicological Information

Component Oral LD50 (rat) Dermal LD50 (rabbit) Inhalation LC50 4hr (rat)

Glass Fiber: Not determined Not determined Not determined

Section 12. Ecological Information

As sold, this material is not classified as hazardous.

This material is not

biodegradable.

Particulates generated during machining may be subject to Federal and State air pollution control laws.

Section 13. Disposal Considerations

Disposal Methods:

This material (as sold) is not classified as hazardous waste. Dispose of only by methods approved by and used in accordance with local, state and federal regulations for non-hazardous waste.

Particulates generated during machining and fabrication operations may be subject to Federal and State Air Pollution Control Laws.

Section 14. Transport Information

This product, as offered for shipment, is not regulated as a Hazardous Material.

UN Number: Not Applicable

UN Proper Shipping Name: Not Applicable

Transport Hazard Class: Not Applicable

DOT Classification: Not Applicable

Special Provision for Transport: Not Applicable

IMDG Code: Not Applicable. Not expected to be a marine pollutant

Transport Canada: Not Applicable.

Section 15. Regulatory Information

OSHA Hazard Communication Standard: This product is considered non-hazardous under OSHA Hazard Communication Standard (29CFR 1910.1200)

California (Proposition 65): No components exceeding levels listed in “No significant Risk Levels” (NSRLs) for carcinogens or “Maximum Allowable Doses Levels (MADLs), as established in regulation title 27, California code of regulations.

Superfund Amendments and Reauthorization Act of 1986 Title III: This product is not a hazardous chemical under 29CFR 1910.12000, and therefore is not covered by Title III of SARA.

Toxic Substance Control Act (TSCA): All components of this product are on the TSCA inventory or are exempt from TSCA inventory requirements.

HMIS Codes:
Health 1
Flammability 0
Reactivity 0
PPE B

Section 16. Other Information

Revision Information: Revision 2 (May 19, 2015), Complete, to comply with HCS Standard 29 CFR 1910.1200(g). Update to new “SDS” format.

Additional information on this product may be obtained by calling
203-469-1337.

Notice to Reader:

To the best of our knowledge, the information contained herein is accurate. However, this should not be accepted as a guarantee of accuracy without confirming tests at your own facility. The above named manufacturer assumes no liability for accuracy or completeness of the information contained herein. The data relates only to the material as supplied and does not relate to combinations with other materials or processes.

End of SDS Document

5.6

Material Safety Data Sheet

Section 1: PRODUCT AND COMPANY IDENTIFICATION

MSDS Identification: Carbon Fabric, Sized or Unsized **MSDS Number:** 439-3227-00SU-C000-12 **Date:** October 1, 2002 **Page:** 1 of 6 **Supersedes MSDS:** 439-3227-00SU-C000-11

Manufacturer: Emergency Telephone Number: Hexcel Schwebel 800-433-5072 (24-Hour) 2200 South Murray Avenue P.O. Box 2627 **Information Telephone Number:** Anderson, SC 29621 864-260-5799 (Normal Business Hours-ET)

Product Identification: Carbon Fabric: Sized or Unsized

Chemical Family: Woven Carbon Fabric with various types of Sized and Unsized Carbon Fibers.

Section 2: COMPOSITION/INFORMATION ON INGREDIENTS

Component CAS® % by OSHA(PEL) ACGIH®(TLV®)

Number Weight Carbon fiber, 7440-44-0 98.5-100 15 mg/m^3(Total) 10 mg/m^3(Total) synthetic 5 mg/m^3(Respirable) 3 mg/m^3(Respirable)

This product is not classified as a Hazardous Chemical as defined by the OSHA Hazard

Communication Standard, 29 CFR 1910.1200.

Where specific exposure limits for component dusts are not established, the levels provided for (Total/Inhalable) dust and (Respirable) fraction reflect the classification of Particulates Not Otherwise Regulated (PNOR) by OSHA or Specified (PNOS) by ACGIH®.

Section 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Appearance and Odor: Black fibers woven into fabrics of varying weight, width and thickness, depending on the style, with and without sizing, with no distinctive odor.

Statement of Hazard: Warning! May cause temporary mechanical irritation of the eyes, skin or upper respiratory tract.

If sized, vapor or fumes generated from heating or curing this product may cause eye and respiratory tract irritation.

Carbon fibers or dust are electrically conductive and may create electrical short-circuits which could result in damage to and malfunction of electrical equipment and/or personal injury.
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Section 3: HAZARDS IDENTIFICATION (Continued)

EMERGENCY OVERVIEW (continued): Primary Routes of Exposure:
Eye--Yes Skin--Yes Inhalation--Yes Ingestion--No

HMIS® Rating: Health--1 Flammability--0 Reactivity--0 Special--None

Potential Health Effects: Eye: Contact may cause mechanical irritation to the eyes. If sized, vapor or fumes from exposure of this product to elevated temperatures may cause irritation to the eyes. Dust from machining, grinding or sawing the cured product may cause mechanical irritation.

Skin: Contact may cause mechanical irritation to the skin and possible dermatitis. Dust from machining, grinding or sawing the cured product may cause mechanical irritation.

Inhalation: May cause mechanical irritation to the upper respiratory tract. If sized, vapor or fumes from exposure of this product to elevated temperatures may cause irritation to the respiratory tract. Dust from machining, grinding or sawing the cured product may cause mechanical irritation.

Ingestion: Ingestion unlikely under normal conditions of use. If any of this product or the cured

product dust is swallowed, seek medical attention immediately.

Medical Conditions Aggravated by Exposure: Preexisting eye, skin or respiratory disorders may be aggravated by exposure to this product or to the dust from machining, grinding or sawing the cured product.

Carcinogenic Information: None of the components present in this material at concentrations equal to or greater than 0.1 % are listed or regulated by IARC, NTP, OSHA or ACGIH® as a carcinogen.

Other: OSHA(PEL) ACGIH®(TLV®)

Exposure limits for cured product dust as [Particulates Not Otherwise 15 mg/m^3(Total) 10 mg/m^3(Inhalable) Regulated (PNOR) by OSHA or 5 mg/m^3(Respirable) 3 mg/m^3(Respirable) Specified (PNOS) by ACGIH®]:

Section 4: FIRST AID MEASURES

Eye: In case of eye contact, immediately flush eyes with large amounts of water for at least 15 minutes, keeping the eyelids open. Get medical attention immediately.

Skin: In case of contact that causes irritation, immediately wash skin with soap and room temperature to cool running water. Use a washcloth to help remove the fibers. To avoid further irritation, do not rub or scratch irritated areas. Rubbing or scratching may force fibers into the skin. Get medical attention immediately, if the irritation persists.

Inhalation: If large amounts of dust, fiber, fumes or vapor are inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, qualified personnel may administer oxygen. Get medical attention immediately.
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Section 4: FIRST AID MEASURES (Continued)

Ingestion: Ingestion of this product or the dust from it is unlikely. If swallowed, get medical attention immediately.

Section 5: FIRE FIGHTING MEASURES

Flash Point/Method of Determination: Not determined

Means of Extinction: Use water spray, dry chemical or CO_2 to extinguish fires. **Special Fire Hazards:** Avoid exposure through use of a self-contained, positive-pressure breathing apparatus.

Section 6: ACCIDENTAL RELEASE MEASURES

Procedures in case of Accidental Release or Leakage: Avoid contact with skin, eyes or clothing (See Section 8). Clean up material, put into a suitable container and dispose of properly (See Section 13).

Section 7: HANDLING AND STORAGE

Precautions to be taken in Handling and Storage: Store in a cool, dry place. Maintain sealed against contamination from dirt and moisture.

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Eye/Face Protection: Avoid eye contact. Wear safety glasses with side shields, as necessary, when using this product or when machining, grinding or sawing the cured product.

Skin Protection: Protective clothing such as a loose fitting long sleeved shirt that covers to the base of the neck, long pants and gloves, as necessary to prevent irritation. Skin irritation is known to occur primarily at pressure points such as around the neck, wrist, waist and between the fingers.

Respiratory Protection: Not ordinarily required. If sized and sufficient vapor or fumes are being generated during heating or curing of this product, use a NIOSH approved organic vapor respirator. If sufficient dust or fibers are generated during use or when machining, grinding or sawing the cured product, use a NIOSH approved dust respirator.

Ventilation: Use local exhaust sufficient to control vapor, fumes, fibers or dust generated. If exhaust ventilation is not available or is inadequate, use a NIOSH approved respirator, as appropriate.

General Hygiene Recommendations: Before eating, drinking, smoking or using toilet facilities, wash face and hands thoroughly with soap and water. Remove any contaminated clothing and launder before reuse. Use vacuum equipment to remove fibers and dust from clothing and work areas. Compressed air is not recommended.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Odor...Black fibers woven into fabrics of varying weight, width and thickness, depending on the style, with and without sizing, with no distinctive odor. **Melting Point (^{o}F/^{o}C)**..... 6512^{o}F/3600^{o}C **Specific Gravity (Water=1)**..... 1.5-1.9 **pH of Undiluted Product**..... Not determined **Volatile [Percent (%) by Weight]**..... 0 **Percent (%) VOC**..... Not determined **Solubility in Water**..... Negligible

Section 10: STABILITY AND REACTIVITY

Stability: Stable under proper handling and storage conditions

Incompatible Materials: None

Products evolved from Heat of Combustion or Decomposition: The products of combustion and decomposition depend on other materials present in the fire and the actual conditions of the fire. Burning will decompose the sizing system, if appropriate, and produce carbon and nitrogen oxides, phenols, aldehydes, acrolein, carboxylic acid, traces of incompletely burned carbon products and other unidentified gases and vapors that may be toxic. Avoid inhalation.

Hazardous Polymerization: Will not occur under proper conditions of use. Rapid heating of the product in bulk may produce an uncontrolled exothermic reaction that may char and decompose the sizing system, if appropriate, generating unidentified gases and vapors that may be toxic. Avoid inhalation.

