**LFEV-Y5**

v0.1

**Lafayette College: Electrical and Computer Engineering**

Safety Plan: v0.1

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This document outlines the safety plans for maintenance and operation of LFEV systems. The appropriate section of this document must be present and read before work begins on any component listed in this document.

08

**Fall**

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# General Requirements

## Participation

The guidelines laid out in this document apply to all students involved with the Lafayette Formula Electric Vehicle (LFEV) project. All students must agree to and comply with all restrictions described in this document. Students may not grant access to any system listed in this document to any person not directly involved in the LFEV project.

## Documentation

This safety plan and all included test procedures will be archived on the course website. The hardcopy found with the documents in AEC room 400 shall be the definitive revision of the document. This copy of the document must be read and understood by all participating students.

## Changes

All students involved in the LFEV project will be notified of any and all revisions to the safety plan before the revised plan goes into effect. The definitive copy of this document in AEC room 400 must be replaced with every new revision, and any participant in the safety plan must review and agree to comply with all alterations to the document.

# Design requirements

## References

All systems designed for the LFEV project must adhere to the safety guidelines in

GPR005 of the 2017 LFEV Statement of Work and the referenced 2017 SAE Formula Hybrid Rules. All designs must be peer reviewed and specifically verified to follow the safety guidelines established in these documents.

# Equipment guidelines

## TSV packs

The TSV pack must be kept in the designated high voltage area while energized with more than one cell. All work on an energized TSV pack must be done within this area, following the operating procedures laid out in this document.

Charging with the low current port may be done only with the TDK Lamda charger. Charging is limited to 20 A and 30 V.

Charging and discharging through the low current port may be done only in an environment cleared of other materials. No person shall stand or sit within 2 meters of the accumulator or load except as is necessary to connect/disconnect a cable, or interact with the control panel. Such interaction will be limited to what is necessary to complete the test.

Discharging of the accumulator through the high current ports may only be done in an environment cleared of other materials. Discharging will be done through the Transistor Devices load or the motor. No person shall stand or sit within 2 meters of the accumulator or load except as is necessary to conduct the test. This boundary shall apply once (and as long as) the load is connected to the accumulator.

The TSV pack must be kept in the designated high voltage area while energized with more than one cell. All work on an energized TSV pack must be done within this area, following the operating procedures laid out in this document.

## Tractive System Interface

Do not connect unapproved cables or components to the TSI. The TSI may only be operated in the designated high voltage area when energized above 30 volts, or directly connected to one or more packs. All work on an energized TSI must be done within this area, following the operating TSV Pack procedures laid out in this document.

## Dynamometer

The Dynamometer may only be operated in AEC room 401, following the operating procedures laid out in this document. Maintenance may be performed on any component as long as the system is not energized.

These steps must be taken every time room 401 is to be energized:

1. Make sure all moving parts have nothing obstructing them

2. Have authorized personnel (Professor Nadovich) energize the system.

3. Once High Voltage is available in the room, it must be vacated

4. An emergency stop button inside the doorway of AEC 401 is available if communication with the throttle or power supply is lost.

# Component Selection

## TSV

### Wires

Wires that carry charge current are selected at 2/0 AWG. According to Formula Hybrid appendix E this can take 300A continuously. PCB traces from the power connector to current sensing resistor are augmented with copper braid. High current wires are 0.5 in by 1 in aluminum bars with a calculated maximum current of 838 A at 40 degrees C over ambient. This statistic was taken from last year.

### Connectors

Anderson Power connectors for the accumulator are chosen for charging, with continuous current ratings of 26 A or greater. TE Connectivity connectors are chosen for connecting charging current to PacMan. They are rated for 35 A continuous current. Fuse holders and fuses on the charging wires are rated for 25 A. The high current fuse is a 200 A fuse that melts after 150 sec at 350 A. ITT Cannon connectors were chosen for high current output connectors. They are rated for 400 A continuous current.

### Other components

The charge relay on PacMan is rated for 20 A continuous current. The current sensing resistor on PacMan is rated for 1 W. 20 A through the 1 mOhm resistor will dissipate 400 mW. The AIR relay is a Gigavac relay rated for 350 A continuous current.

## TSI

No components have been explicitly specified for TSI yet. Before any high voltage tests happen with TSI the relevant parts must be approved.

