Static Fire Checklist

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Date: 7/1/2023 **Formula/Propellant Name:** Undecided

Materials List:

- Safety Measures
  - Safety Glasses **[ ]**
  - Earplugs **[ ]**
  - First aid kit **[ ]**
  - Fireproof Jacket **[ ]**
  - Appropriate Clothing and footwear **[ ]**
  - Hand warmers (during winter) **[ ]**
  - ~~Metal Fire Extinguisher **[ ]**~~
  - Regular Fire Extinguisher **[ ]**
- Motor Supplies:
  - Motor(s) **[ ]**
  - Test Stand(s) **[ ]**
  - Ratchet Straps **[ ]**
  - Ground Stakes **[ ]**
  - Data Acquisition System **[ ]**
  - Load Cell **[ ]**
  - Load Cell adapter/hardware to sit on Load Cell [ ]
  - Thermocouple **[ ]**
  - Extra bolts **[ ]**
  - Pressure Transducer (as needed) **[ ]**
  - Teflon Tape **[ ]**
  - Wire Spool **[ ]**
  - Igniters (plus extra) **[ ]**
  - 12 V Battery (or car battery) **[ ]**
  - Scrap Propellant **[ ]**

- Hardware Supplies:
    - Table **[ ]**
    - Multimeter **[ ]**
    - Adjustable Wrenches **[ ]**
    - RTV High Temp. Sealant **[ ]**
    - Sandpaper **[ ]**
    - Calipers **[ ]**
    - Cameras **[ ]**
    - Grease **[ ]**
    - Igniter Ammo Box **[ ]**
    - Screwdrivers **[ ]**
    - Clamps **[ ]**
    - Exacto knives/box cutter **[ ]**
    - Allen keys **[ ]**
    - Adjustable Wrench (multiple sizes) **[ ]**
    - Shovel **[ ]**
    - Measuring Scale **[ ]**
    - Mallets **[ ]**
- Other:
    - at least 2-3 charged computers with Python, matplotlib, and this repository downloaded and USB ports **[ ]**
    - Wire strippers + cutters **[ ]**
    - Paper towels **[ ]**
    - Electrical tape **[ ]**
    - ~~MicroSD card to USB dongle (or however your computer needs)~~ **~~[ ]~~**
    - Snax **[ ]**
    - **Keys for airfield [ ]**

Approval for Testing

At least 1 week prior to the test, ensure that Anthony Zolnik (Manager of Infrastructure for Aero/Astro), Rob Albright (Crow Island property manager), Marie Gentile (EHS officer), and the current Rocket Team Safety Officer have been informed of the test. Notify the fire marshal of the municipality being tested. Make arrangements to get the key to the test facility prior to the test.

Transport of Testing Materials

- Ensure that there are enough cars for the transportation of all materials and personnel, without overloading.
- Ensure that there is a driver for each car at least 48 hours prior to the test. All drivers must be at least 18 years of age and hold a valid US drivers' license. Drivers must show up to the test alert and not under the influence of any substance.
- For each driver, there must be a co-driver that will also be alert and not under the influence. The co-driver will be responsible for navigation and ensuring the safety of the driver and passengers.
- All flammable containers MUST be stored in the trunk of the car inside of the small yellow flammables cabinet in RT lab. Flammables may never be in the passenger compartment.

Test Stand Setup:

- Integrate the motor with the test stand:
    - Secure the plate with the load cell at the appropriate level for the motors being tested.
    - Screw the pressure transducer into the forward closure. Use Teflon tape
    - Run the wires from the pressure sensor and load cell to the data acquisition system.
    - Insert the motor into the test stand with a load cell adapter sitting on top of the load cell. Ensure the pressure sensor wire is looped through the slot in the hardware to prevent crimping of the wire.
- Integrate the test stand:

    - Secure the top half of the test stand with bolts and adjust the height depending on the height of the motor
    - Secure the motor by screwing in more bolts. Ensure the motor is tightened symmetrically such that it is even. Do not over tighten the bolts and allow a little bit of space between the bolts and sides of the motor so it can still move up and down.
    - Hammer in ground stakes about 10 feet away in a triangle pattern.
    - Tie straps to the three eye bolts on the top centering ring and then to the ground stakes. Ensure the ratchet straps are not twisted and are straight. Tighten them.

- Position the cameras with a clear view of the motor
- Make sure both fire extinguishers are present and ready for use.
- Perform data test:
    - Turn on DAQ and wait till a solid green light
    - Verify that the load cell is reading reasonable data by pushing down on the motor. Push for 30 sec- 1 min and turn off the DAQ.
    - Verify that the pressure transducer is reading atmospheric pressure.

Static Fire Procedure:

NOTE: It is advisable in summer heat and dry weather to spray the surrounding area of the test stand with water and pre-dampen the environment to mitigate spreading fire.

1. Non-essential personnel vacate to the firing line of 200 ft
2. Conduct an igniter test 30 ft - 40 ft away from the test stand by wiring up an igniter and touching the leads of the wire to the leads of the car battery. If it pops and lights, the battery is sufficient for testing.
3. Verify that the ignition system is safe and that the interlock is not connected
4. Install the igniter in the motor (need 1-2 people with fireproof jacket)
    a. Insert the starter through the nozzle as far as possible into the motor
    b. Attach the lead wires to the ignition system
    c. Verify that the ignition system is not shorted on any nearby metal, such as the test stand

    d. Set up the ignition system such that the motor can be started from >200 ft away
5. Activate the sensors
    a. Check that all cameras are recording
    b. Power on the data logger to start recording data
6. All personnel retreat to the firing line
7. Ignite the motor:
    a. Arm the ignition system. (Hold the wire ends) Ensure everyone is recording and callout what motor/propellant this is (if characterizing, nozzle throat also helpful to note)
    b. Ignite by pressing ends of wire to the battery leads.
    c. Wait for the propellant to burn out. Wait 60 sec- 90 sec after the last flame in the motor.
    d. If the propellant did not burn, wait 60 seconds before approaching the motor.
8. Approach the motor:
    a. Shut down all cameras
    b. Power down the DAQ
    c. Remove the USB from the DAQ
9. Load all data from the camera and the DAQ onto a single laptop
10. Wait until the motor case has cooled to a safe-to-touch temperature (usually about 15-30 min)

Clean-Up:

- Disassemble the ignition system
- Tear down the firing line
- Remove all cameras from the site
- Remove the test stand
- Notify Anthony Zolnik, Rob Albright, Marie Gentile, and the current Rocket Team Safety Officer that the test is finished.

In the Event of an Emergency:

- The most likely failure mode will be fire. If a fire occurs on site:
    - Use the fire extinguisher for small fires that can be contained by personnel wearing PPE

  OR
    - Call 911 for large fires that pose an immediate danger to life, limb, and property
- If a fire occurs during transport of motor:
    - Immediately pull over
    - Evacuate all personnel to the minimum safe distance as recommended by the Tripoli Rocketry Association (distance is 200ft, but still try to get as far away as possible)
    - Call 911, do not try to fight the fire
- Notify Anthony Zolnik, Rob Albright, Marie Gentile, the current Rocket Team Safety Officer, the local fire marshal, and any test facility staff of ANY emergency.

Results of Test: (Circle one of the below)

Successful **Unsuccessful**

Rationale/description of results: