



A. Preliminary Procedure

Test Firing of Liquid Fuelled Rocket Engine



November 2019

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A2 Purpose and Scope of Document

A2.0 Purpose

This document will provide a guide to preparing people and systems prior to departure to the test site and describes risk and hazard analysis of the test site. The test firing site will be quite a distance away from Portland State University. The test site must be scoped out for animal, environmental, and fire risk. The locations of the command center, test stand, safe zone, workstation, and staging areas must be decided prior to test site arrival.

A2.1 Scope

This procedure will outline the necessary steps that need to be followed prior to travel to the test site. This includes site planning preparations, minimum safe distance location, environmental hazard identification, and team readiness. This document also contains first aid, PPE, system/subsystem components, equipment, tools, and site kit checklists.

A3 Site Planning Preparations

A3.0 Site Map

The test firing location is at a quarry in Tualatin, OR at the coordinates 45.35569, -122.8139.

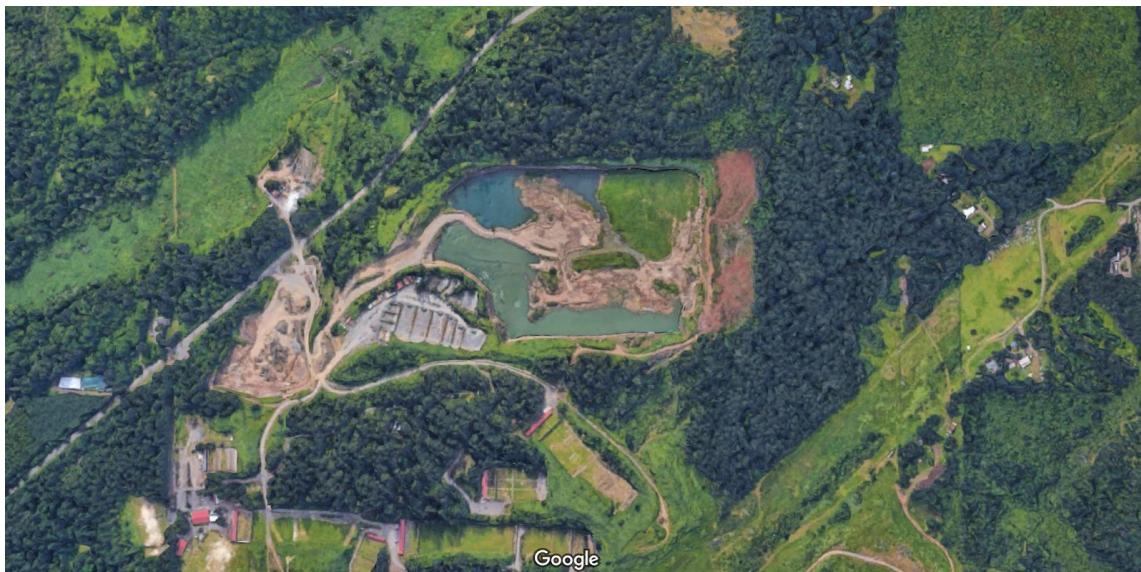


Figure 3.1: Test firing location overview



The minimum safe distance is calculated to at least 300 feet from the test stand. As such the command center, workstations, and staging area must be set up within the safe zone (>300ft from test stand).



Figure 3.2: Test Stand, Command Center, Staging, Storage, and Workstation Locations

The location of the test stand will be at the center of the quarry since there is only one entry point to the location. The Staging, Storage, and Workstations will be set up at one of the road branches, leaving the other road available for transport. The Command Center will be about 850 feet away from the Test Stand, far exceeding the minimum safe distance.



Figure 3.3: Measured distance between the Test Stand and the Command Center



The closest man made structure is a parking lot which is also within the safe zone. These parking lots are currently not in use but will still remain safe during the test firing procedures.



Figure 3.4 Closest man made structures to the Test Stand

A3.1 Environmental Analysis

A3.2.0 Emergency Contact Information

- Washington County Non-Emergency: 503-629-0111
- Washington County 911 Administration: 503-690-4911

Nearby Facilities:

- Urgent Care:
 - ZOOM+Care, 25600 SW Argyle Ave B, Wilsonville, OR 97070, 503-684-8252
 - Legacy Medical Center Emergency Room, 19300 SW 65th Ave, Tualatin, OR 97062, 503-692-1212
- Fire Response:
 - TVF&R Station, 15440 SW Oregon St, Sherwood, OR 97140, 503-649-8577
- Animal Control:
 - Animal Services, 1901 SE 24th Ave Hillsboro, OR 97123, 503-846-7041



A3.2.1 Weather Hazards

The main environmental concerns for the Pacific Northwest are floods, wildfires & wildfire smoke, earthquakes, and tsunamis.

A3.2.1.0 Floods

The flood risk to the test site is found using the National Flood Service risk assessment tool¹. The test site has low risk for flooding.

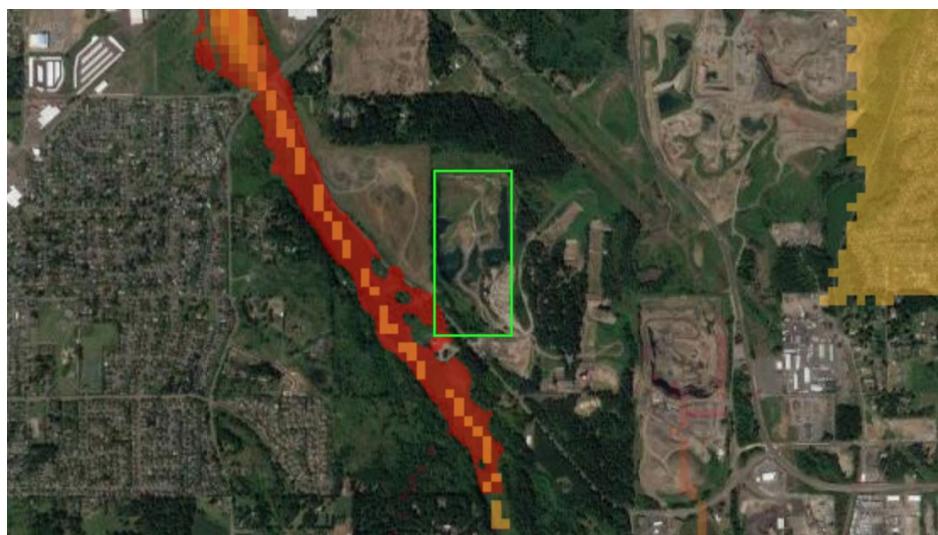


Figure 3.5: Flood Risk Map, Test Site within the green rectangle

A3.2.1.1 Wildfire & Wildfire Smoke

Wildfire occurrence has increased on the US West Coast in the last few years. To make sure that personnel are not put at risk from fire or the smoke produced, the site must undergo safety clearance prior to departure. The burn probability for the test site is low according to the Advanced Oregon Wildfire Risk Explorer². However, during the site setup and firing procedures the team must adequately prevent any unintended burning.

¹ National Flood Service Risk Assessment Tool: <http://floodtools.com/Map.aspx>

² Advanced Oregon Wildfire Risk Explorer Tool:
https://tools.oregonexplorer.info/OE_HtmlViewer/index.html?viewer=wildfireplanning

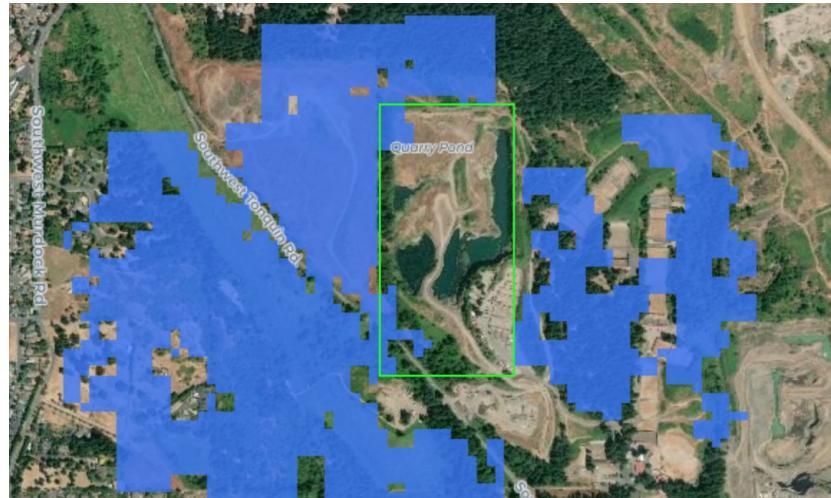


Figure 3.6: Test Site within green rectangle, low burn probability (<=1 in 10,000)

A3.2.1.2 Earthquakes & Tsunamis

The Cascadia Subduction Zone, which lies off of the Oregon and Washington coasts, put much of Oregon at risk for large earthquakes and tsunamis. However, if a large earthquake does occur there will be emergency notifications and a Tsunami warning will be issued to all Oregon, Washington, and California residents. The testing site and greater Portland area are outside of the Tsunami risk zone therefore there is no Tsunami evacuation plan for central Oregon. All of Oregon is at risk of earthquakes. Seismic activity is heavily monitored by several organizations in the Pacific Northwest therefore earthquake, tsunami, and flooding risks are all handled by government organizations such as the National Oceanic and Atmospheric Administration (NOAA) and the National Earthquake Information Center (NEIC). Developments will be monitored during the environmental checks the day of test firing.

A3.2.2 Animal Presence

Some animals are rare, some are common, few are deadly, and all should be recognized. The main animal risks in Oregon include black bears, cougars, coyotes, foxes, elk, rattlesnakes, scorpions, spiders, ticks, mosquitoes, wasps, and hornets.

A3.2.2.0 Mammals

There is only one species of bear and one species of mountain lion in Oregon. Although black bears and cougars are common throughout Oregon, they are not typically present in heavily populated urban areas. If one is spotted, it should not be approached and animal control should be contacted.



Figure 3.7: American Black Bear (Left) & Oregon Cougar (Right)

Coyotes and foxes are typically non-aggressive toward humans and are usually only active at night. However, they are fairly common in the greater Portland area and have been spotted in the test site area and should not be provoked.



Figure 3.8: Coyote⁴ and Kit Fox⁵

Elk and deer are very common in all parts of Oregon, including the test site area. Although they are not typically dangerous or aggressive, they can cause harm if provoked and should be left alone.

³ Black Bear and Cougar Image Source: <https://www.oregonzoo.org/gallery/tags/american-black-bear>

⁴ Oregon Coyote Image Source: <https://tinyurl.com/tlvvhqr>

⁵ Oregon Kit Fox Image Source: <https://www.dfw.state.or.us/news/2015/june/061615b.asp>



Figure 3.9 Elk⁶ & Deer⁷

A3.2.2.1 Reptiles

There is one poisonous snake in Oregon, the Western Rattlesnake. It is not deadly but it is known to bite when provoked, startled, or threatened. This snake is very rare as it is a threatened species. If anyone is bitten they should seek medical attention.



Figure 3.10: Western Rattlesnake

A3.2.2.2 Arachnids

The only arachnid threats in the test site area include one scorpion species, and one spider species. Scorpions are very rare in the Pacific Northwest but are native in the test site area.

⁶ Oregon Elk Image Source: <https://oregonlive.com>

⁷ Oregon Deer Image Source: <https://felixwong.com/2015/06/astoria-oregon/>

⁸ Western Rattlesnake Image Source: https://oregonencyclopedia.org/articles/rattlesnakes_in_oregon/



They generally hide under rocks, trees, and debris. They can sting but are not dangerous to humans; a sting from this scorpion is treated as a non-emergent injury similar to a wasp-sting.



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Figure 3.11 Forest Scorpion found in Central Oregon

The only venomous spider species present in Oregon is the Western Black Widow and is generally found in dark areas under logs or rocks. This spider is non-deadly but if any personnel believe that they've been bitten they should seek medical attention.



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Figure 3.12 Western Black Widow

A3.2.2.3 Insects and Misc.

Yellowjacket, hornets, and paper wasps are some of the most common wasps in Oregon. They can sting repeatedly and can cause allergic reactions in humans and care should be taken to not provoke them.

⁹ Forest Scorpion Image Source: <https://troutsnotes.com/uroctonus-mordax/>

¹⁰ Western Blac Widow Image Source: <https://bugguide.net/node/view/26346>



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Figure 3.13 Yellowjacket Wasp & Paper Wasp

Honey bees are very common in Oregon, especially around the test site and Portland area. They are typically not aggressive but can cause allergic reactions in some people. If any personnel have a bee allergy they must bring their own prescribed medication in the event of a sting.



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Figure 3.14: Oregon Honey Bee

Ticks are common in all parts of Oregon, including the test site. Ticks transmit Lymes disease and Alpha-Gal after being latched onto a person's skin after 24 hours. All personnel should wear appropriate clothing to prevent ticks from attaching to their skin and apply deet or permethrin following package instructions. Personnel should check skin for any ticks during and after the test fire; if any are found they should be removed immediately using tweezers.

¹¹ Yellowjacket Image Source: <https://en.wikipedia.org/wiki/Yellowjacket>

¹² Oregon Wasp Image Source: https://upload.wikimedia.org/wikipedia/commons/1/1a/Wasp_colony.jpg

¹³ Oregon Honey Bee Image Source: https://en.wikipedia.org/wiki/Honey_bee



Figure 3.15: Ticks¹⁴ attached to exposed skin

A4 Environmental Conditions Check

1. Weather Check
 - a. Check weather for current and predicted conditions.
 - i. View forecast here:
<https://www.accuweather.com/en/us/tualatin-or/97062/weather-forecast/2187196>
 - ii. If heavy rain, snow, lightning, or hail is present or expected the test firing is a No-Go.
 - iii. If the temperature is too extreme then the test firing is a No-Go.
 1. If temperature is above 30 °C (100 °F), this puts team at risk for heat exhaustion. Test firing is a No-Go
 2. If the temperature is below 5 °C (40 °F), this puts team at risk for hypothermia. Test firing is a No-Go.
 - b. Check for any recent seismic activity and current risk of Tsunami.
 - i. View seismic activity here:
<https://earthquaketrack.com/p/united-states/oregon/recent>
 - ii. Check for Tsunami advisories here: <http://nvs.nanoos.org/TsunamiEvac>
2. Wildfire Check
 - a. Check for any wildfires near the test site here:
<https://projects.oregonlive.com/wildfires/map#6/44.190/-120.700>
 - i. If any wildfires are at or near the test site then test firing is a No-Go.
 - b. Check air quality here: <https://www.airnow.gov/>
 - i. If air quality is in an unhealthy range then test firing is a No-Go.
3. Animal Review/Preparedness
 - a. Mammals (See section 3.2.2 for Animal Presence reference)
 - i. Review what Black Bears and Cougars look like and how to respond.