Section 11: TOXICOLOGICAL INFORMATION

Component Toxicity Data: Median Lethal Dose

(Species): Oral (LD_{50})...Not determined Inhalation

(LC_{50})...Not determined Dermal (LD_{50})...Not determined
Irritation Index, Estimation of Irritation (Species):
Skin...Not determined Eyes...Not determined
Inhalation...Not determined

Section 12: ECOLOGICAL INFORMATION

No ecological data has been determined.
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Section 13: DISPOSAL CONSIDERATIONS

Waste Disposal Methods: Material for disposal should be placed in appropriate sealed containers to avoid potential human and environmental exposure. It is the responsibility of the generator to comply with all federal, state, provincial and local laws and regulations. We recommend that you contact an appropriate waste disposal contractor and environmental agency for relevant laws and regulations. Under the U.S., Resource Conservation and Recovery Act (RCRA), it is the responsibility of the user of the product to determine at the time of disposal, whether the product meets relevant waste classification.

Section 14: TRANSPORT INFORMATION

DOT: Proper Shipping Name.... Not
regulated Hazard Class..... Not
regulated Identification Number..... Not
regulated Packing Group..... Not
regulated Label Required..... None

Section 15: REGULATORY INFORMATION

SARA Title III: Section 302/304 Extremely
Hazardous Substance: None

Section 311 Hazardous Categorization:
None

Section 313 Toxic Chemicals:
None

CERCLA Section 102(a) Hazardous Substance:
None

RCRA Information: Currently, the product is not listed in federal hazardous waste regulations 40 CFR, Part 261.33, paragraphs (e) or (f), i.e. chemical products that are considered hazardous if they become wastes. State or local hazardous waste regulations may also apply if they are different from the federal regulation. It is the responsibility of the user of the product to determine at the time of disposal, whether the product meets relevant waste classification and to assure proper disposal.

WHMIS (Canada):
Classification: None

This product has been classified in accordance with hazard criteria of the "Controlled Products Regulations" and this MSDS contains all the information required by the "Controlled Products Regulations."

Ingredient Disclosure List:
None
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Section 15: REGULATORY INFORMATION (Continued)

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): Warning! The state of California has determined that the following listed component chemicals in this product may cause cancer, birth defects or other reproductive harm: None

U.S., EPA, TSCA Information: This product is an article as defined by TSCA and is not required to be listed in the TSCA inventory.

Ozone Depletion Information: This product does not contain or is not manufactured with ozone depleting substances as identified in Title VI, Clean Air Act "Stratospheric Ozone Protection" and the regulations set forth in 40 CFR, Part 82.

Section 16: OTHER INFORMATION

Special Precautions: Airborne carbon fibers or dust are electrically conductive and may create electrical short-circuits that could result in damage to and malfunction of electrical equipment and/or personal injury.

Explanation and Disclaimer: Wherever such words or phrases as "hazardous," "toxic," "carcinogen," etc. appear herein, they are used as defined or described under state employee right-to-know laws, Federal OSHA laws or the direct sources for these laws such as the International

Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), etc. The use of such words or phrases should not be taken to mean that we deem or imply any substance or exposure to be toxic, hazardous or otherwise harmful. **Any exposure can only be understood within the entire context of its occurrence, which includes such factors as the substance's characteristics as defined in the MSDS, amount and duration of exposures, other chemicals present and preexisting individual differences in response to the exposure.**

The data provided in this MSDS is based on the information received from our raw material suppliers and other sources believed to be reliable. We are supplying you this data solely in compliance with the Federal OSHA Hazard Communication Standard, 29 CFR 1910.1200 and other Federal and state laws as described in Section 15: Regulatory Information.

The information contained in this MSDS is proprietary and confidential to Hexcel Corporation. This MSDS and the information in it are not to be used for purposes other than compliance with the Federal OSHA Hazard Communication Standard. If you have received this MSDS from any source other than Hexcel Corporation or its authorized agent, the information contained in it may have been modified from the original document and it may not be the most current revision.

Liability, if any, for use of this product is limited to the terms contained in our sale terms and conditions. We do not in any way warrant (expressed or implied, including any implied warranty for merchantability or fitness for a particular purpose) the data contained or the product described in this MSDS. Additionally, we do not warrant that the product will not infringe any patent or other proprietary or property rights of others.

Contact: David M. Rubin,
Hexcel Schwebel Environmental, Health and Safety Manager

5.7

SDS – Pro-X® Rocket Motor Reload Kits Page 1/7 Version 4.00 Revision Date. 2015-06-01

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SAFETY DATA SHEET

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Pro-X® Rocket Motor Reload Kits & Fuel Grains

1.0 PRODUCT / COMPANY IDENTIFICATION

Product Name: Pro24, Pro29, Pro38, Pro54, Pro75, and Pro98 Rocket Motor Reload Kits **Synonyms:** Rocket Motor, Hobby Rocket Motor, HPR Reload Kit **Part Numbers:** Reload kits: P24R-Y-#G-XX, P29R-Y-#G-XX, P38R-Y-#G-XX,

P54R-Y-#G-XX, P24R-Y-#GXL-XX, P29R-Y-#GXL-XX, P38R-Y-#GXL-XX, P54R-Y-#GXL-XX, Propellant grains: P75AC-PG-XX, P98AC-PG-XX, P98AC-MB-PG-XX

Where: Y = reload type (A = adjustable delay, C = C-slot)
# = number of grains &
XX = propellant type

Product Use: Solid fuel motor for propelling hobby rockets

Manufacturer / Supplier: Cesaroni Technology Inc.
P.O. Box 246 2561 Stouffville Rd. Gormley, Ont. Canada L0H 1G0 **Telephone Numbers:**

Product Information: Tel: +1-905-887-2370 Fax: +1-905-887-2375 **24 Hour Emergency Telephone Number:** Tel: +1-613-996-6666 (CANUTEC)

2.0 HAZARDS IDENTIFICATION

Signal Word: **Warning** GHS Pictogram: Hazard Statement: H204 Fire or Projection Hazard

Precautionary Statements

P210 Keep away from heat/sparks/open flames/hot surfaces. No smoking P250 Do not subject to grinding/shock/friction. P370+P380 In case of fire: Evacuate Area. P372 Explosion risk in case of fire. P373 DO NOT fight fire when fire reaches explosives. P401 Store in accordance with local/regional/national regulations. P501 Dispose of in accordance with local/regional/national regulations.