# Operating Procedure

Any work involving the components listed in this section must follow the procedures listed below. If any component not listed has components that exceed 30 volts but has no procedure listed below, a safety plan must be developed and listed before any work can be done on the system.

## Opening the Packs

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| Process Restrictions |
| **Restricted Spaces** |
| 1. Only people working directly with the pack may be within the HV area |
| 1. No nonessential objects on the same surface within 1 meter of the TSV Pack |
| 1. No more than 3 people may work on the TSV Pack at any given time |
| **Safety Manager** |
| 1. A safety manager must be appointed to ensure safety practices are followed |
| 1. They must remain outside the HV area, with a direct view of the work |
| 1. They must wear safety glasses at all times, and must carry a cell phone |
| **Equipment** |
| 1. All tools used inside the TSV Pack must be insulated |
| 1. Only cotton or wool clothing may be worn when working in the HV area |
| 1. Safety glasses must be worn at all times while working in the HV area |
| 1. No metal finger rings or loose metal jewelry are allowed in the HV area while work is being performed |

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| Process |
| **Opening the Pack** |
| 1. Approve Plan of Action with qualified instructor |
| 1. Appoint safety manager |
| 1. Clear high voltage area of non­participating personnel |
| 1. Clear TSV Pack work area |
| 1. Proceed with approved plan of action |

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| WARNINGS |
| Do not connect the TSV Pack to anything outside of the high voltage area |
| Only one loose cell may be outside of the HV area or room 401 at any time |
| There must be an emergency stop reachable from outside of the HV area |

## Operating the Packs

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| Process Restrictions |
| **Restricted Spaces** |
| 1. Only one person, working directly with the pack, may be within the HV area |
| **Safety Manager** |
| 1. A safety manager must be appointed to ensure safety practices are followed |
| 1. They must remain outside the HV area, with a direct view of the work |
| 1. They must wear safety glasses at all times, and must carry a cell phone |
| **Equipment** |
| 1. Only cotton or wool clothing may be worn when working in the HV area |
| 1. Safety glasses must be worn at all times while working in the HV area |

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| Process |
| **Charge\*/Discharge** |
| 1. Approve Plan of Action with qualified instructor |
| 1. Appoint safety manager |
| 1. Clear high voltage area of non­participating personnel |
| 1. Clear TSV Pack work area |
| 1. Connect pack to power supply or load |
| 1. Activate power supply or load |
| 1. Monitor charge\*/discharge |
| 1. Deactivate power supply or load |
| 1. Disconnect pack from power supply or load |
| \*During charge, the safety manager may give the position to another person. This person must acknowledge the responsibilities before taking the role |

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| WARNINGS |
| Do not connect the TSV Pack to anything outside of the high voltage area |
| There must be an emergency stop reachable from outside of the HV area |

## Running the Dynamometer

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| Process Restrictions |
| **Restricted Spaces** |
| 1. No one may be in room 401 while the dynamometer is being operated |
| **Safety Manager** |
| 1. A safety manager must be appointed to ensure safety practices are followed |
| 1. They must have a direct view of room 401 |
| 1. They must wear safety glasses at all times, and must carry a cell phone |
| **Equipment** |
| 1. No equipment should be used in room 401 when the Dynamometer is running |

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| Process |
| **Startup** |
| 1. Approve Plan of Action with qualified instructor |
| 1. Appoint safety manager |
| 1. Clear dynamometer of loose tools or other obstructions |
| 1. Clear room 401 of people |
| 1. Have a qualified instructor untag and unlock the power supply switch |
| 1. Turn on power supply (but do not activate) |
| 1. Set warning tape across the room 401 door |
| 1. Begin running tests from remote computer interface |
| **Shutdown** |
| 1. Shut down power supply output remotely |
| 1. Remove room 401 warning tape |
| 1. Turn off power supply |
| 1. Have qualified instructor retag and relock power supply switch |

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| WARNINGS |
| Only a qualified instructor may untag and unlock the power supply switch |
| Ensure the power supply switch is tagged out before performing any work |
| The motor should never be operated with an individual in the same room |
| There must be an emergency stop located outside of the danger zone |

# Revision history

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| Date | Initials | Version | Changes |
| 2017-02-13 | GF | v0.1 | Initial draft |
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