¹⁴ Pacific Northwest Tick Image Source: <https://tinyurl.com/upqbm7t>



1. Check for reported sightings in the test site area.
 2. If one is spotted do not run or turn your back. Slowly back to a safe location and call animal control.
 - ii. Review what Coyotes, Wolves, and Foxes look like and how to respond.
 1. If a coyote, wolf, or fox is spotted be as big and loud as possible. Do not run or turn your back. Wave your arms, clap your hands, and shout in an authoritative voice.
 2. If the coyote is accompanied by pups or appears to be sick or injured do not haze, leave the area, and call animal control.
 - iii. Review what Elk and Deer look like.
 1. If an Elk is spotted it is usually in a pack. Do not approach or try to startle them. Quietly move away to a safe location.
 2. If a deer is spotted it will typically run away. Do not approach or try to startle them. Quietly move away to a safe location.
- b. Reptiles
- i. Review what the Western Rattlesnake looks like and how to respond
 1. Do not agitate, approach, or try to capture any snake.
 2. If seen or heard move at least 6 feet away and notify all personnel.
- c. Arachnids
- i. Review what the Western Black Widow looks like and how to respond.
- d. Insects
- i. Review what they look like.
 1. If a yellowjacket, wasp, or bee is spotted do not wave hands or try to swat it away. Move away from the area in a calm manner.

A5 Team Readiness Check

1. Check Personnel Apparel
 - a. Footwear
 - i. Non-slip and closed toe.
 - ii. No flip-flops, heels, or open toe footwear will be allowed.
 1. If inappropriate footwear is worn it must be changed prior to test site departure.
 - b. Clothing
 - i. Clothing must be appropriate for the current and predicted weather conditions.
 - ii. Clothing must cover ankles to prevent bug/tick bites.
2. Check Personnel Health
 - a. All Personnel must be well rested, well fed, and well hydrated.
 - i. Any personnel that shows signs of impaired motor skills, poor decision making and risk taking, poor memory and information processing, and/or decreased overall productivity will not be allowed to the test site.



- b. Allergy Preparedness
 - i. If any personnel have a known allergy (such as bee allergy) verify that they have the proper treatment.
 - c. Personal Safety Preparedness
 - i. Apply permethrin or deet in a well ventilated area to prevent ticks.
 - ii. Apply bug-repellent to prevent mosquitos.
 - iii. Apply sun-screen as weather requires.
3. Role Check
- a. Safety Team
 - i. Range Safety Officer
 - 1. Constantly monitors environment, weather, animal risk, and team health.
 - 2. Distributes water, snacks, sunscreen, etc. as needed.
 - 3. Ensures safety zone restrictions are being met by personnel and observers.
 - 4. May terminate test at any time
 - ii. Materials Safety Member
 - 1. Constantly monitors material safety procedures, materials handling, emergency response, and storage safety.
 - 2. In charge of overseeing the transport and storage of tanks and materials.
 - 3. Observing proper PPE use around materials.
 - b. Test Firing Team
 - i. LFE/LFETS Control Team
 - 1. Monitors systems and subsystems of the Liquid Fuel Engine and Liquid Fuel Engine Test Stand.
 - 2. Monitors assembly of all components
 - 3. Monitors assembly of all components.
 - 4. Monitors material handling procedures, materials transportation, and material safety during fueling procedure.
 - ii. Test Stand Automated Regulation (TSAR) Control
 - 1. Monitors systems and subsystems of the Test State Automation Regulation.
 - 2. Maintains Lock-Out Tag-Out system.
 - 3. Monitors assembly and control of all components.
 - c. Administration and Communications Team
 - i. Test Director
 - 1. Maintain radio communication with personnel
 - 2. Announce each item of hotfire checklist
 - 3. Attain verbal confirmation of completion for each item of firing procedure before checking off and moving to the next item
 - 4. Monitors workstation use.



5. Maintains flightline procedures for tool use.
 - a. Prevents tools from getting lost and/or causing damage to test firing systems.

- ii. Public Relations

1. Livestream and announcements: Sets up livestream system and makes announcements to the public on test firing status.

- d. Critical/Non-Critical Roles

- i. Primary & Secondary Personnel Contacts Critical Roles

Roles	Primary	Primary Contact	Secondary	Secondary Contact
Test Director	Andrew Greenberg	503-708-7711	n/a	n/a
Range Safety Officer	Risto Rushford	208-819-5997	Kathleen Joslyn	406-750-5256
Materials Safety	Curtis Palmer	479-225-0920	Bertrand DeChant	503-413-9477
LOX Transport & Fill	Jacob Evans	503-941-6640	Zach Reed	360-713-3423
LFE Control Technician	Teresa Nyugen	503-860-2673	Solomon Reid	208-596-9941
LFETS Control Technician	Mike Mckenzie	360-931-3454	Marc Wasserman	503-804-2103
TSAR Control Technician	Jennifer Jordan	503-791-0263	David Lay	717-377-4197
Public Relations	Catie Spivey	904-314-5936	Jacob Tiller	503-888-2196

- ii. Other Roles, to be supervised by critical roles

1. Fuel and N2 Transport and Fill Team
 2. Ignition Technician

- iii. First Aid Certified Personnel & Contact Information

Trained Personnel	Contact Information	Expiration Date
Risto	208-819-5997	n/a ¹⁵
Kathleen	406-750-5256	n/a
Jennifer Jordan	503-791-0263	n/a
Marc Wasserman	503-804-2103	n/a
Teresa Nyugen	503-860-2673	n/a

¹⁵ Training is not yet completed. To be completed at upcoming Red Cross event.



- iv. If any primary and secondary critical roles are vacant then the test firing is a No-Go.
- v. If any primary and/or secondary non-critical roles are vacant then any available volunteers must go through training procedures prior to departure.
 - 1. If no volunteers are available for a non-critical role then the test firing is a No-Go.
- vi. At least one member must be first aid certified.
 - 1. If no members are first aid certified then the test firing is a No-Go.

A6 Packing Check

- 1. Review Proper Lifting Procedures (Environmental/Personnel Safety Member)
 - a. When possible a dolly or cart will be used instead of manually lifting.
 - b. When lifting maintaining straight spine alignment, bending at the knees and not at the waist, moving items as close to the body as possible, keeping elbows close to body, and not twisting when lifting.
- 2. Equipment Check (Equipment Safety Member)
 - a. Check charge status of all batteries; including system batteries and tool batteries. Must be fully charged and not overcharged.
 - b. Verify that there are no exposed wires, no chips, no cracks, and no damage to tools.
- 3. Materials Check (Materials Safety Member)
 - a. While observing proper PPE use, check all materials. Verify that there are no leaks/spills on any materials storage.
 - i. If there are leaks refer to Materials Handling procedures for specific material.
- 4. Check Kits
 - a. PPE Kits
 - i. General Kit
 - Latex Gloves, enough for all team members
 - Heavy duty gloves
 - Long Gloves (forearm/elbow length)
 - Shock Proof Goggles
 - Earplugs, enough for all team members
 - Sunglasses uv-protected, enough for all team members
 - Respiratory Masks, enough for all team members
 - ii. LOX Kit
 - Face Shield
 - Safety Glasses
 - Apron Gloves
 - Hearing Protection



- Dish Detergent
- Isopropyl Alcohol (>85% concentration)
- Nitrile Gloves
- KimTech lint-free wipes
- Distilled/Deionized water
- Ultrasonic Cleaning Machine
- Assorted Brushes/Scrubbers
- Sealable Plastic Bags

b. First Aid Kit

- Sunscreen
- Sunburn relief ointment
- Bug Spray/Insect Repellent
- Deet Spray
- Permethrin
- Adhesive bandages
- Antibiotic ointment and/or antiseptic wipes
- Sterile gauze
- Cold compress
- Hydrocortisone ointment
- Rubbing alcohol
- Hydrogen peroxide
- Hand sanitizing gel
- Eye wash solution
- Cotton balls and swabs
- Medical gloves
- Thermometer
- Tweezers
- Fever and pain reducers
- Antihistamines
- Burn cream

c. Environment Kit

- Snacks, enough for all team members (keep allergy list on hand)
- Water, enough for all team members
- Fire Extinguisher (Class-D)
- Roadside car repair kit
- Generator
- Generator fuel
- Shop lights
- Flashlights/spare batteries
- Space heater
- Trash bags

d. Tool & Site Kit



- Multimeter
- Screwdriver kit
- Wrench kit
- Leak check fluid
- Wire crimpers
- Impact Driver (ground stakes)
- Inspection mirrors
- Tape for cable management
- Hi-vis tape for low hanging structures and trip hazards
- Dolly
- Cart
- Flags for marking safe distance zone

e. System Components

i. LFE

- Engine

ii. LFETS

- Test Stand
- PPE Equipment for transporting materials
- Fuel Tank
- LOX Tank
- Nitrogen Tank

iii. TSAR

- GoPros/High-Speed Cameras
- Power supply
- Data/power cable
- Control box
- Lock-Out Tag-Out box

f. Command Center

- Canopy
- Fire Extinguisher (ABC)
- Livestream camera
- Tripod
- Spare camera batteries
- Laptop
- Wifi Hotspot
- Speaker
- Radios/Walkie-Talkies
- Extra Batteries for Radios
- Folding Table

5. Load Kits into Transport Vehicle(s)

- a. Environmental/Personnel Safety Member will monitor proper lifting techniques and team safety



Portland State Aerospace Society

- b. Materials Safety Member will transport tanks and materials while wearing proper PPE.
6. Depart to Test Site.



B. Site Setup Procedure

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B2 Purpose and Scope of Document

B2.0 Purpose

This document will provide a guide to preparing the test site for test-firing procedures. The site must be scoped out for potential risks, have those identified risks mitigated, set up the safe zone of minimum safe distance. The systems must also be set up and prepared for pre-test firing procedures.

B2.1 Scope

This procedure will outline the necessary steps that need to be followed to prepare and set up the test-firing site, including site cleanup, risk assessment, system setup, and public relations.

B3 Environmental Risk & Setup

1. Check for debris, animals, bystanders, weather, dust, smoke, team health, and team safety.
 - a. Environmental (see Preliminary Procedure A Section 4 *Environmental Conditions Check*):
 - i. Clean up debris around test site.
 1. Be aware of any animals in debris.
 - ii. Check for any holes in the ground.
 1. Fill or mark the holes.
 - iii. Check for any trip/fall hazards.
 1. Mark all trip and fall hazards with flags or high-visibility tape.
 - iv. Monitor weather, smoke hazards, and other environmental hazards.
 - b. Animal (See Preliminary Procedure A Section 3.2.2 *Animal Presence*):
 - i. Monitor site for animal presence.
 1. If any animals are observed, notify the team and do not provoke.
 2. If an observed animal is potentially dangerous then leave the area, as recommended, and notify animal control.
 - ii. In the event of an animal bite.
 1. Follow procedures for specific wound care if the bite is toxic.
 2. Contact the nearest hospital and transport affected person(s).
 - c. Team Health:
 - i. Distribute water and snacks to the team.
 1. Double check for allergies
 - ii. Distribute sunscreen, bug spray, and DEET as needed.



- iii. Distribute sunglasses as needed.
- iv. Set up space heaters or coolers dependant on weather.
- v. Monitor team health.
 - 1. Monitor team health for any signs of impaired motor skills, poor decision making and risk-taking, poor memory, and information processing, and/or decreased overall productivity.
 - 2. Report any changes in team health to Range Safety Officer (RSO).

B4 Site Setup

1. Establish “command center”, test stand location, storage, and workstation location.



2. Safe Zone

- a. Measure the distance between the test stand and the minimum safe distance.
 - i. The actual minimum safe distance is defined by [these equations \(page 4.4\)](#)
 1. The following design parameters are used:
 - a. Specific heat ratio of propellants, $k = 1.1251$
 - b. Ambient pressure, $P_0 = 14.7 \text{ psi}$
 - c. Chamber pressure, $P_1 = 350 \text{ psi}$
 - d. Chamber volume, $V = 27.35 \text{ in}^3$
 2. The stored energy of the engine system is then calculated
 - a. Stored energy, $E = 2527.4166 \text{ J}$
 - b. Stored energy, $W_{\text{TNT}} = E \text{ (kJ)}/4500 = 0.0005616 \text{ kg}$
 3. Then minimum distance, $D = z * (W_{\text{TNT}})^{\frac{1}{k}}$
 - a. Where $z = 200 \text{ ft}$ based off of .2 psi - .4 psi worst case distance for debris and missile damage.
 - b. Then the minimum distance is $\sim 16.5 \text{ ft}$ for debris and missile damage.



- ii. While the distance calculations give a safe distance of 16.5 ft, we set the minimum safe distance to ultimately be 300 ft to ensure team safety.
- b. Clearly mark the safe distance with flags and high-visibility tape.
3. Unpacking
 - a. Use dollies, carts, and clear communication when moving tables, tools, and components.
 - b. Set up materials storage location away from any workstations and tool use.
 - c. Check for any sharp corners, file/mark as needed.
 - d. Set up shop lights if visibility is poor.

B5 Command Center Setup

1. Set up canopy, tables, chairs, and laptop.
2. Set up command center livestream using a mobile device and begin updating viewers on progress.
 - a. Login Information
 - i. YouTube (for streaming)
 1. [Login](https://www.youtube.com/): <https://www.youtube.com/>
 2. Username: *psas.rockets*
 3. Password: _____
 - ii. Facebook (for sharing stream link & updates)
 1. [Login](https://www.facebook.com): <https://www.facebook.com>
 2. Username: *info@psas.pdx.edu*
 3. Password: _____
 4. Confirm recovery email: *info@psas.pdx.edu*
 - iii. Instagram (for posting the link to stream & updates)
 1. [Login](https://www.instagram.com/pdxaerospace): <https://www.instagram.com/pdxaerospace>
 2. Username: *pdxaerospace*
 3. Password: _____
 - iv. Twitter (for sharing stream link & updates)
 1. [Login](https://twitter.com/): <https://twitter.com/>
 2. Username: *pdxaerospace*
 3. Password: _____
 - b. Set up Mobile Hotspot for internet connectivity.
 - c. Set up camera at command center (mobile) and at test stand (stationary).
 - i. Test Stand Camera
 1. Secure camera tripod at a safe distance from the test stand.
 2. Verify the test stand camera angle and focus.
 - ii. Command Center Camera
 1. Can be a laptop or phone camera. Must be mobile.
 - d. Login to the PSAS YouTube channel and begin the livestream at command center.