Emergency Overview:

There articles contain cylinders of ammonium perchlorate composite propellant, encased in inert plastic parts. The forward closure also contains a few grams of black powder. ProX Rocket motor reload kits are classified as explosives, and may cause serious injury, including death if used improperly. All explosives are dangerous and must be handled carefully and used following approved safety procedures under the direction of competent, experienced personnel in accordance with all applicable federal, state and local laws and regulations. Avoid inhaling exhaust products. **General Appearance:**

Cardboard tubes contain various plastic parts. Inside the plastic tube are cylinders of composite propellant (rocket fuel). The forward closure also contains a small quantity of black powder. All parts are odourless solids.

Potential Health Effects:

Eye :

Not a likely route of exposure. May cause eye irritation. **Skin:**

Not a likely route of exposure. Low hazard for usual industrial/hobby handling.

Ingestion:

Not a likely route of exposure.

Inhalation:

Not a likely route of exposure. May cause respiratory tract irritation. Do not inhale exhaust products.

3.0 COMPOSITION / INFORMATION ON INGREDIENTS

Propellant

Ingredient Name CAS Number Percentage ----------

Ammonium Perchlorate ..... 7790-98-9 40-85 % Metal Powders ..... 1-45 % Synthetic Rubber ..... 10-30 %

Black Powder Ignition pellet

Ingredient Name CAS Number Percentage ----------

Potassium Nitrate ..... 7757-79-1 70-76 % Charcoal ..... n/a 8-18 % Sulphur ..... 7704-34-9 9-20 % Graphite ..... 7782-42-5 trace

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4.0 FIRST AID MEASURES

Eyes

:

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid. **Skin:**

Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.

Ingestion: Do NOT induce vomiting. If conscious and alert, rinse mouth and drink 2-4 cupfuls of milk or water.

Inhalation: Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Burns: Burns can be treated as per normal first aid procedures.

5.0 FIRE FIGHTING MEASURES

Extinguishing Media:

In case of fire, use water, dry chemical, chemical foam, or alcohol-resistant foam to contain surrounding fire.

Exposure Hazards During Fire:

Exposure to extreme heat may cause ignition.

Combustion Products from Fire:

During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. **Fire Fighting Procedures:**

Keep all persons and hazardous materials away. Allow material to burn itself out. As in any fire, wear a self- contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. **Special Instructions / Notes:**

These articles burn rapidly and generate a significant flame for a short period of time. Black powder is a deflagrating explosive. It is very sensitive to flame and spark and can also be ignited by friction and impact. When ignited unconfined, it burns with explosive violence and will explode if ignited under even slight confinement. Do not inhale exhaust products.

6.0 ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel): Spills: Clean up spills immediately. Replace articles in packaging and boxes and seal securely. Sweep or scoop up

using non-sparking
tools.

7.0 HANDLING AND STORAGE

Handling: Keep away from heat, sparks and flame. Avoid contamination. Do not get in eyes, on skin or on

clothing. Do not taste or swallow. Avoid prolonged or repeated contact with skin. Follow manufacturer's instructions for use.

Storage: Store in a cool, dry place away from sources of heat, spark or flame. Keep in shipping packaging

when not in
use.

8.0 EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls:

Use adequate explosion proof ventilation to keep airborne concentrations low. All equipment and working surfaces must be grounded. **Personal Protective Equipment:**

Eyes
:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. **Skin:**

Clothing should be appropriate for handling pyrotechnic substances. **Clothing:**

Clothing should be appropriate for handling pyrotechnic substances. **Respirators:**

A respirator is not typically necessary. Follow the OSHA respirator regulations found in 29CFR1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

9.0 PHYSICAL AND CHEMICAL PROPERTIES

Physical State: solid Appearance: rubber cylinders inside plastic parts Odour: none Odour Threshold: Not available. pH: Not available. Vapour Pressure: Not available. Vapour Density: Not available. Viscosity: Not available. Evaporation Rate: Not available. Boiling Point: Not available. Freezing/Melting Point: Not available. Coefficient of water/oil distribution: Not available. Autoignition Temperature: 280°C Flash Point: Not available. Explosion Limits, lower (LEL): Not available. Explosion Limits, upper (UEL): Not available. Sensitivity to Mechanical Impact: unprotected black powder can be ignited by impact Sensitivity to Static Discharge: unprotected black powder can be ignited by static discharge Decomposition Temperature: > 400°C Solubility in water: black powder is soluble in water Specific Gravity/Density: black powder = 1.7-2.1

Propellant = not available

Molecular Formula: Not applicable Molecular Weight: Not applicable.