- i. Add additional test stand camera(s) to the livestream
 1. On the Ingestion Settings tab, click Add a Camera.
 - a. (Can add up to 6).
 2. Add a unique thumbnail and title for the test stand camera.
 - a. Create a custom camera name for the main camera by clicking back on the Main Camera tab.
 3. Click Save.
 - a. **Note the standard player has an additional 50 pixels at the top for thumbnails. These allow users to navigate to each unique camera.
- ii. Note: Play royalty-free and copyright free music only.
 1. Royalty-Free Music: <https://www.hooksounds.com>
- e. Login to the PSAS Instagram, Twitter, and Facebook accounts.
 - i. Share livestream link to all social media sites.
- f. Monitor updates from team via radio/walkie-talkies and update audience accordingly.
 - i. Share updates on stages to Instagram, Twitter, Facebook, and announce updates on the YouTube livestream.

B6 Test Stand & Test Stand Automated Regulation (TSAR) Setup

1. Pass out Lock-Out/Tag-Out keys to all test stand technicians.
 - a. Keep the keys on person until the Pre-Test Firing Procedure stage.
2. Verify that no test stand components are receiving power.
3. Check for damage while unloading and unpacking components.
 - a. Assess observed damage and refer to Go/No-Go contingency plans and relay any observed damage to Range Safety Officer (RSO).
4. Distribute and test radios
 - a. Call checks
 - b. Verify that at least one radio is available at the test stand site and the command center while setting up systems.
5. Begin connecting and assembling Test Stand Automated Regulation/Liquid Fuel Engine Test Stand (TSAR/LFETS) system components.
 - a. Set up TSAR Command laptop.
 - b. Set up high-speed cameras toward test stand and engine.
 - i. Verify angles and focus.
 - c. Set up a stationary livestream camera toward test stand.
6. Transport Test Stand to designated site.
7. Connect ethernet cable to TSAR data acquisition and control system mounted to Test Stand.



C. Test Firing Procedure

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C2 Purpose and Scope of Document

C2.1 Purpose

This document is used to conduct a static test fire, aka “hot fire” of the PSAS liquid fuel rocket engine. The document contains step by step instructions intended to be read and completed by the personnel indicated in the subsections to follow. Each item must be checked off before proceeding to the next unless otherwise stated.

C2.2 Scope

This procedure outlines the necessary steps that will be followed to fill propellants, conduct a test fire, and shutdown the system after the firing. For the locations of system components, see the Piping & Instrumentation Diagram (Appendix A) and the Test Stand Automation State Diagram (Appendix B).

C3 Personnel

The test firing procedure requires the nine (9) people to fulfill the following seven roles:

1. Test Director

The test director maintains radio communication with personnel at the Test Stand and the control booth. It is the test director’s responsibility to announce each item of the hot fire checklists and obtain verbal confirmation before checking the item off and moving to the next item.

2. LOX Transport and Fill Team (2 people)

The LOX transport team will transport the LOX dewar from the test facility parking lot to the test stand site using a predetermined path and method. They will have gone through LOX and Material Handling Safety training prior to Test Firing Procedure. They will wear PPE as outlined in LOX handling procedures and are responsible for filling the LOX tank. Two people are required for moving heavy items and to provide assistance in case of any incidents.

3. Fuel and N2 Transport and Fill Team (2 people)

The fuel team will transport the fuel containers and compressed N2 cylinder from the parking lot to the test stand. They are responsible for connecting the N2 cylinder to the pressure manifold and filling the fuel tank per tank filling procedures. Two people are



required as tanks may be heavy. These two personnel must be supervised by the Materials Safety Officer.

4. Test Stand Automated Regulation (TSAR) Control Operator & Liquid Fuel Engine (LFE) Control Operator (2)

The control operator is the person seated at the control center viewing the data logging and command screen. The control operator inputs commands into the Test Stand Automation System (TSAR). A second control operator monitors the video and data acquisition system to ensure the test is recorded.

5. Instrumentation Test Stand Automated Regulation (TSAR) Control Operator

The instrumentation operator is responsible for connecting and running power and data lines from the test stand to the control center as well as setting up video recorders in the designated locations around the test stand. This operator also confirms that all data acquisition and automation systems are operational.

6. Ignition Operator

The ignition operator's role is to mount and wire the ignition system into the bell of the engine.

7. Range Safety Officer (RSO)

The range safety officer monitors the activities of the personnel and observers to ensure keep out zones are not violated. The range safety officer has the power to terminate a test at any point if safety conditions are violated.

C4 Nitrogen Setup

This task is to be performed by the N2 and fuel team.

C4.1 Nitrogen Setup Procedure

- 1. Don appropriate PPE for handling IPA and compressed gas.
- 2. Move delivered N2 cylinder from staging area to test stand location using a predetermined pathway.
- 3. Inspect the N2 fitting on the test stand to check for damage or debris. If damage is found, stop and escalate to Test Director.



- 4. Connect the gas hookup fitting onto the nitrogen cylinder connection. Take care to avoid cross-threading.
- 5. Slowly open the hand valve on the nitrogen cylinder and listen for leaks. Monitor pressure gauge for any visible decrease in pressure level.
- 6. Slowly open HV-5 (tank valve) to allow nitrogen gas to pressurize the system and listen for leaks. Monitor pressure gauge for any visible decrease in pressure level.
- 7. If no leaks are observed, radio the Test Director that “Nitrogen installation is complete.”

C5 Fuel Filling

This checklist is to be performed by the N2 and fuel team.

C5.1 Isopropyl Alcohol Tank Filling Procedure

- 1. Confirm system is locked out, and open HV-9, manual fuel vent valve.
- 2. Verify that fuel tank pressure is zero on test stand monitor (ambient pressure).
- 3. Remove dust cap from fill port on fuel tank (near HV-8) and connect the outlet of the fuel hand pump to the fuel fill/drain line.
- 4. Pour fuel from storage container into clean staging container.
- 5. Using the fuel hand pump, pump pre-measured fuel into tank until staging container is empty. Attempt to avoid spillage.
- 6. Close valve HV-8 then disconnect fuel pump.
- 7. Close valve HV-9, then verify valve HV-1 is also closed.
- 8. Radio Test Director that fuel filling is complete.
- 9. Pack up fuel filling equipment and transport back to staging area.



C6 LOX Filling and Engine Chill

The following procedure is to be performed by the LOX fill team with oversight by safety officer.

LOX team members shall wear the required PPE and carry a radio to communicate with the control station. LOX filling will occur after fuel and N2 filling have occurred to allow all other personnel to clear the test stand during filling.

C6.1 Pre-Fill N2 Purge

- 1. Verify N2 cylinder is connected to test stand and PIT-2 gauge shows pressure > 1000 psi.
- 2. Verify valves HV-2, HV-7 and HV-10 are closed.
- 3. Check that all personnel have moved back from test stand.
- 4. Radio test stand control to begin pre-fill N2 purge (wherein SOV-2 and SOV-6 will open and gas will flow through the system). Pre-fill purge is controlled by test stand automation.
- 5. When N2 purge is complete, approach test stand and open valve HV-6 and HV-10 to prepare for LOX fill.

C6.2 Liquid Oxygen Fill and Engine Chill

- 6. Connect transfilling hose to Liquid Oxygen Dewar liquid output.
- 7. Connect transfilling hose to Liquid Oxygen tank liquid input.
- 8. Open LOX fill valve SOV-7.
- 9. Close pressure relief valve on Liquid Oxygen Dewar. As pressure builds inside the Dewar, Liquid Oxygen will begin to flow into the tank.
- 10. Monitor TT-4 to verify that Liquid Oxygen is flowing into the tank.
- 11. Monitor TT-2 and TT-3 to verify that Liquid Oxygen is flowing through the plumbing fixtures towards engine to pre-chill all components.
- 12. Monitor TT-3. When TT-3 reads less than - 120 °C (-190 °F), close SOV-6.



- 13. Monitor TT-4 and TT-5. When TT-5 reads equal to TT-4, the tank is full and transfilling is complete.
- 14. Close HV-6 and SOV-7.
- 15. Open pressure relief valve on Liquid Oxygen Dewar.
- 16. Disconnect transfilling hose and remove dewar from test stand.

C7 Hot Fire Procedure

The following procedure is to be performed by the **Test Director**.

C7.1 Hot Fire Procedure

- 1. Announce to all personnel, “The hot fire checklist has started. All personnel must immediately clear the pad and return to safety zones.”
- 2. Verify all keys have been returned to control, and then remove the test stand arming Lock-Out/Tag-Out (LOTO).
- 3. Confirm with range safety officer (RSO) that the pad is clear of personnel.
- 4. Instruct the TSAR operator to ARM the system and announce, “Pad is clear, automation system is armed.”
- 5. Instruct instrumentation operator to begin recording and data acquisition.
- 6. Instruct LFE operator to begin engine chill procedure with automation command CHILL. Announce, “We are beginning the engine chill now.”
- 7. Continue chilling until LOX line TT’s read approximately -180 °C.
- 8. Instruct LFE operator to input the READY command. Announce, “Engine chill complete.”
- 9. Instruct LFE operator to input PRESSURIZE command to pressurize the system via automation protocol.
- 10. Confirm all PT’s read pressures within acceptable range. Announce, “The system is now pressurized. Prepare for final callouts.”
- 11. Conduct final Go/No-Go call-outs.



- 12. If all systems report GO, announce, “All systems are green. Test firing is now imminent. We are starting auto-firing sequence for 10 seconds.”
- 13. If any system reports NO GO, instruct control operator to input SHUTDOWN command and announce, “Shutdown, shutdown, shutdown. We are in shutdown. System is depressurizing.” **Skip to step 16.**
 - NOTE: System cannot remain pressurized for more than 1 minute after pressurization. If any issues are encountered during callouts, system must be depressurized immediately by inputting SHUTDOWN command.
- 14. Instruct TSAR operator to input FIRE command via automated protocol with a 10 second countdown. Announce, “Firing in 10... 9... etc.” based on countdown on automation display.
- 15. Hot fire proceeds via the pre-established test firing protocol.
- 16. After hot fire and purge is complete, confirm system automation state is now in SHUTDOWN.
- 17. Confirm all PTs in pressurized sections read AMBIENT PRESSURE.
- 18. Instruct TSAR operator to safe the system by removing the arming key. Announce, “Test firing is complete. System has depressurized. Teams may now approach the test stand.”

C8 Post-Fire Procedures

C8.1 LOX Boil Off

- 1. LOX is allowed to flash off from the stand tank through the vent system.
- 2. (Test Stand Automated Regulation) TSAR informs the TSAR manager once the LOX tank temperature rises.
- 3. The LOX vent valve is closed.
- 4. TSAR monitors tank pressure.
- 5. If tank pressure rises, the Post-Fire procedure restarts.
- 6. Once the vent valve is closed and tank pressure does not rise the team decides whether the stand is safe to approach.



C8.2 N2 Unloading Procedure

- 1. Ensure test stand is in a safe state and Lock-Out/Tag-Out (LOTO) is reengaged.
- 2. Bring N2 transport dolly to test stand.
- 3. Close HV-5 on N2 tank.
- 4. Open HV-1 and HV-2 and allow gas to bleed off until PIT-2 reads ambient pressure.
- 5. Unscrew N2 tank from fitting.
- 6. Place tank onto dolly and transport back to staging area.

C8.3 Fuel Unloading Procedure

- 1. Ensure test stand is in safe shutdown state and Lock-Out/Tag-Out (LOTO) is reengaged.
- 2. Open HV-9, manual vent valve.
- 3. Place fuel staging container underneath fill/drain fitting.
- 4. Open HV-8 and allow residual fuel to drain from system into container.
- 5. Remove container back to staging area and transfer to disposal container.



D. Handling & Storing Liquid Oxygen (LOX) Procedure

Test Firing of Liquid Fuelled Rocket Engine



November 2019

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D2 Purpose and Scope of Document

D2.0 Purpose

The purpose of this document is to address proper procedural handling and storing of Liquid Oxygen (LOX). Liquid oxygen is a cryogenic liquid and an oxidizer, so certain hazards need to be taken into consideration when it is used. Cryogenic liquids are classified as a liquid with normal boiling temperatures below -130° F. These liquids can cause severe frostbite if skin contact occurs. Contact with any component that is used with liquid oxygen can also cause injury due to the very low temperatures^[1]. Since most organic sources can become combustible in the presence of liquid oxygen special care must be taken to ensure that all components used with liquid oxygen are properly cleaned, maintained, stored, and assembled to prevent any contamination in the system that may lead to fire or explosion.

D2.1 Scope

This document will outline the necessary precautions and safety measures that need to be followed when working with Liquid Oxygen, as well as cleaning procedures for components that will be used with liquid oxygen.

D3 Personal Protective Equipment & Clothing

D3.1 PPE

Due to the physical safety risks associated with cryogenic liquids, all persons involved in the transport, handling, and use of liquid oxygen shall employ the Personal Protective Equipment (PPE) described in the following sections.

1. Safety Glasses
 - a. The eyes are the most vulnerable part of the body if exposed to the extreme cold temperatures of cryogenic liquids and vapors. Safety glasses must always be worn by any person in contact with or in the vicinity of liquid oxygen as well as a face shield.
2. Face Shield
 - a. Safety glasses will protect the eyes from small splashes of liquids, but due to the high risks involved with cryogenic liquids a full-face shield shall be used by any person in contact with or in the vicinity of liquid oxygen.
3. Apron



- a. To further protect the torso and body, a full-length apron made of leather or other suitable material shall be worn by any person in contact with or within the vicinity of liquid oxygen.
4. Gloves
 - a. Long (forearm or elbow length), loose-fitting gloves made from leather or other suitable material (such as thermally insulated welding gloves) must always be worn when handling cryogenic liquids or when working with parts and components in contact with cryogenic liquids. Gloves must be loose fitting to allow for quick removal if a cryogenic liquid is spilled into the glove.
5. Hearing Protection
 - a. Liquid oxygen will boil and convert to its gaseous state at room temperature. Even in a well-insulated container some boil-off will occur. Any sealed container used to store liquid oxygen will have a pressure relief system that allows vapors to be released from the container [2]. These relief systems will often have small openings and the escaping vapor can cause noise levels that can injure the ears. Ear plugs or earmuffs may be required during filling and draining procedures if large amounts of boil-off are anticipated.

D3.2 Clothing

All persons involved in the handling and transport of liquid oxygen must wear suitable clothing for the task, in addition to the PPE outlined above. The following sections will define the accepted clothing to be worn when working with or near liquid oxygen.

1. Shirt
 - a. Shirts must be long-sleeved and made of a non-absorbent material. Fitment must be loose enough that clothing does not cling to the skin in the event of liquid oxygen contact, but not so loose that clothing may become snagged or entangled while working. No exposed skin on the torso or arms will be acceptable for any person working with or in the vicinity of liquid oxygen.
2. Trousers
 - a. Trousers must be full length in order to be worn on the outside of boots or safety shoes. Trousers worn must not have a cuff around the ankle area or excess pockets along the legs that may trap and hold liquid oxygen if a spill were to occur. Trousers should be made of a non-absorbent material. No exposed skin on the legs will be acceptable for any person working with or in the vicinity of liquid oxygen.
3. Footwear
 - a. Footwear must be closed-toed and non-absorbent with non-slip soles. Additionally, footwear should extend far enough up the ankle area such that the trousers are worn over the footwear to prevent any liquid oxygen entering the shoe in the event of a spill.



D4 Parts Preparation for LOX service

D4.1 Cleanroom and Workspace Preparation

Before any parts or components that will be in service with liquid oxygen are handled, the workspace must be cleaned and prepared to the same levels of cleanliness associated with the parts themselves. All workstations and equipment to be used in the cleaning process must be free of clutter and sources of contamination. Food and beverages are strictly prohibited in any area where liquid oxygen, or parts and components to be used with liquid oxygen, are being handled.

D4.2 Breakdown of Parts

Due to the complicated interior geometries of the valves, sensors, and meters that will be in service with liquid oxygen, cleaning the components in an assembled form is not possible. Each component must be disassembled from the system to be cleaned and stored individually to ensure a thorough interior cleaning.

D4.3 Cleaning Procedures

Prior to any service with liquid oxygen all parts and components must undergo the cleaning processes outlined in the following sections. Failure to completely and thoroughly clean parts and components that will be in service with liquid oxygen presents a risk of contamination that can lead to fires or explosions [3]. Any and all organic matter, including but not limited to grease, oils (including skin oils/fingerprints), dust, lint and fibers must be completely removed from the components in question. Gloves must be worn at all times when handling components that will be in service with liquid oxygen, components should absolutely never be touched with bare hands.

D4.3.1 Selection of Cleaning Agents

Initial cleaning procedures require a mild detergent capable of removing large particulate and other visible contaminants. The initial detergent must be water soluble and easily rinsed away from the part component being cleaned [3]. Solvents used in the subsequent stages need to have strong degreasing properties in order to remove residual greases and oils that remain after the initial cleaning phase. Solvents should be residue-free and evaporate in air at room temperature to ensure that no solvent is left behind in crevices or voids within the part. Nitrile Gloves shall be used at all times when handling components to be used in liquid oxygen service. Any rags or wipes must be lint free.



D4.3.2 Necessary Equipment List

The following list outlines all the equipment and materials necessary to clean and prepare components for liquid oxygen service:

- Dish Detergent
- Isopropyl Alcohol (>85% concentration)
- Nitrile Gloves
- KimTech lint-free wipes
- Distilled/Deionized water
- Ultrasonic Cleaning Machine
- Assorted Brushes/Scrubbers
- Sealable Plastic Bags

These materials are included in the LOX Kit (See Preliminary Procedures).

D4.3.3 Initial Cleaning Procedure

The initial cleaning phase involves immersing the component in a solution of dish detergent and water and allowing to soak for 5-10 minutes. After soaking the part can be scrubbed inside and out, with cleaning brushes or scrubbing pads. Special care must be taken with valves, regulators, meters/sensors, and all soft seals to avoid damaging the component. The part will be inspected visually to ensure all particulate and visible contamination is removed. After initial cleaning the part must be completely and thoroughly rinsed of all detergent. It is imperative that all detergent is rinsed away from the component prior to advancing to the next phase of cleaning.

D4.3.4 Solvent Cleaning Procedure

After the initial cleaning procedure is finished the component can undergo the solvent cleaning phase. Components and parts with intricate internal geometries may be impossible to thoroughly clean by hand. These pieces will be cleaned in an Ultrasonic cleaning machine filled with Isopropyl Alcohol. Other components, such as pipes and tubes, can be adequately cleaned by hand. For these components a clean, lint-free cloth will be soaked with solvent and the component will be thoroughly washed, inside and out, with the solvent. If necessary, a second or even third cloth may be required to achieve an adequate level of cleanliness.

D4.3.5 Drying Procedure

When the components have been thoroughly cleaned with solvent they should be placed on a drying rack in a clean, contaminant free area to dry. The solvent chosen (Isopropyl Alcohol) will dissolve in air at atmospheric pressure leaving no residue on the component. Allow 24 hours of drying time to ensure that all interior cavities and voids have completely dried. It is critical that the drying area is completely free of any sources of contamination that may negate the previous



cleaning phases during drying. Drying racks/areas shall be clearly labelled as a “Clean Area” to avoid accidental contamination by untrained individuals.

D4.3.6 Cleanliness Inspection

After the 24-hour drying period the components shall be inspected for cleanliness prior to packaging and storage. Initial inspection will involve white light and a visual check for particulate, greases, and oils. Upon verification of visual cleanliness, a second inspection will be done with ultra-violet light to inspect for any contaminants that were not visible under white light. Final checks will be done with a clean, dry lint-free cloth. The part will be wiped with the dry cloth, which will undergo a white light and ultra-violet inspection to check for any residue left behind on the component [3] if the dry cloth failed to remove all foreign material. If any component fails these systems of checks, that component will be cleaned again beginning with the initial cleaning procedure.

D4.4 Parts Storage

After components have been inspected and are verified to be clean, they will be placed into a sealable plastic bag which will be placed within another sealable plastic bag (“double bagged”). Each bag will hold only one part or component. Each bag will be clearly labelled with the name/identifier of the component within as well as a designation “Cleaned for Oxygen Service” to ensure that any person handling the bags can take necessary precautions to avoid contamination of the cleaned components [3]. Containers must be stored upright for the pressure relief valves to operate effectively.

D5 Storage

D5.1 Initial Inspection of Storage Container

Containers used for storing liquid oxygen must be inspected prior to use for defects and worn components. Storage containers have a pressure relief valve attached to allow for release of vapors produced from evaporation within the container. These pressure relief valves must be free of all moisture that could freeze onto the valve and prevent the escape of vapors leading to potential explosions of the container [2]. If a pressure relief valve is found to be faulty, contact the manufacturer for further instructions, and if possible, move the container to an open and remote space.

D5.2 Storage Location

Liquid oxygen containers should be stored indoors, protected from the effects of adverse weather. The storage site should be well ventilated to allow for the removal of the vapors



released from the container. If possible, the containers should be stored in a locked cage or cabinet to avoid any mechanical shock caused by bumping or collision with the container. Containers should always be stored in an upright position to ensure proper operation of pressure relief valves. The storage site should be clearly marked with “No Smoking” and “No Open Flames” signs [2].

D6 First Aid Procedures

D6.1 Eye Contact

If eye contact occurs with either the liquid oxygen or gaseous oxygen byproduct of boil-off, immediately warm the affected area with water not exceeding 105° F. Continue to rinse the affected area for at least ten minutes [1]. Seek Medical assistance immediately.

D6.2 Skin Contact

In the case of skin contact, remove any clothing that may restrict blood flow to the affected area. Avoid rubbing the affected area [1], as tissue suffering from frostbite can be prone to tearing. Frozen tissue (frostbite) is often painless, exhibiting a waxy and sometimes yellow appearance [2]. Upon thawing the tissue will experience swelling and will become painful. Immerse the affected area in warm water not exceeding 105° F [2] until feeling has returned to the area. When the tissue has thawed dry the area thoroughly and cover with clean, dry bandages. If fingers or toes are affected, ensure that the bandages are separating the appendages and preventing contact between adjacent fingers or toes. Seek medical assistance immediately.

D6.3 Clothing Contact

In the case of a liquid oxygen spill on clothing, remove the affected articles of clothing immediately. Allow the liquid oxygen to completely evaporate from clothing before further handling [1]. If the underlying skin was affected by the contact, follow the procedures outlined above to treat the area.

D7 Spills and Cleanup

Liquid oxygen is not toxic and poses no environmental risks in the event of a spill [1], but due to the strong oxidizing properties of liquid oxygen the risk of fire or explosion can be very high if spilled on a surface containing organic compounds (such as asphalt) [2]. The following sections will outline the necessary actions to be taken if liquid oxygen is spilled during use.

1. Shut Off All Sources of Liquid Oxygen



- a. When possible, shut down all sources of liquid oxygen flow to stop the spill. This is only advisable if the task can be done remotely (via a solenoid operated valve, for example). If the source cannot be shut down remotely, do not approach the spill site.
2. Clear the Area of All Personnel
 - a. Safety personnel and team management should be notified immediately of the spill and all personnel should be evacuated from the area. Do not walk over or touch the area affected by the spill, and do not allow any machinery or vehicles to drive over the affected area as these could cause explosions due to the friction between tires and the ground.
3. Allow Adequate Time for Evaporation of Liquid Oxygen
 - a. Allow at least 30 minutes for the spilled liquid oxygen to fully evaporate. Any persons in the vicinity of the spill must be directed to an open, ventilated area and allow at least 20 minutes for any oxygen vapors in their clothing to fully evaporate [2].

D8 Transportation

All transport of liquid oxygen, including by road, rail, water or air shipments, must comply with regulations from the U.S. Department of Transportation. Any persons involved in the transportation of liquid oxygen require a Commercial Driver's License as well as Hazardous Material training [4]. For these reasons, liquid oxygen will be transported to the test site by the supplier and none of the project team members will be involved in transportation.

D9 References

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E. Emergency Shutdown Procedure

Test Firing of Liquid Fuelled Rocket Engine



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E1 Purpose and Scope of Document

E1.1 Purpose

The purpose of this document is to address the Emergency Shutdown Procedure, which may be initiated without any operator input if the test stand detects certain inputs from pressure and/or temperature transmitters. During test firing of the liquid fuel engine, certain hazardous conditions may arise in the engine or test stand. Pressure and temperature transmitters are integrated into the test stand in order to monitor test conditions and can trigger alerts or initiate automatic control sequences if hazardous conditions should occur.

E1.2 Scope

This document describes the Emergency Shutdown procedure for a liquid fuel engine test firing on the test stand, including:

- Which signals from pressure/temperature transmitters shall trigger the procedure
- Which actuators should be activated as a result and in what sequence
- What steps the remote station operator must take in the event of an Emergency Shutdown

E2 Personal Protective Equipment & Clothing

E2.1 PPE

No-one shall be in the immediate vicinity of the liquid fuel engine or test stand during a test firing. All personnel should be outside the stand-back radius. PPE required is the general requirement for all personnel present at the test site.



E3 Hazardous Conditions Initiating Emergency Shutdown

E3.1 Hazard and Operability (HAZOP) Study

Hazardous conditions are identified in the HAZOP document referenced in the Test Stand Design document.

E3.2 Fuel Node

E3.2.1 Low Pressure – PRV-1 Fails Closed (Deviation 1.2.3.)

PRV-1 fails closed, causing a reduction of N2 in the fuel pressurizing line and resulting in reduced fuel supply to the engine. Signal from PT-1 or PT-3 below the low-pressure threshold will trigger the Emergency Shutdown procedure in the TSAR system.

E3.2.2 Low Pressure – SOV-1 Fails Closed (Deviation 1.2.4.)

SOV-1 fails closed, causing a reduction of N2 in the fuel pressurizing line and resulting in reduced fuel supply to the engine. Signals from PT-1 and/or PT-3 below the low-pressure threshold will trigger the Emergency Shutdown procedure in the TSAR system.

E3.2.3 High Temperature (Deviation 1.3.3.)

High temperature in the fuel node causes an increase in fuel pressure. TSAR detects TT-1 signal above high-temperature threshold (150 F) and initiates Emergency Shutdown.

E3.2.4 Low Flow (Deviations 1.6.1., 1.6.2.)

Low flow condition due to low fuel pressure or fuel line leak. TSAR system detects signal from FE-1 below low-flow threshold and initiates Emergency Shutdown.

E3.4 Low Pressure (Deviation 2.2.1.)

Sufficient N2 supply for purging is expected as part of regular firing and emergency shutdown procedure. It is critical that sufficient N2 is available, so the N2 cylinder must be completely charged as a condition for initiating a test fire procedure. TSAR system shall read signal from PIT-2 to determine whether sufficient N2 pressure is available. If N2 pressure is below low-pressure threshold, TSAR will impose lockout.



E3.5 LOX Node

E3.5.1 High Pressure – PT-2 or PT-4 failed (Deviations 3.1.3., 3.1.4.)

PT-2 or PT-4 are somewhat redundant. If one pressure transmitters fails to send signal in event of high-pressure state, TSAR will read high-pressure signal from the other transmitter and initiate Emergency Shutdown.

E3.5.2 Low Pressure – Low N2 Supply (3.2.1.)

Test Stand Automated Regulation (TSAR) detects signal below low-pressure threshold from PT-4.

E3.5.3 Low Pressure – PIT-6 Fails (3.2.2.)

TSAR detects low-pressure signal from PT-2 or PT-4

Low Flow (3.6.1.) Low Liquid Oxygen (LOX) level in tank (LOX supply depleted) causes low LOX flow into engine.

E4 Emergency Shutdown State

The emergency shutdown (abort) procedure and states are detailed in the Appendix A - TSAR State Diagram. If emergency shutdown is automatically triggered by TSAR or initiated by the system operator, the following sequence occurs:

1. The system enters the Emergency Purge state (SOV-8 Closed, SOV-4 Closed, SOV-2 Closed, SOV-1 Closed, SOV-3 Open, IV1 Closed, IV2 Closed, SOV-5 Closed, SOV-6 Closed, IG Off).
2. 3 seconds pass
3. The system enters Safe State 0 (APC On, SOV-8 Open, SOV-4 Open, SOV-2 Closed, SOV-1 Closed, SOV-3 Closed, IV1 Closed, IV2 Closed, SOV-5 Closed, SOV-6 Closed, IG Off)
4. 10 seconds pass
5. The system enters the Lockout state (SS0 except APC off)
6. “SHUTDOWN” command to shut down system



F. Contingency Plans

Test Firing of Liquid Fuelled Rocket Engine



November 2019

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F2 Purpose and Scope of Document

F2.0 Purpose

This document will provide a guide to preparing people and systems for actions in response to non-nominal events during the test stand testing activity.