10.0 STABILITY AND REACTIVITY

SDS – Pro-X® Rocket Motor Reload Kits Page 4/7 Version 4.00 Revision Date. 2015-06-01

Chemical Stability:

Stable under normal temperatures and pressures.

Conditions to Avoid:

Heat, static electricity, friction, impact

Incompatibilities with Other Materials:

Combustible or flammable materials, explosive materials

Hazardous Products Of Decomposition:

Oxides of nitrogen

Hazardous Polymerization:

Will not occur.

SDS – Pro-X® Rocket Motor Reload Kits Page 5/7 Version 4.00 Revision Date. 2015-06-01

11.0 TOXICOLOGICAL INFORMATION

Routes of Entry: Skin contact – not likely

Skin absorption – not likely Eye contact – not likely Inhalation – not likely Ingestion – not likely **Effects of Acute Exposure to Product:**

No data available

Effects of Chronic Exposure to Product:

No data available

Exposure Limits:

Black Powder Pellets

Ingredient Name CAS Number OSHA PEL ACGIH TLV ---------- ---------- ---------- ----------

Potassium Nitrate 7757-79-1 not established not established Charcoal n/a not established not established Sulphur 7704-34-9 not established not established Graphite 7782-42-5 2.5 mg/m^3 15 mmpct (TWA)

Propellant

Ingredient Name CAS Number OSHA PEL ACGIH TLV ----------
---------- ---------- ----------

Ammonium Perchlorate 7790-98-9 not established not established metal powder varies varies
Synthetic Rubber not established not established

Irritancy of the Product:

No data available

Sensitization to the Product: No data available **Carcinogenicity:**

Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA

Reproductive Toxicity:

No data available

Teratogenicity:

No data available

Mutagenicity:

No data available

Toxically Synergistic Products:

No data available

LD50:

No data available

12.0 ECOLOGICAL INFORMATION

Environmental Data:
Ecotoxicity Data:

Not determined.

EcoFaTE Data:

Not determined.

13.0 DISPOSAL CONSIDERATIONS

Product As Sold: Pack firmly in hole in ground with nozzle pointing up. Ignite motor electrically from a safe distance and wait 5 minutes before approaching. Dispose of spent components in inert trash. **Product Packaging:** Dispose of used packaging materials in inert trash. **Special Considerations:** Consult local regulations about disposal of explosive materials.

14.0 TRANSPORT INFORMATION

Shipping Information –
Canada

TDG Classification: Class 1.4 Explosive **Proper Shipping Name:** Articles, Explosive, N.O.S. (Model Rocket Motors) **UN Number:** 0351 **UN Classification Code:** 1.4 C **Packing Group:** II **UN Packing Instruction:** 101

Shipping Information - USA / IMO

Proper Shipping Name: Articles, Explosive, N.O.S. (Model Rocket Motors) **UN Number:** 0351 **UN Classification Code:** 1.4 C **DOT / IMO Label:** Class 1 – Explosive – Division 1.4C

Shipping Information - IATA

Proper Shipping Name: Articles, Explosive, N.O.S. (Model Rocket Motors) **UN Number:** 0351 **UN Classification Code:** 1.4 C **IATA Labels:** Class 1 – Explosive – Division 1.4C

Cargo Aircraft Only

15.0 REGULATORY INFORMATION

Canada

This product has been classified according to the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

WHMIS Classification: Not Controlled (explosive)

Domestic Substance List (DSL) Status:

All ingredients are listed on Canada's DSL List.

Canadian Explosives Classification: Rocket Motors - **R2, PE3** This products are authorized explosives in Canada.

These products are not considered “Controlled Goods” in Canada under the Controlled Goods Regulations.

United States of America

TSCA Inventory Status:

All ingredients are listed on the TSCA inventory.

Hazardous Chemical Lists

CERCLA Hazardous Substance (40 CFR 302.4) No SARA Extremely Hazardous Substance (40CFR 355) No SARA Toxic Chemical (40CFR 372.65) No **European/International Regulations**

The product on this MSDS, or all its components, is included on the following countries’ chemical inventories: EINECS – European Inventory of Existing Commercial Chemical Substances

European Labelling in Accordance with EC Directives

Hazard Symbols: Explosive.
Risk Phrases:

R 2 Risk of explosion by shock, friction, fire or other sources of ignition. **R 11** Highly flammable **R 44** Risk of explosion if heated under confinement. Safety Phrases:

S 1/2 Keep locked up and out of the reach of children. **S 8** Keep container dry. **S 15** Keep away from heat. **S 16** Keep away from sources of ignition -- No smoking.

S 17 Keep away from combustible material. **S 18** Handle and open container with care. **S 33** Take precautionary measures against static discharges. **S 41** In case of fire and/or explosion do not breathe fumes.

16.0 OTHER INFORMATION

MSDS Prepared by: Regulatory Affairs Department

Cesaroni Technology Inc.
P.O. Box 246 2561
Stouffville Rd. Gormley,
ON Canada L0H 1G0

Telephone: 905-887-2370 x239 Fax:
905-887-2375 Web Sites:
www.cesaronitech.com
www.Pro38.com

The data in this Material Safety Data Sheet relates only to the specific material or product designated herein and does not relate to use in combination with any other material or in any process.