F2.1 Scope

This procedure will outline the necessary steps that need to be followed during contingency events.

F3 Environmental

1. If heavy rain, snow, lightning, or hail is present or expected the test firing is a No-Go.
2. If the temperature is too extreme then the test firing is a No-Go.
 - a. If temperature is above 30 °C (100 °F), this puts team at risk for heat exhaustion.
Test firing is a No-Go
 - b. If the temperature is below 5 °C (40 °F), this puts team at risk for hypothermia.
Test firing is a No-Go.
3. If any wildfires are at or near the test site then test firing is a No-Go. (See Preliminary Procedure, 3.2.1. *Weather Hazards*)
4. If air quality is in an unhealthy range then test firing is a No-Go. (See Preliminary Procedure, 3.2.1. *Weather Hazards*)
5. If any dangerous animals are present then the test firing will be scrapped and animal control will be notified. (See Preliminary Procedure, *Animal Presence* 3.2.2.)

F4 Critical Roles

1. If any primary and secondary critical roles are vacant then the test firing is a No-Go.
2. If any primary and/or secondary non-critical roles are vacant then any available volunteers must go through training procedures prior to departure.
 - a. If no volunteers are available for a non-critical role then the test firing is a No-Go.
3. At least one member must be first aid certified.
 - a. If no members are first aid certified then the test firing is a No-Go.
4. If any changes occur to critical role health then the firing will be rescheduled.



F5 Damage during transport/unloading

1. Assess damage and if it can be repaired.
 - a. If not repairable, reconvene at Rocket Room for assessment and reschedule.
2. Verify that repairs are successful.
3. If repairs are not successful or uncertain, reconvene at Rocket Room for assessment and reschedule.

F6 Lock-Out Tag-Out key lost

1. Roll call for all team members.
2. Verify that all team members are in a safe zone.
3. Continue with firing procedures.

F7 Things don't work

1. Scrap for day and reconvene at Rocket Room for assessment and reschedule.
2. Reason: failed pre-inspection (less dangerous, all we lose is time)

F8 Failure to fill

1. Check that systems are safe.
2. If damage to LOX dewar or pressure vessel
 - a. If no Boiling Liquid Expanding Vapor Explosion (BLEVE)
 - i. Vent until empty
 - ii. Skip to Post Test Firing Procedures, tear down and reconvene at Rocket Room for assessment and reschedule.
 - b. If Boiling Liquid Expanding Vapor Explosion (BLEVE)
 - i. Take cover until subsides
 - ii. Inspect all personnel for injury
 - iii. Wait until liquid evaporates

F9 Valve failure

1. Depressurize system
2. Vent oxygen if applicable
3. Cut power
4. Do post test-fire procedures
5. Reconvene at rocket room



F10 Failure to ignite

1. Shut it down, vent everything
2. Do post test-fire procedure

F11 Spill

1. Isopropyl Alcohol
 - a. If on ground/surface:
 - i. Small spills: clean with a towel or wait to evaporate
 - ii. Large spills: evacuate area wait for it to evaporate
 - b. If on skin: no action necessary
 - c. If in eyes: rinse with water
2. Liquid Oxygen (LOX) - See the LOX Handling Procedures

F12 Rapid Unscheduled Disassembly

1. Take Cover
2. Wait for abnormal activity to cease
3. Check every person in the area for injuries
 - a. Use first aid kit and call 911
4. Ensure tanks have depressurized
5. Collect debris
6. Check in with neighboring businesses and residents

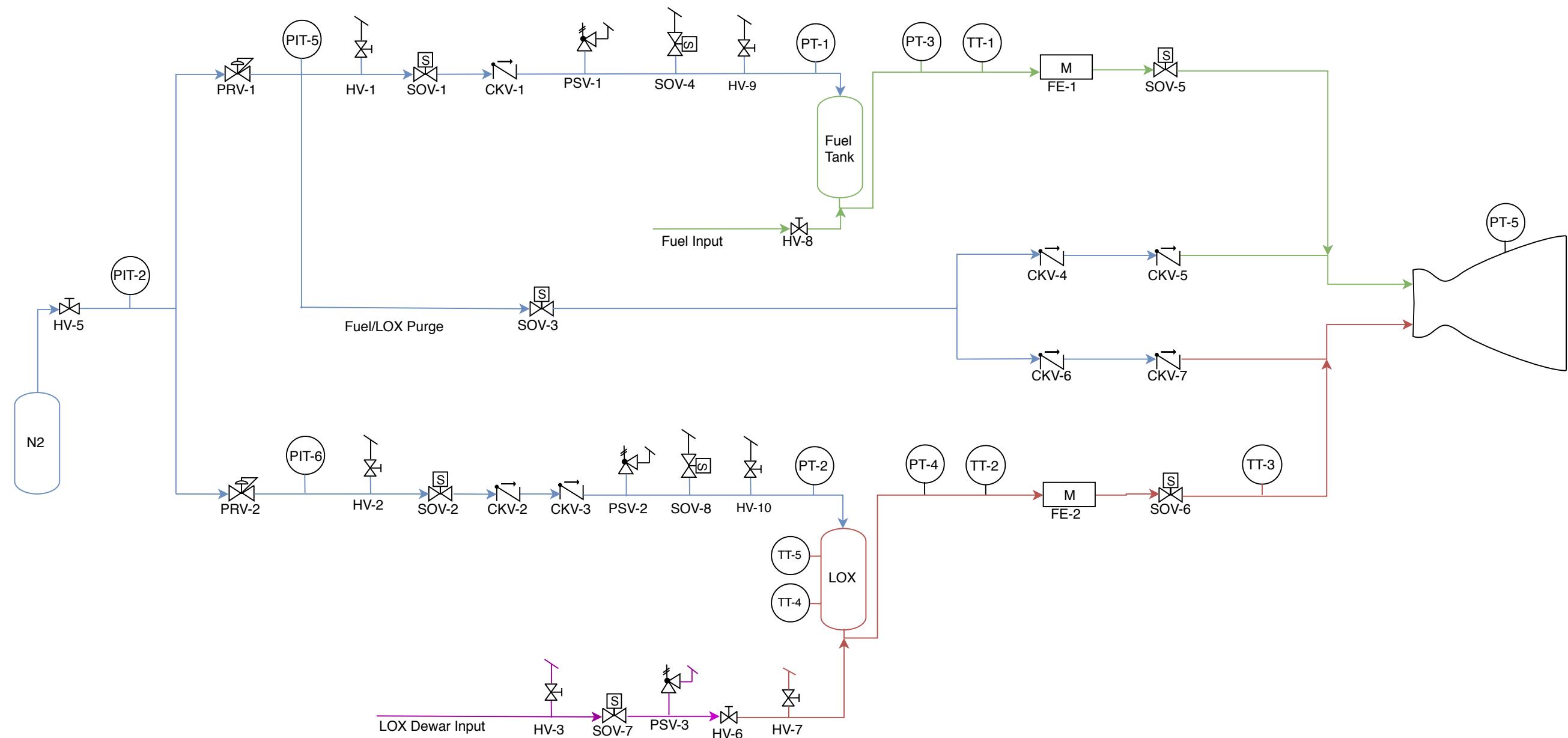
F13 Fire in wrong place

1. Evacuate all people from the area
2. If small and easily contained: Use applicable fire extinguisher to put out
3. If large: Immediately call 911

Symbol	Acronym	Detail
N2	N/A	Nitrogen Pressure Vessel
Fuel Tank	N/A	Isopropyl Alcohol Pressure Vessel
LOX	N/A	Liquid Oxygen Pressure Vessel
Liquid Fuel Rocket Engine	N/A	Liquid Fuel Rocket Engine
PIT N2	N/A	Pressure Indicator and Transducer
PIT-0	N/A	Pressure Indicator and Transducer
PT-1	N/A	Pressure Transducer
TT-1	N/A	Temperature Transducer
M	FE-0	Mass Flow Meter and Regulator
HV-0	HV-0	Hand Turn Valve, Vented to Atmosphere
HV-0	HV-0	Hand Turn Valve
PRV-0	PRV-0	Pressure Relief Valve
SOV-0	SOV-0	Solenoid Operated Valve ,Vented to Atmosphere
SOV-0	SOV-0	Solenoid Operated Valve
PSV-0	PSV-0	Pressure Safety Valve
CKV-0	CKV-0	Check Valve

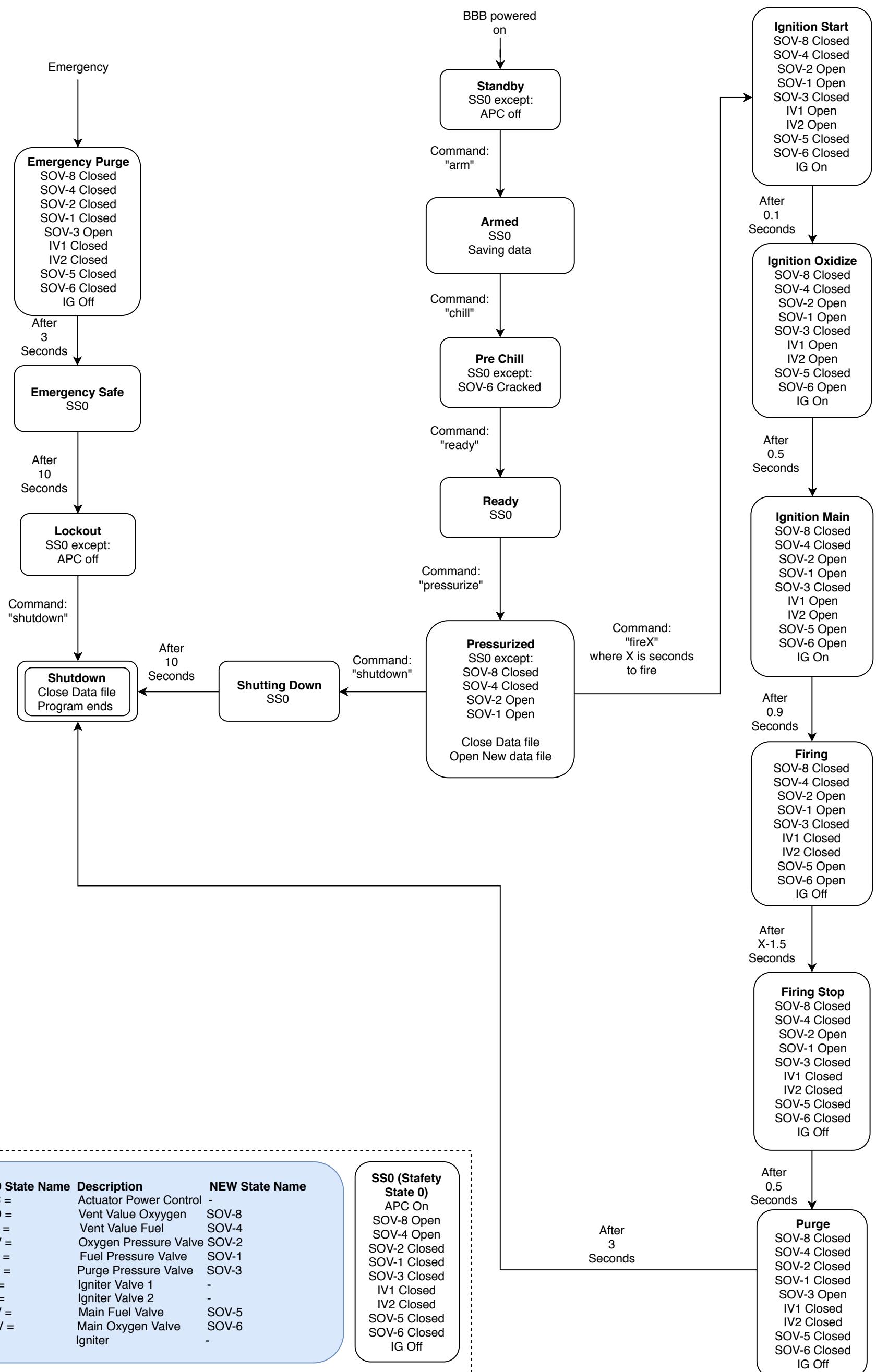
Liquid Fuel Engine Test Stand

2019-2020 Portland State University LFE/LFETS Capstone Team



Test Stand Automation

Valve State Diagram, version 11/29/19



PSAS Safety Procedure Checklist

Hearing Hazards: (High-noise levels >85 dBA)

	Venting	All personnel will be at least 300ft away from the test stand when venting occurs. Ear plugs will be included in the PPE kit for all personnel.
	Purging	All personnel will be at least 300ft away from the test stand when combustion purging occurs. Ear plugs will be included in the PPE kit for all personnel.
	Pump whine	All personnel will be at least 300ft away from the test stand when pressurization occurs. Noise level from Electronic Feed System will be <85 dBA.
	Motor whine	The valve motors on the test stand do not produce noise >85 dBA.
	Rocket motor firing	All personnel will be at least 300ft away from the test stand when ignition occurs. Ear plugs will be included in the PPE kit for all personnel and inserted once firing countdown begins. See test firing procedures.
	Grinding	No grinding is required during the test procedure.

Head Hazards:

	Low structure or equipment	All identifiable head hazards will be flagged with high-visibility tape.
	Dropped tools and equipment	Battery/power supplies will be stored in housings to prevent short circuiting from occurring. The team will implement basic flight line procedures to prevent tools from being unattended, misplaced, and/or dropped.
	High Velocity Components	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear safety glasses when using motorized tools.
	Pointy Corners	All possible structures, housings, and components will be sanded, filed down to prevent injury. When working with sharp tools, injury prevention methods will be implemented dependant on the specific tool guidelines. Sharps gloves will be included in the PPE kit. Files, sanding paper, and first aid will be included in the kits if any sharp corners are observed during site setup procedures.

Hand Hazards:

Hot touch temperatures (Caution >113F, Warning >120F)

Cold touch temperature (Caution <54F, Warning <32F)

	Spinning Tools/Equipment	Technicians assembling/maintaining the test systems will be required to wear safety glasses when using motorized tools. All personnel will be required to be trained on the equipment before operating it. The standard operating procedures will be followed for all tools/equipment. Any PPE required for the specific tools/equipment will be included in the PPE kit.
	Cutting	Personnel will be required to be trained on any cutting equipment before operation. The standard operating procedures will be followed for all tools/equipment. Any PPE required for the specific tools/equipment will be included in the PPE kit.
	Sharp edges	All possible structures, housings, and components will be sanded, filed down to prevent injury. When working with sharp tools, injury prevention methods will be implemented dependant on the specific tool guidelines. Sharps gloves will be included in the PPE kit. Files, sanding paper, and first aid will be included in the kits if any sharp corners are observed during site setup procedures.
	Pointing corners	All possible structures, housings, and components will be sanded, filed down to prevent injury. When working with sharp tools, injury prevention methods will be implemented dependant on the specific tool guidelines. Sharps gloves will be included in the PPE kit. Files, sanding paper, and first aid will be included in the kits if any sharp corners are observed during site setup procedures.
	Abrasion due to heavy lifting	Heavy duty gloves will be included in the PPE kit. Where possible, ergonomic handles will be installed on heavy components.
	Chemical Exposure	Refer to specific material handling procedures for each chemical present. PPE, spill response material, and first aid will be included in the kits.
	Crushing due to pinch points	Any identifiable pinch points will be addressed by adding handles to the structure if possible. Clear communication and roles will be implemented during the assembly process, refer to setup procedures.
	Cryogenic Exposure	Refer to specific material handling procedures for liquid oxygen. PPE, burn cream, and general first aid will be included in the kits.
	Frostbite	Weather conditions will be observed during preliminary procedure. Weather conditions will be monitored at the test site by a site safety member who will respond to any unsafe working conditions accordingly; see preliminary procedure.

Eye Hazards:

	Pressure Jets	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear safety glasses maintaining the system. Pressurization will not occur until all personnel are at a minimum safe distance.
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	Projectile Impact	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear safety glasses when using motorized tools.
	Particles	During site setup, if there is excess wind, dust, and/or smoke present all personnel will be required to wear the necessary PPE. Refer to the site setup procedure.
	Metal/Wood Chips	Workstations will be kept clean and tidy. Tweezers will be included in the first aid kit.
	Dust	During site setup, if there is excess wind, dust, and/or smoke present all personnel will be required to wear the necessary PPE. Refer to the site setup procedure.
	Cryogenic Spray	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear safety glasses maintaining the system. Pressurization and depressurization will not occur until all personnel are at a minimum safe distance.
	Chemical Fumes/Spray/Splash	When working with open materials containers, all present personnel will be required to wear the necessary PPE. Refer to the materials handling procedures for all hazardous materials.
	Venting Toward Personnel	The vent valve output will be marked with high-visibility markings. Personnel will not be near the test stand when venting can occur. Refer to pre-test firing procedures.
	Welding/Arc Exposure	Welding will only occur in a controlled shop space with properly trained personnel. All necessary PPE will be required.
	Bright Lights	See site setup procedures. Shop lights and flashlights will only be used in poor/no visibility conditions. UV protected sunglasses will be included for all personnel in the PPE kit.
	Bright Sunlight	UV protected sunglasses will be included for all personnel in the PPE kit.
	LASER Light Exposure	No lasers are present in the test firing system.

Respiratory Hazards:

	Toxic gases or liquids	All work with hazardous materials will be completed in a well ventilated space with proper PPE worn. Respiratory masks will be included in the PPE kit. All materials have handling procedures and MSDS available. Team member health will be monitored by the safety team. Refer to the site setup procedure.
	Asphyxiation	All work with hazardous materials will be completed in a well

	(Venting/Leaking Inert and Hazardous gases)	ventilated space with proper PPE worn. Respiratory masks will be included in the PPE kit. All materials have handling procedures and MSDS available. Team member health will be monitored by the safety team. Refer to the site setup procedure.
	Insufficient O2	All work with hazardous materials will be completed in a well ventilated space with proper PPE worn. Respiratory masks will be included in the PPE kit. Team member health will be monitored by the safety team. Refer to the site setup procedure.
	Confined spaces	All work with hazardous materials will be completed in a well ventilated space with proper PPE worn. Respiratory masks will be included in the PPE kit. Team member health will be monitored by the safety team. Refer to the site setup procedure.
	Carbon Fibers	No carbon fiber materials will be used the test firing system.
	Fiberglass Fibers	No fiberglass fibers will be used in the test firing system.
	Particles	During site setup, if there is excess wind, dust, and/or smoke present all personnel will be required to wear the necessary PPE. Refer to the site setup procedure.
	Dust	During site setup, if there is excess wind, dust, and/or smoke present all personnel will be required to wear the necessary PPE. Refer to the site setup procedure.
	Chemical Venting/Leaking/Fumes/Spray	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear proper PPE while fuelling the system. Pressurization, depressurization, and venting will not occur until all personnel are at a minimum safe distance. Refer to materials handling procedure. All materials will have an MSDS available.
	Solvent Fumes/Spray	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear proper PPE while fuelling the system. Pressurization, depressurization, and venting will not occur until all personnel are at a minimum safe distance. All materials will have an MSDS available.
	Propellant Fumes/Venting/Spray	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Technicians assembling/maintaining the test systems will be required to wear proper PPE while fuelling the system. Pressurization, depressurization, and venting will not occur until all personnel are at a minimum safe distance. Refer to materials handling procedure. All materials will have an MSDS available.
	Battery Fumes	Battery systems will be housed. Respiratory masks will be included in the PPE kit. Team member health will be monitored by

		the safety team. Refer to the site setup procedure.
	Unmarked Solvent Containers	All containers will be clearly marked with hazards and labelled with contents. All materials will have an MSDS available.

Back Injury Hazards:

	One-person lifting >35-lbs	Proper lifting methods will be observed throughout the test firing. When possible a dolly or cart will be used instead of manually lifting. When lifting maintaining straight spine alignment, bending at the knees and not at the waist, moving items as close to the body as possible, keeping elbows close to body, and not twisting when lifting. Safety team will monitor personnel health throughout the test procedures. Dollies and carts will be included in the site kit.
	Two-person >48-lbs	Proper lifting methods will be observed throughout the test firing. When possible a dolly or cart will be used instead of manually lifting. When lifting both team members will clearly communicate, maintain straight spine alignment, bend at the knees and not at the waist, move items as close to the body as possible, keeping elbows close to the body, and not twisting when lifting. Safety team will monitor personnel health throughout the test procedures. Dollies and carts will be included in the site kit.

Skin Exposure Hazards:

	Chemical Exposure	All materials have handling procedures and MSDS available. Safety gloves will be included in the PPE kit. Team member health will be monitored by the safety team. Refer to the site setup procedure.
	Cryogenics	All materials have handling procedures and MSDS available. Safety gloves will be included in the PPE kit. Burn treatments will be included in the first aid kit. Team member health will be monitored by the safety team. Refer to the site setup procedure.
	Flames	Safety team will assess proper clothing during preliminary procedures. Ignition will occur when all personnel is at the minimum safe distance. Safety gloves will be included in the PPE kit. Burn treatments will be included in the first aid kit. Team member health will be monitored by the safety team. Refer to the site setup procedure and pre-test firing procedure.
	Sunburn	The team shall have sunblock available in the first aid kit. All personnel on site will be required to apply the sun protection dependant on weather conditions. The safety team will monitor weather and team member health. Refer to the site setup procedure.
	Hot gases/liquids	All pressures and temperatures will be monitored at the command

		center. All personnel will be at the minimum safe distance until a safe state is observed. Refer to test firing procedure and post test firing procedure.
	Cold gases/liquids	All pressures and temperatures will be monitored at the command center. All personnel will be at the minimum safe distance until a safe state is observed. There is a materials handling procedure and MSDS for the cryogenic materials. Refer to materials handling procedure, test firing procedure, and post test firing procedure.
	Flames	Safety team will assess proper clothing during preliminary procedures. Ignition will occur when all personnel is at the minimum safe distance. Safety gloves will be included in the PPE kit. Burn treatments will be included in the first aid kit. Team member health will be monitored by the safety team. Refer to the site setup procedure and pre-test firing procedure.
	Venting Toward Personnel	All personnel will maintain a strict safe distance from the firing structures when depressurization and venting occurs. Technicians assembling/maintaining the test systems will be required to wear proper PPE while maintaining the system. Refer to the post test firing procedure.
	High power LASERS	No lasers are present in the test firing system.
	Radiant Energy Exposure	All personnel will maintain a strict safe distance from the firing structures until a safe state is observed at the command center. Refer to post test firing procedure.
	High pressure gas or liquid jets	All personnel will maintain a strict safe distance from the firing structures before system start-up occurs. Pressurization, depressurization, and venting will not occur until all personnel are at a minimum safe distance. Refer to materials handling procedure.

Foot Hazards:

	Rolling equipment	The safety team will assess proper footwear during the preliminary procedure. When moving dollies, cars, or equipment clear communication will be used. The safety team will monitor proper safety procedures and team member health. Refer to the preliminary procedure and site setup procedure.
	Dropping heavy equipment and tools	The safety team will assess proper footwear during the preliminary procedure. All equipment and tools will be used by trained personnel in a controlled environment. Refer to the site setup procedure.
	Chemical exposure (spraying, leaking)	The safety team will assess proper footwear during the preliminary procedure. When working with open materials containers, all present personnel will be required to wear the necessary PPE. Refer to the materials handling procedures for all hazardous materials. Refer to the preliminary procedure.

	Frostbite	The safety team will assess personnel for appropriate clothing dependent on weather; for cold weather wear appropriate multiple layers of winter clothes. Space heaters and appropriate PPE will be included in the site kit and team member health will be monitored throughout the test firing. Refer to the preliminary procedure and site setup procedure.
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Electrostatic Discharge, Electrical Shock, or Burn Hazards: (with potential voltage or current hazards [>30 V or 4 mA])

	Triboelectric Effect	Proper grounding procedures will be followed and EG grounding straps and bracelets will be available.
	Improper/Insufficient Grounding	Fuses will be built into the subsystems to prevent injury in the event of a short circuit.
	Exposed Power Bus	All electric systems and power supplies shall be housed to prevent short circuiting and electric shock.
	Exposed Electrical Connections	All electric systems and power supplies shall be housed to prevent short circuiting and electric shock.
	Exposed Live Connector Pins	Only trained technicians will be allowed to perform maintenance on the system. The system will be powered down whenever connections are being made. Refer to the site setup procedure.
	High Current	High current devices shall be powered off while technicians perform maintenance on the system. Refer to the site setup procedure.
	High Voltage	High voltage devices shall be powered off while technicians perform maintenance on the system. Refer to the site setup procedure.
	Mating or Demating of High-Power Connectors	Only trained technicians will be allowed to perform maintenance on the system. The system will be powered down whenever connections are being made. Refer to the site setup procedure.
	Arc Flash	Only trained technicians will be allowed to perform maintenance on the system. The system will be powered down whenever connections are being made. Refer to the site setup procedure.
	Batteries [rated >25 Ah]	Power supplies shall be housed to prevent short circuiting and electric shock.

Fall Hazards:

	Ladders	No ladders will be used for the test firing.
	Work stands	All work stands will be firmly planted on solid ground with an additional personnel member present to assist.
	Platforms	No platforms will be used for the test firing.

	Holes	During site check procedures, any fall or trip hazards will be identified and mitigated.
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Environmental Exposure Hazards:

	Dehydration	The safety team will monitor personnel health and will distribute water to all team members. Water will be included in the site kit. Refer to the preliminary procedure and site setup procedure.
	Sunstroke	The safety team will assess personnel for appropriate clothing dependent on weather; for hot weather wear light, loose fitting and light weight clothes and/or wear brimmed hat. Sunscreen and water will be included in the PPE kit. Refer to the preliminary procedure and site setup procedure.
	Frostbite	The safety team will assess personnel for appropriate clothing dependent on weather; for cold weather wear appropriate multiple layers of winter clothes. Space heaters and appropriate PPE will be included in the site kit and team member health will be monitored throughout the test firing. Refer to the preliminary procedure and site setup procedure.
	Hypothermia	The safety team will assess personnel for appropriate clothing dependent on weather; for cold weather wear appropriate multiple layers of winter clothes. Space heaters will be included in the site kit and team member health will be monitored throughout the test firing. Refer to the preliminary procedure and site setup procedure.

Psychological Hazards:

	Lack of sleep	The safety team will assess all personnel for health risks during the preliminary procedure. During site setup if any of the following are observed the safety team will act accordingly; impaired motor skills, poor decision making and risk taking, poor memory and information processing, and/or decreased overall productivity. ¹ Refer to preliminary procedure and site setup procedure.
	Long tasks	The safety team will monitor all team members to ensure personal health. Multiple team members will be present and trained to rotate tasks to prevent exhaustion. Refer to the site setup procedure.
	Tedious tasks	The safety team will monitor all team members to ensure personal health. Multiple team members will be present and trained to rotate tasks to prevent exhaustion. Refer to the site setup procedure.

Visibility Hazards:

¹ See Reference 1.

	Poor or no lighting	The team will bring shop lights and flashlights to the test site.
	Poor visibility	If visibility is blocked by environmental conditions the team will refer to the site check procedures. If visibility is blocked by structures/components personnel will use inspection mirrors and/or relocation to perform the present task.
	Visibility blocked	If visibility is blocked by environmental conditions the team will refer to the site check procedures. If visibility is blocked by structures/components personnel will use inspection mirrors and/or relocation to perform the present task.

Housekeeping Hazards:

	Loose Tools	The team will implement general flight line techniques for tracking tool use. No tools will be left unattended.
	Debris	The team will refer to site check procedures to eliminate any debris present. The team will have bins to store any waste and prevent hazards.
	Slip	The team will review safety procedures during the pre-check procedures on footwear guidelines. During site check procedures, any slip hazards will be identified and mitigated.
	Trip	All trip hazards on site will be identified during site check procedures. All cords will be marked and secured.
	Fall	No ladders or platforms will be used for the test firing.