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if the company has been advised of the possibility of such damages.

5.8

DUPONT -- KEVLAR BRAND FIBER

========== MSDS Safety Information

========== MSDS Date: 11/19/1999 MSDS Num: CKSQM Product ID: KEVLAR BRAND FIBER MFN: 01 Responsible Party Cage: TO822 Name: DUPONT Address: 1007 MARKET STREET City: WILMINGTON DE 19898 Info Phone Number: 1-800-441-3637; 800-453-8527 Emergency Phone Number: 800-424-9300 Resp. Party Other MSDS No.: SP1889 Preparer's Name: EDMUND MERRIMAN Chemtrec IND/Phone: (800)424-9300 Review Ind: Y Published: Y ========== Contractor Summary ========== Cage: TO822 Name: DUPONT Address: 1007 MARKET STREET City: WILMINGTON DE 19898 Phone: 1-800-441-3637; 800-453-8527 Cage: TO979 Name: DUPONT ADVANCED FIBERS SYSTEMS Box: 27001 City:

RICHMOND VA 23261 Phone: 800-453-8527

========== Ingredients

========== Cas: 26125-61-1 Name: POLY(TEREPHTHALOYLCHLORIDE/P-PHENYLENEDIAMINE) (PARA-ARAMID POLYMER) > Wt: 89. ---------- Cas: 7732-18-5 RTECS #: ZC0110000 Name: WATER, ABSORBED % low Wt: 0. % high Wt: 7. ---------- Name: PULP WET-LAP % low Wt: 35. % high Wt: 70. ---------- Cas: 7757-82-6 RTECS #: WE1650000 Name: SODIUM SULFATE IN KAVLAR PULP < Wt: .1 ---------- Name: SODIUM SULFATE IN OTHER FORMS < Wt: 2. ---------- Name: FINISH < Wt: 2. < Wt: 2. ========== Health Hazards Data

========== Carcinogenicity Inds - NTP: NO IARC: NO OSHA: NO Effects of Exposure: EYE: FIBER FLY & DUST MAY CAUSE IRRITATION. SKIN: CONTINUAL RUBBING OF FIBERS & FIBER PIECES ON THE SKIN MAY CAUSE IRRITATION. INGESTION: KEVLAR IS NONTOXIC WHEN EATEN. INHALATION: KEVLAR IS TOO BIG TO INHALE INTO THE LUNGS, BUT FIBER DUST & FLY FROM PROCESSING MAY BE BREATHED INTO THE NOSE & THROAT. WORKING UNPROTECTED IN DUSTY CONDITIONS MAY CAUSE UPPER RESPIRATORY IRRITATION & COLD-LIKE SYMPTO MS. CHRONIC: PROCESSING KEVLAR OR MACHINING MATERIALS CONTAINING KEVLAR MAY CREATE FIBER DUST IN THE AIR SMALL ENOUGH TO BE BREATHED INTO THE LUNGS. BREATHING HIGH CONCENTRATIONS OF DUST FOR LONG PERI ODS MAY CAUSE LUNG INJURY. Explanation Of Carcinogenicity: NONE OF THE COMPONENTS PRESENT IN THIS MATERIAL AT CONCENTRATIONS EQUAL TO OR GREATER THAN 0.1% ARE LISTED BY AIRC, NTP, OSHA, OR ACGIH AS A CARCINOGEN. Signs And Symptions Of Overexposure: EYE: IRRITATION. SKIN: IRRITATION. INHALATION: UPPER RESPIRATORY IRRITATION AND COLD-LIKE SYMPTOMS. First Aid: EYE: IN CASE OF CONTACT IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN IF IRRITATION PERSISTS OR DEVELOPS. INHALATION: IF

LARGE AMOUNTS OF FUMES, DUST OR FIBERS ARE INHALED, REMOVE TO FRESH AIR. IF BREATHING IS DIFFICULT, GIVE OXYGEN & CALL PHYSICIAN. IF PERSISTENT COUGH OR OTHER SYMPTOMS DEVELOP, GET MEDICAL ATTENTION. SKIN: WASH WITH SOAP & WATER. USE HAND CREAMS TO SOOTH & MOISTEN IRRITATED SKIN. GET MEDICAL ATTENTION IF IRRITATION PERSISTS AFTER CONTACT STOPS. INGESTION: IN CASE OF GASTRO-INTESTINAL DISTRESS FOLLOWING ACCIDENTAL INGESTION, CALL PHYSIC IAN.