Animal Hazards:

	Predators	Potential wildlife presence will be identified during site-pre check ² . Very low risk of attack from bears, cougars, coyotes, and/or wolves ³ . If sightings have occurred recently refer to site check procedures.
	Poisonous Snakes	Potential wildlife presence will be identified during the site setup procedures. ⁴ Out of 15 native snake species ⁵ only one is venomous. The Western Rattlesnake is not aggressive unless provoked.
	Scorpions	Potential wildlife presence will be identified during the site setup procedures. Scorpions in the Pacific Northwest are very rare and not dangerous except to people who are hypersensitive ⁶ . The sting is similar to that of a yellow jacket. Refer to the site setup procedure.

² See Reference 2

³ See Reference 3

⁴ See Reference 4

⁵ See Reference 5

⁶ See Reference 6

	Spiders	Potential wildlife presence will be identified during the site setup procedures. Black widow (very rare), sac spider (rare), brown recluse (very rare), and hobo spider (somewhat rare) are the only venomous spiders observed in the Pacific Northwest. ⁷ These spiders prefer dark/cluttered spaces. They can bite and cause irritation but are not deadly. Refer to site setup procedures.
	Fire Ants/Bees/Wasps/Hornets	Potential wildlife presence will be identified during the site setup procedures. Insect repellent will be included in the first aid kit and will be worn by all team members. DEET and tweezers will be brought to the test site to repel/remove Pacific Northwest ticks.

Stored Energy Hazards: (containing energy to create a pressure blast, BLEVE, shrapnel, or fireball hazard upon unexpected release with >14,250 ft-lb, >100-psig, or >0.01-lb of TNT.)

	Mating or demating high-pressure lines, connectors, or disconnects	All personnel will be at the minimum safe distance when depressurization and venting occurs. All pressures and temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.
	Cross-Mating of Pressure Lines	All personnel will be at the minimum safe distance when pressurization occurs. In the event of cross-mating all power will be cut, depressurization and venting will occur. All pressures and temperatures will be monitored at the command center.
	Rocket Motors or Engines	All personnel will be at the minimum safe distance before any pressurization occurs.
	Liquified Gas Vessels	All personnel will be at the minimum safe distance before any pressurization, depressurization, and venting occurs. Pressures and temperatures will be monitored from the command center. Refer to pre-test firing procedure and post test firing procedure.
	Pressure vessels	All personnel will be at the minimum safe distance when depressurization and venting occurs. All pressures and temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.
	Pressurized Enclosures	All personnel will be at the minimum safe distance when depressurization and venting occurs. All pressures and temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.

⁷ See Reference 7

	Sealed Containers	All personnel will be at the minimum safe distance before any pressurization occurs.
	Springs	We have no springs with a dangerous energy density.
	Rotating/Spinning Machinery	All personnel will be required to be trained on the equipment before operating it. No motorized tools will be used near materials storage. All pressures and temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.

Ignition Hazards:

	Smoking	No open flames will be present during any site setup procedures. All personnel will be at the minimum safe distance range before the system is powered and before ignition occurs. Refer to the site setup procedure.
	High Voltage Arcing Sparking	Only trained technicians will be allowed to perform maintenance on the system. The system will be powered down whenever connections are being made. All personnel will be at the minimum safe distance range before the system is powered. Refer to the site setup procedure.
	Electrical Short Circuit	Power supplies shall be housed to prevent short circuiting and electric shock. Wherever possible, fuses will be present on each electric circuit.
	Cross-Mating Electrical Connectors	Only trained technicians will be allowed to perform maintenance on the system. The system will be powered down whenever connections are being made. Refer to the site setup procedure.
	Triboelectric effect	All personnel will maintain the minimum safe distance from the test stand before the system receives power. Refer to pre-test firing procedure.
	Hot Equipment/Motors/Valves	All temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.
	Components	All personnel will maintain the minimum safe distance from the test stand when test-firing startup occurs.
	Grinding	All personnel will maintain the minimum safe distance from the test stand when test-firing startup occurs.
	Sparkling Tools	All personnel will be required to be trained on the equipment before operating it. No motorized tools will be used near materials storage. Refer to the site setup procedure.

Fire/Explosion Hazards:

	Flammable Liquids/Gases	All materials have materials handling procedures and MSDS available. No tools will be used near the materials storage. All necessary PPE will be worn when handling materials. No open flames or sparks will be present when handling flammable materials. Refer to materials handling, site setup, and testing procedures.
	Leaking/Venting	All personnel will be at the minimum safe distance when depressurization and venting occurs. All pressures and temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.
	Oxidizer Liquids/Gases	All materials have materials handling procedures and MSDS available. No tools will be used near the materials storage. All necessary PPE will be worn when handling materials. No open flames or sparks will be present when handling flammable materials. Refer to materials handling, site setup, and testing procedures.
	Leaking/Venting	All personnel will be at the minimum safe distance when depressurization and venting occurs. All pressures and temperatures will be monitored at a safe state and all power will be cut prior to any personnel approaching the test stand. Refer to test firing procedure and post test firing procedure.
	Flammable Materials	No flammable materials, debris, or structures will be near the test stand when ignition occurs. All materials have materials handling procedures and MSDS available. No tools will be used near the materials storage, debris, waste, or structures. All necessary PPE will be worn when handling materials. No open flames or sparks will be present when handling flammable materials. Refer to materials handling, site setup, and testing procedures.
	Batteries (Overcharging, Short Circuit)	Power supplies shall be housed to prevent short circuiting and electric shock. Charges will be monitored to prevent over charging. Refer to the preliminary procedure.
	Battery Gases	All batteries will be housed to prevent short circuiting, sparks, and respiratory hazards. No tools will be used near the battery housing. Refer to site setup procedures.
	Flammable Solvent Soaked Rags	All waste will be disposed of in safe containers. Workstations will be kept in a clean and tidy state. Workstations with power tools will be kept in a controlled location. Refer to site setup procedures.

Kinetic Energy Hazards: (systems & machinery moving, lifting, rotating, deploying, falling, tip over, or retracting)

	Mechanisms	All personnel will be reminded to remain aware of mechanisms.
	Actuators	We will not actuate components when people are within the minimum safe distance.
	Surfaces	We will take care when handling objects that have sharp corners, abrasive surfaces, or extreme temperatures.
	Structure	We will inspect all components for cracks, defects, or other abnormalities. Before and during transportation of the test stand, we will ensure it is sufficiently supported.
	Towing	Before any towing operations, we will ensure secure connections and redundancies between vehicles and what is to be towed.
	Equipment	Heavy equipment will be handled with respect.
	Pinch points	All personnel will be reminded to remain aware of pinch points.
	Winching	All personnel will be warned and instructed to keep their hands clear from winches and their bodies free of the winch line.
	Ballistic Rockets	There will be no actual rockets launched at the test fire.

Hazardous or Safety Critical Functions:

	Requires Continuous Monitoring	Automatic fail-safe mechanisms are in place to ensure that the test stand will shutdown in the event that monitoring ceases.
	Is Computer Controlled	Personnel are not responsible for the minute management of test stand subsystems.

Safety Critical Equipment Damage:

	ESD	Proper grounding procedures will be followed and EG grounding straps and bracelets will be available.
	Impact	Safety critical equipment will be visually marked so that all personnel know to be especially careful when handling it.
	Contamination	Before any operation, all safety critical equipment will be inspected to ensure that no foreign material is present.

Adverse Environmental Hazards:

	Earthquake	During the preliminary procedure, the safety team will check for any recent seismic activity, assess risk for a
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		Tsunami, and will monitor the status throughout the test firing. During site setup, if there is any change in seismic activity the safety team will make decisions accordingly. Refer to the preliminary procedure and site setup procedure.
	Hail	During the preliminary procedure, the safety team will check for current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. There will be an enclosure included in the kit for the command center. Refer to the preliminary procedure and site setup procedure.
	Lightning	During the preliminary procedure, the safety team will check current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. Refer to the preliminary procedure and site setup procedure.
	Heavy Rain	During the preliminary procedure, the safety team will check current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. There will be an enclosure included in the kit for the command center. Refer to the preliminary procedure and site setup procedure.
	High Winds	During the preliminary procedure, the safety team will check current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. There will be an enclosure included in the kit for the command center. Refer to the preliminary procedure and site setup procedure.
	Blowing Sand or Dust	During the preliminary procedure, the safety team will check for current wildfire locations, assess risk, and will monitor the status throughout the test firing. During site setup, if there is excess wind, dust, and/or smoke present all personnel will be required to wear the necessary PPE. Refer to the preliminary procedure and site setup procedure.
	Snow	During the preliminary procedure, the safety team will check for current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. There will be space heaters available in the site kit. Refer to the preliminary procedure and site setup procedure.

	Flooding	The test firing site will be assessed for flood risk. During the preliminary procedure, the safety team will check current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. Refer to the preliminary procedure and site setup procedure.
	Storm Surge	During the preliminary procedure, the safety team will check current weather conditions, assess risk, and will monitor the status throughout the test firing. During site setup, if there is any change in weather the safety team will make decisions accordingly. Refer to the preliminary procedure and site setup procedure.
	Hurricanes	Hurricanes are not a risk in the Pacific Northwest.

References:

1. <https://www.americansafetycouncil.com/content/osha-10-safety/>
2. <http://oe.oregonexplorer.info/wildlife/wildlifewviewer/>
3. https://oregonexplorer.info/oe-resources-reports-and-publications/215?combine=fact+sheet&sort_bef_combine=created+DESC&items_per_page=10
4. <https://jrbp.stanford.edu/content/health-safety-information>
5. <https://myodfw.com/wildlife-viewing/species/snakes>
6. <https://pnwhandbooks.org/insect/structural-health/public-health/public-health-scorpion>
7. <https://pnwhandbooks.org/node/7942/print>

Name:

Safety Guidelines for Fieldwork

Date Created:	11/21/2014	Date Revised:	5/11/2015	Reviewed By:	Scott Jaqua, Heather Randol
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I. General Field Safety Guidelines

Fieldwork is an important part of teaching and research at Portland State University (PSU). Environmental Health & Safety (EHS) has composed this booklet to help you prepare for health and safety problems you might encounter when fieldwork takes you off campus.

For more specific information on fieldwork hazards and precautions, talk to your supervisor or contact Environmental Health & Safety (EHS) at 503-725-3738 or www.pdx.edu/environmental-health-safety.

This booklet is designed to be a guide. It is meant to help researchers and instructors think about risks that might be encountered in the field. This guide cannot anticipate every possible hazard that might be encountered, so common sense and a respect for the unpredictable nature of working and learning in the field must be employed. Thus, all equipment, supplies, and planning considerations should be approached within the context of the fieldwork environment and the nature of the work being performed.

One of the most important phases of your fieldwork experience is planning and preparation. Here are some suggestions for a safe trip:

- A. **Written Plan:** Prepare a written plan of your trip to leave with a responsible party at your group office or with EHS. *A blank Field Research Safety Plan template is included at the end of this booklet. Include the following:
 1. Activities: General nature of your activities
 2. Your itinerary: Locations; arrival and departure dates; means of transportation, names, addresses, and phone numbers of all fieldwork participants
 3. Contacts:
 - a. If possible, designate local contacts at or near your fieldwork site who can reach you if necessary and who are familiar with your check-in, daily activities, and checkout arrangements. Inform the local contacts of any medical conditions of the field team members as appropriate.
 - b. If possible, while working in remote areas, field-workers should check in at regular intervals with an accountable person about the fieldwork location and the approximate time of return. The accountable person should be provided with the telephone numbers of people to call (group office, University contact) if the workers do not return or report in when expected.
 4. Home contact: The sponsoring department office should also have the

name and phone number of family to contact in case any worker is injured or taken ill. Fieldworkers should check in with their group office or PI regularly and should advise the group office of any changes in schedule or points of contact.

- B. **Transportation:** Determine, reserve and plan appropriate transportation.
1. If flying, provide flight itinerary, insurance information, and participant(s) names on Field Research Safety Plan or to department contact.
 2. If driving, ensure all drivers have appropriate license(s) and insurance. The PSU Risk Management Office can assist with this.
 - a. As with all fieldwork trips, check local weather and road conditions prior to travel.
 1. Carry safety equipment that is appropriate for the conditions and the season.
 2. Evaluate vehicle needs considering destination, number of passengers, fieldwork equipment, and any necessary safety equipment.
 3. If towing anything, anticipate increased stopping distance and consider the quality of the vehicle's brakes prior to open-road driving.
 4. PSU driving guidelines:
 - a. Only persons over the age of 18 are authorized to drive a motor vehicle on University travel. This applies even if the driver owns the vehicle he/she intends to drive.
 - b. No person convicted in the past 5 years of a traffic crime (i.e. served jail time) shall be permitted to drive on University travel.
 - c. Drivers are expected to monitor their fatigue levels and take rest periods based on their comfort and safety.
 - d. All passengers and drivers must wear seatbelts.
 - e. When using vans and other oversized vehicles there should be no more than 12 occupants.
 5. Off-road vehicular activities
 - a. Utilizing these transportation means require specialized skill, whether snowmobile, all terrain vehicles (ATV's), or 4-wheel drive road vehicle. Always ensure driver is familiar with vehicle capabilities, terrain conditions, local off-road and ATV ordinances (including light and helmet requirements).
 - b. It is strongly recommended that additional vehicle safety equipment be carried for these activities (i.e. winch, jack, shovel).
These kinds of alternative transportation methods pose significant risks. There have been numerous accidents involving off-road SUV's, vans, and ATV's. Care must be taken if any of these modes of transportation will be utilized. Ensure safety and survival equipment is available, if necessary, and in good condition.
 - c. Consider an ATV safety course or review the information provided by the State of Oregon:

<http://www.oregon.gov/oprd/ATV/Pages/index.aspx>

6. Biking
 - a. Observe all local bike transportation ordinances, including helmet requirements
 - b. Bike(s) should have front and rear lights and safety and repair supplies should be available for any mishap that might be encountered.
7. Boating (including floatation devices)
 - a. Boating safety education is required for all operators in Oregon waters. A boating education card issued by the Oregon State Marine Board (OSMB) must be carried at all times when operating a powerboat of more than 10 horsepower. See www.oregon.gov/osmb/boated/pages/index.aspx for training options.
 - b. Observe all local boating ordinances, including floatation device and alcohol regulations.
 - c. Be familiar with the watercraft. Understand its handling capabilities, capacity, anchoring, engine troubleshooting, and emergency response.
 - d. Ensure that oars and paddles are available as back up to motor(s) (if applicable).
8. Hiking, backpacking, walking
 - a. Use global positioning system (GPS) devices to ensure safe navigation, but paper maps should also be included in case of loss of power or coverage. Familiarity with GPS operation is necessary for this to be effective.
 - b. Survival supplies (flashlight, matches, survival blanket, first aid kit) should be brought along each trip considering the expected duration and number of participants.
 - c. Ensure all participants have proper clothing and footwear considering weather, seasonal variations, and terrain.