========== Handling and Disposal ========== Spill Release Procedures: WASH, SHOVEL OR MOP UP AND PLACE IN SOLID WASTE CONTAINERS. FIBER IS NOT BIODEGRADABLE; DO NOT FLUSH TO DRAINS. CLEAN UP DUSTS AND PULP WITH HIGH EFFICIENCY PARTICULATE AIR(HEPA) FILTERED VACUUM EQUIP MENT, OR BY WET CLEANING. AVOID THE USE OF DRY SWEEPING OR AIR JET BLOWING OF FIBERS AND DUST, WHICH CAN RE-SUSPEND RESPIRABLE DUST IN THE AIR. Waste Disposal Methods: KEVLAR FIBER IS NOT A HAZARDOUS WASTE AS DEFINED BY REGULATIONS IMPLEMENTING THE RESOURCE CONSERVATION AND RECOVERY ACT(RCRA). WASTE MATERIALS OF KEVLAR MAY BE TREATED, STORED, TRANSPORTED AND DISPOSE D OF IN ACCORDANCE WITH STATE AND LOCAL REGULATIONS GOVERNING THE DISPOSAL OF OTHER COMMON OR NON-RC RA REGULATED WASTE MATERIALS. Handling And Storage Precautions: DO NOT TOUCH MOVING THREADLINES OF KEVLAR FIBER. ENTAGLEMENT WITH THIS HIGH STRENGTH FIBER CAN SEVERELY CUT OR EVEN SEVER FINGERS. KEVLAR IS DEGRADED BY ULTRAVIOLET LIGHT. DO NOT STORE IN DIRECT SUN L IGHT. FLUORESCENT LIGHTING WILL CAUSE DISCOLORATION, BUT WILL NOT AFFECT FIBER MECHANICAL PROPERTIES Other Precautions: USE ONLY WITH ADEQUATE VENTILATION. AVOID DUST GENERATION. DO NOT CONSUME FOOD, DRINK OR TOBACCO IN AREAS WHERE THEY MAY BECOME CONTAMINATED WITH THIS MATERIAL. ========== Fire and Explosion Hazard Information ========== Extinguishing

Media: WATER, FOAM, DRY CHEMICAL, CARBON DIOXIDE (CO2). Fire Fighting Procedures: WEAR SELF-CONTAINED BREATHING APPARATUS. KEEP PERSONNEL REMOVED AND UPWIND OF FIRE. WEAR FULL PROTECTIVE EQUIPMENT (FULL BUNKER GEAR). Unusual Fire/Explosion Hazard: KEVLAR FIBER DUST DOES NOT PRESENT AN EXPLOSION HAZARD.
HAZARD. ========== Control Measures
========== Respiratory Protection: RESPIRATOR USE MUST BE IN COMPLIANCE WITH OSHA STANDARD 29 CFR 1910.134(THE RESPIRATOR STANDARD). AN AIR PURIFYING RESPIRATOR WITH A DUST/MIST/FUME CARTRIDGE OR CANISTER MAY BE USED UNDER CIRCUMSTANC ES MEETING RESPIRATOR STANDARD. DISPOSABLE DUST MASKS EQUIVALENT TO 3M MODEL N95 8210 MAY ALSO BE USED. Ventilation: IF FUMES, FIBER FLY OR DUSTS ARE GENERATED, USE ENGINEERING CONTROLS (WHERE TECHNICALLY FEASIBLE) WHENEVER NECESSARY TO CONTROL EXPOSURES BELOW LIMITS. Protective Gloves: WEAR PROTECTIVE GLOVES AND SLEEVES. Eye Protection: SAFETY GLASSESOR COVERALL GOGGLES. Other Protective Equipment: ISOLATION, ENCLOSURES, EXHAUSTS AND VENTILATION, WETTING AND DUST COLLECTION SYSTEMS MAY BE USED. USE NON-GREASY MOISTURIZING SKIN CREAM TO PREVENT DRYING. Work Hygienic Practices: WASH CONTAMINATED CLOTHING BEFORE REUSE. Supplemental Safety and Health: *DRY AND WET KEVLAR PULP IS PACKAGED IN MOSITURE-PROOF BAGS/BALES TO PREVENT DRYING TO LESS THAN 4% MOISTURE AND POSSIBLE PICKUP OF ELECTROSTATIC CHARGE. IF PACKAGE IS PUNCTURED, RE-MOISTURIZE PULP T O AT LEAST 4% MOSITURE BEFORE USING. ========== Physical/Chemical Properties ========== HCC: N1 M.P/F.P Text: DOES NOT MELT Spec Gravity: 1.45G/CC Solubility in Water: INSOLUBLE Appearance and Odor: ODORLESS, GOLDEN, SOLID: YARN, FELT, FABRIC, PAPER, PULP, FLOC, STAPLES
========== Reactivity Data
========== Stability Indicator: YES Materials To

Avoid: NONE REASONABLY FORESEEABLE. Hazardous Decomposition Products: FIBER DECOMPOSITION TEMPERATURE >400C. AT LOWER TEMPERATURES FINISH MAY BOIL OFF AS A FUME, WHICH SHOULD BE VENTED. Hazardous Polymerization Indicator: NO

========== Toxicological Information

========== Toxicological Information: EYE EFFECTS: KEVLAR IS UNTESTED FOR EYE INJURY. SKIN EFFECTS: KEVLAR FIBER IS NOT A SKIN IRRITANT OR A SKIN SENSITIZER IN ANIMALS. SKIN SENSITIZTION HAS NOT BEEN OBSERVED IN HUMAN SKIN PATCH TESTS OR IN INDUSTRIAL EXPERIENCE. ACUTE ORAL EFFECTS: KEVLAR POLYMER HAS VERY LOW TOXICITY BY INGESTION. ORAL ALD > 7500 MG/KG IN RATS. ACUTE INHALATION EFFECTS: INDUSTRIAL EXPERIENCE SHOWS THE INHALATION OF KEVLAR FIBROUS DUST & FLY MAY CAUSE MECHANICAL IRRITATION OF THE MUCOUS MEMBRANES OF NOSE & THROAT.CHRONIC INHALATION EFFECTS: A 2 YEAR INHALATION STUDY PRODUCED PULMONARY FIBROSIS AT 25, 100 & 400 F/ CC. ==========

Ecological Information ========== Ecological: KEVLAR FIBERS ARE NON-BIO-DEGRADABLE IN THE ENVIRONMENT & DO NOT LEACH MATERIAL TOXIC TO FLORA OR FAUNA. FINISHES & ADDITIVES USED WITH KEVLAR ARE TESTED FOR THEIR POTENTIAL EFFECTS ON MANUFACTURING W ASTEWATER TREATMENT SYSTEMS. BIOCOMPATIBILITY & AQUATIC TOXICITY TESTS GIVE THE FOLLOWING RESULTS: FINISHES DO NOT APPEAR TO BE INHIBITORY OR TOXIC TO MICROBES COMMONLY FOUND IN BIOLOGICAL TREATMENT S YSTEMS. BIODEGRADATION & NORMAL ANTI-FOAM TREATMENTS SHOULD CONTROL FOAMING. DEGRADATION OF
& NORMAL ANTI-FOAM TREATMENTS SHOULD CONTROL FOAMING. DEGRADATION OF SCOURED FINISHES SHOULD NOT RESULT IN INCREASED EFFLUENT TOXICITY. MOST FINISHES ARE SUBSTANTIALLY OR COMPLE TELY BIODEGRADABLE, BUT A FEW ARE NOT.

========== MSDS Transport Information

========== Transport Information: NOT

REGULATED. ========== Regulatory Information ========== Sara Title III Information: SECTION 313: NOT REPORTABLE. Federal Regulatory Information: TSCA: KEVLAR FIBER PRODUCTS ARE LISTED ON THE TSCA INVENTORY. CLEAN AIR ACT AMENDMENTS OF 1990: KEVLAR FIBER PRODUCTS AND THEIR PACKAGING DO NOT CONTAIN NOR ARE THEY MANUFACTURED WITH ANY OF THE OZONE -DEPLETING SUBSTANCES LITEDD IN EITHER XLASS I (CHLOROFLUOROCARBONS, HALONS, CARBON TETRACHLORIDE AND METHYL CHLOROFORM OR CLASS II (HYDROCHLOROFLUOROCARBONS). FDA: SOME BUT NOT ALL, KEVLAR FIBER PROD UCTS ARE APPROVED FOR USE AS ARTICLES OR COMPONENTS OF ARTICLES INTENDED FOR REPEATED CONTACT WITH F OOD (CFR 21 PART 177.1732, 4/92 EDITION). State Regulatory Information: CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65): KEVLAR FIBER CONTAINS NONE OF THE SUBSTANCES KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER OR REPRODUCTIVE TOXICIT Y. PENNSYLVANIA AND NEW JERSEY RIGHT-TO-KNOW LAWS: KEVLAR FIBER IS CONSIDERED AN ARTICLE AND IS NOT SUBJECT TO THE PROVISIONS OF THE PENNSYLVANIA AND NEW JERSEY RIGHT-TO-KNOW LAWS.
========== Other Information
========== Other Information: CANADA: KEVLAR IS NOT WHIMIS CONTROLLED. THIS MATERIAL IS NOT TDG REGULATED. NFPA RATINGS: HEALTH-0, FLAMMABILITY-1, REACTIVITY-0. NPCA RATINGS: HEALTH-0 * (CHRONIC HEALTH EFFECTS), FLAMMABILITY-1, RE ACTIVITY-0.
========== Transportation Information
========== Responsible Party Cage: TO822 Trans ID NO: 154525 Product ID: KEVLAR BRAND FIBER MSDS Prepared Date: 11/19/1999 Review Date: 08/24/2000 MFN: 1 Net Unit Weight: UNKNOWN Multiple KIT Number: 0 Unit Of Issue: CY Type Of Container: CYLINDER
========== Detail DOT Information

========== DOT PSN Code: ZZZ DOT Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION ========== Detail IMO Information ========== IMO PSN Code: ZZZ IMO Proper Shipping Name: NOT REGULATED FOR THIS MODE OF TRANSPORTATION ========== Detail IATA Information ========== IATA PSN Code: ZZZ IATA Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION ========== Detail AFI Information Detail AFI Information _____ AFI PSN Code: ZZZ AFI Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION ========== HAZCOM Label ========== Product ID: KEVLAR BRAND FIBER Cage: TO822 Assigned IND: Y Company Name: DUPONT Street: 1007 MARKET STREET City: WILMINGTON DE Zipcode: 19898 Health Emergency Phone: 800-424-9300 Date Of Label Review: 08/24/2000 Status Code: A Origination Code: F Eye Protection IND: NO Skin Protection IND: NO Signal Word: NONE Respiratory Protection IND: NO Health Hazard: None Contact Hazard: None Fire Hazard: None Reactivity Hazard: None ========== Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever expressly or implied warrants, states, or intends said information to have any application, use or viability by or to any person or persons outside the Department of Defense nor any person or persons contracting with any instrumentality of the United States of America and disclaims all liability for such use. Any person utilizing this instruction who is not a military or civilian employee of the United States of America should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation regardless of similarity to a corresponding Department of Defense or other

government situation.