- C. **Physical & Environmental Hazards:** Learn about potentially hazardous terrain, and weather conditions in the areas where you plan to work. Additionally, if travelling overseas, investigate the political climate in the country you plan to visit.

1. Many general physical and environmental hazards exist in nearly every location worldwide. Your supervisor/sponsor, other field-workers, or local residents and authorities such as state and national park services personnel, may be able to provide you with helpful information. While these hazards are too numerous and diverse to list in this guide, they should be added to the Field Research Safety Plan and discussed among the fieldwork team to ensure familiarity.

2. If working around water, especially the ocean, be aware of hidden hazards like moving rocks, logs, waves, currents, underwater structures, and eddies.
3. If your trip involves travelling outside the country, you should contact the Center for Student Health & Counseling (SHAC) and/or your healthcare provider to learn about required and recommended vaccinations for your location. Some countries require proof of vaccinations prior to entry.
4. Take a Cardiopulmonary Resuscitation (CPR) or First Aid class. Contact SHAC, the PSU Recreation Center, or the American Red Cross for information.

D. **Safety Provisions:** Assemble safety provisions (only those necessary for the location and environment you may encounter) and check everything before you leave; safety provisions may include:

- First aid kit and first aid manual. These should be taken on any trip.
- Medications you regularly take – include an extra bottle in case you lose one.
- Allergy treatments (if you have allergies)
- Sunscreen and hat
- Water purification tablets or filter devices
- Vehicle/boat emergency kit including flares
- Flashlight
- Cell phone and/or smart phone
- Two-way radio, satellite phone, or emergency beacon if available (especially if you will be working alone in an isolated or dangerous area)
- Personal protective equipment for fieldwork activities (safety glasses/goggles, gloves, hard hat, appropriate footwear). EHS can recommend protective equipment depending on your activities.
- Photo identification in case of accident or injury
- The “Buddy” system is the safest way to work. Whenever possible, fieldwork activities should be performed in teams of at least two people.
- Contact the Office of Risk Management or visit them at <http://www.pdx.edu/risk/home> to obtain information about travel insurance and waivers.
- Ask your health insurance provider how your coverage applies to medical treatment in the fieldwork locale, should that become necessary.

E. **Medical Care and First Aid**

1. Emergency Medical Care

The following guidelines apply to all off-campus activities that involve employees and students:

- a. First Aid Kits are strongly recommended for all fieldwork activities. Contact EHS or SHAC for advice on the contents of a first aid kit.

- b. Contact SHAC and/or your healthcare provider for advice on special equipment or medication.
 - c. Have at least one employee trained in first aid when field activities are remote. This person should be documented on the Field Research Safety Plan
 - d. Know where the closest hospital or emergency medical services are located. Document this information on the Field Research Safety Plan.
 - e. Each department has its own procedures for obtaining insurance coverage for emergency medical treatment. Field-workers should know what these are before they leaving. If department resources are not available, contact the Office of Risk Management.
2. If a PSU employee suffers a job-related injury or illness, his or her supervisor must be notified immediately, or as soon as possible. Additionally, the [PSU Injury Report Form](#) must be completed for any incident.
The [SAIF 801](#) form must be completed if an employee seeks medical treatment or misses time from work due to an on the job injury.
These forms are available on the Human Resources Policies & Forms page: <http://www.pdx.edu/hr/policies-contracts-forms>

II. Animals and Plants

Dangerous animals and plants are present worldwide. General safety rules can help protect you from these hazards.

- A. Like with terrain and environmental concerns discussed in C.1, above, all field researchers should learn about potentially hazardous plants and animals in the areas where you plan to work. Your supervisor/sponsor, other field-workers, or local residents and authorities, such as state and national park services personnel, may be able to provide you with helpful information. While these hazards are too numerous and diverse to list in this guide, they should be added to the Field Research Safety Plan and discussed among the fieldwork team to ensure familiarity.
- B. If you are working with wild-caught animals, review the guidelines from the [Institutional Biosafety Committee](#) and the [Institutional Animal Care and Use Committee](#) to see if your research requires approval from one of these committees. For further information, contact the [Office of Research Integrity](#)
- C. A number of animals and pests may be encountered in fieldwork. Follow these general guidelines to minimize hazards:
 - Keep food and garbage in sealed containers and stored away from your campsite or work area.
 - Thoroughly shake all clothing and bedding before use.
 - Do not camp or sleep near obvious animal nests or burrows.
 - Be aware of the appearance and habitat of likely pests. Carefully look for pests before placing your hands, feet, or body in areas where pests live or hide (e.g., woodpiles or crevices).

- Avoid contact with sick or dead animals.
- Wear clothes made of tightly woven materials
- Wear insect repellent.
- Minimize the amount of time you use lights after dark in your camp or work site because they may attract pests and animals.
- Use netting to keep pests away from food and people.
- Carry a first aid manual and kit with you to treat bites or stings. If the pest is poisonous or if the bite does not appear to heal properly, seek medical attention immediately.

III. Diseases

Viruses, bacteria, fungi, and parasites cause diseases in nearly every location worldwide.

- A. All fieldwork personnel should become aware of the diseases that could be encountered in the region where fieldwork will take place. Some diseases are transmitted by animal or insect bite, while others are airborne, so personnel must understand what might be encountered during their work.
Contact PSU Office of Research Integrity for assistance with biological risk assessments.
- B. This guide is not intended to cover every health risk in every location. Always check with your health care provider before travelling out of the country to learn about specific health risks for the region in which you will conduct your research.
- C. Proper Rodent Handling
Steps can be taken to reduce the risk of rodent-borne diseases.
 1. Most important: Make the area unattractive to rodents. Cover or repair holes into a building to prevent unwanted rodents. The Centers for Disease Control and Prevention (CDC) provides good guidelines for prevention and cleaning up from a rodent infestation:
<http://www.cdc.gov/rodents/index.html>
 2. If camping, keep the area clean of trash, store food carefully, and stay clear of burrows to prevent attracting rodents. If rodent feces or dead rodents are discovered, some precautions will help reduce the risk of exposure to rodent-borne diseases when cleaning the area:
<http://www.cdc.gov/rodents/cleaning/index.html>
- D. If fieldwork activities involve animal observation and/or capture, PSU Institutional Animal Care and Use Committee (IACUC) must review the activities to determine whether formal approval is required.

E. Other Diseases

Many other diseases, vector-borne and directly transmitted, may pose a problem when travelling. Always check with a physician to learn the specific diseases that exist in your region of study.

IV. Resources

Many available resources may provide more in-depth information regarding your research environment. Please use the references in this section for further information on topics discussed in this booklet.

On Campus

- Environmental Health & Safety: EHS is available for hazard information and hazard evaluations <http://www.pdx.edu/environmental-health-safety>
- Student Health and Counseling (SHAC): SHAC is available for student medical exams and other health-related information. They can also make recommendations for faculty and staff concerning immunizations and regional concerns
Contact SHAC: 503-725-2800 or <http://www.pdx.edu/shac>
- Risk Management Office: The PSU Risk Management Office is available to answer questions and assist with waivers and travel insurance.
<http://www.pdx.edu/risk>
- Human Resources: The PSU Human Resources department is available for questions about workers' compensation coverage and injury reports.
They can be reached at 503-725-4926 or <http://www.pdx.edu/hr>

Off Campus

- First Aid/CPR Training: First Aid and CPR training is available from the American Red Cross: www.redcross.org/cpr-training or 503-284-1234.
- General: The Centers for Disease Control and Prevention (CDC) offers a web site that describes many topics related to travel, both domestic and international: <http://www.cdc.gov/travel/>
- Medical: Information about a variety of illnesses, including dehydration, carbon monoxide poisoning, sunburn, excessive heat, hypothermia, and high altitude sicknesses, can be found on-line at <http://my.webmd.com>.
- Diseases: The CDC offers more detailed information about many diseases on their web site: <http://www.cdc.gov/travel/diseases.htm>.
- The Oregon Health Authority offers information about infectious diseases and immunizations. Call (877) 398-9238 or www.oregon.gov/oha
- The Multnomah County Health Department offers information on infectious diseases and immunizations. Call (503) 823-4000 or www.web.multco.us/health
- Weather: More information on extreme weather and how to protect yourself can be found from the National Weather Service at <http://weather.gov/safety.html>.

- Impure Water: For more information about water-borne diseases, the CDC provides information on-line at http://www.cdc.gov/ncidod/diseases/list_waterborne.htm.
- North America Hunting Season: To get more information concerning hunting seasons and regulations, contact the U.S. Forest Service by phone at (202) 205-8333 or on-line at <http://www.fs.fed.us/>.
- Poison Plants: More information about poison plants, including photos, can be found at: <http://poisonivy.aesir.com/>.
- Hantavirus: The CDC has detailed information about Hantavirus available at <http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/generalinfoindex.htm>.
- Lyme Disease: The American Lyme Disease Foundation provides information about the disease at <http://www.aldf.com/>.
- International Travel Health and Outbreaks: Updated information about disease outbreaks and international travel health can be found from the World Health Organization (WHO): <http://www.who.int/en/>.
- Travel Advisories: Advisories are announced through the U.S. Department of State. Current travel warnings, public announcements, and consular information sheets can be obtained by calling (202) 647-5225 or by searching on-line at http://travel.state.gov/travel_warnings.html

PORTLAND STATE UNIVERSITY

FIELDWORK SAFETY PLAN

This form may be used by the Principal Investigator (PI), Project Lead, or department representative to assist with the development of a Safety Plan. A single Safety Plan can cover multiple trips to the same location. The Safety Plan should be revised whenever a significant change to the location or scope of fieldwork occurs. EHS and/or Risk Management are available to assist in completion or review of the Safety Plan. The completed Safety Plan should be shared with all members of the fieldwork team and kept on file with the department and/or EHS.

Principal Investigator:		Department:	
Phone number:		Email address:	
Date(s) of travel:			
Project Duration:			
Mode(s) of transportation:	Vehicle	Driver/Operator	
Location(s) of Field Research:	Country:	Geographical Site (State if US):	
Attach map with driving directions from field site to nearest hospital or health care facility)	Nearest City (Name, distance from site):	Nearest medical facility (Location, distance from site):	
University Contact:	Name	Phone, Email address	
Local (Field) Contact:	Name	Phone, Email address	

Field Team Membership: (list the names of all members of the field research team and identify roles)

Name	Affiliation (Faculty, Student, Guest)	Category (check all that apply)				
		Team Leader	Team Member	Other (Specify)	Trained First Aid	Driver/Vehicle Operator

Fieldwork: (Include a brief description of the field work)

Travel Immunizations: (List required immunizations / prophylaxis. Contact ____ for assistance)

Emergency Procedures: (Include detailed plans for field location, including evacuation and emergency communication)

Physical Demands: (List any physical demands required for this field research; i.e. diving, boating, hiking, climbing, high-altitude, heavy lifting)

Risk Assessment: (Check all items that you expect will be encountered during the project or event.)

<p>Environment</p> <ul style="list-style-type: none"> <input type="checkbox"/> High altitude <input type="checkbox"/> Extreme temperature Hot/Cold <input type="checkbox"/> Excessive/Extreme exposure to sun, wind, blowing sand, etc. <input type="checkbox"/> Work over/Under water <input type="checkbox"/> Dusts/Particulate hazards <input type="checkbox"/> Noisy <input type="checkbox"/> Potential for oxygen deficiency or other atmospheric hazard (i.e. gas, vapor, chemical) <input type="checkbox"/> Work at night/poor lighting <input type="checkbox"/> Driving <p>Accessibility</p> <ul style="list-style-type: none"> <input type="checkbox"/> Remote location <input type="checkbox"/> Long distance to medical services (i.e. > 50 miles) <input type="checkbox"/> Lack of communication capability (i.e. poor/no connection) <p>Terrain</p> <ul style="list-style-type: none"> <input type="checkbox"/> Rough/Unusual terrain <input type="checkbox"/> Flash flood potential <input type="checkbox"/> Falling objects (i.e. avalanches, rock falls, etc.) <input type="checkbox"/> Work along roadway shoulders (Attach traffic control plan and permit, if required) <input type="checkbox"/> Heights (i.e. trees, cliffs, etc.) <input type="checkbox"/> Disaster area <input type="checkbox"/> Violence (i.e. political, military, protests, etc.) <p>Flora/Fauna</p> <ul style="list-style-type: none"> <input type="checkbox"/> Wild animal Hazards <input type="checkbox"/> Venomous/Poisonous Animals: <input type="checkbox"/> Insects as known disease carriers <input type="checkbox"/> Trapping/handling animals: <input type="checkbox"/> Toxic/Poisonous Plants: <input type="checkbox"/> Biosafety/IACUC Application/Approval: <input type="checkbox"/> Other: _____ 	<p>Work Tasks</p> <ul style="list-style-type: none"> <input type="checkbox"/> Confined space (natural or man-made) <input type="checkbox"/> Trenching/Excavating <input type="checkbox"/> Hazardous waste generation <input type="checkbox"/> Hazardous material transportation <input type="checkbox"/> Hazardous material handling <input type="checkbox"/> Hazardous material storage on-site <input type="checkbox"/> Lack of potable water <input type="checkbox"/> Lack of sanitary facilities <input type="checkbox"/> Potential for flying debris or impact <input type="checkbox"/> Electrical hazard <input type="checkbox"/> Fire hazards (i.e. welding, cutting, grinding) <input type="checkbox"/> Diving <input type="checkbox"/> Climbing/Strenuous hiking required <p>Planned Equipment Use</p> <ul style="list-style-type: none"> <input type="checkbox"/> Snowmobile/ATV <input type="checkbox"/> Boat/Canoe/Kayak <input type="checkbox"/> Forklift <input type="checkbox"/> Weapon(s) <input type="checkbox"/> Cages/Traps/Snares <input type="checkbox"/> Other: _____ <p>Material(s) Brought to Field Area</p> <ul style="list-style-type: none"> <input type="checkbox"/> Chemicals <input type="checkbox"/> Biological material <input type="checkbox"/> Radiological <input type="checkbox"/> Other: _____ <p>No known hazards</p>
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Other notes