

# CNSI Innovation Workshop and Microfluidics Lab Battery Segment Manufacturing & Assembly Safe Operating Procedures

Last Updated: 5/15/23 Jason

This SOP provides a guide to safely manufacture and assemble battery segments of the GR23 electrical vehicle. Some of the information is compiled from the following sources.

- [Electrical Insulating PPE Guide](#)
- [NFPA 70E PPE](#)

## Location

Battery assembly should take place on one of the workbenches in the Innovation Workshop in Elings 2442.

## Overview

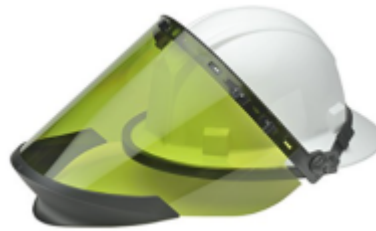
- Safety considerations, how they can occur, and how to avoid electrical accidents
- Battery segment design
- Necessary materials, tools, and equipment
- Machining of insulation panels
- Assembly of Enepaq modules within insulation

## Safety Considerations

- Electrical shock & arc flash
  - There are two primary ways that direct current electrical injury can occur:
    1. Body completing the loop in a high voltage circuit (touching positive and negative terminals of a high potential battery segment)
    2. Non-insulated tool or a conductive material completes the circuit in a medium to high voltage circuit, generating an explosive arc that can produce intense heat
- Electrical Insulating PPE
  - Referencing this [Electrical Insulating PPE Guide](#) and [NFPA 70E PPE](#), working with electric potentials between 50-750VDC (GR23 battery segment is 110V max voltage, entire battery pack is 546V max voltage) requires:

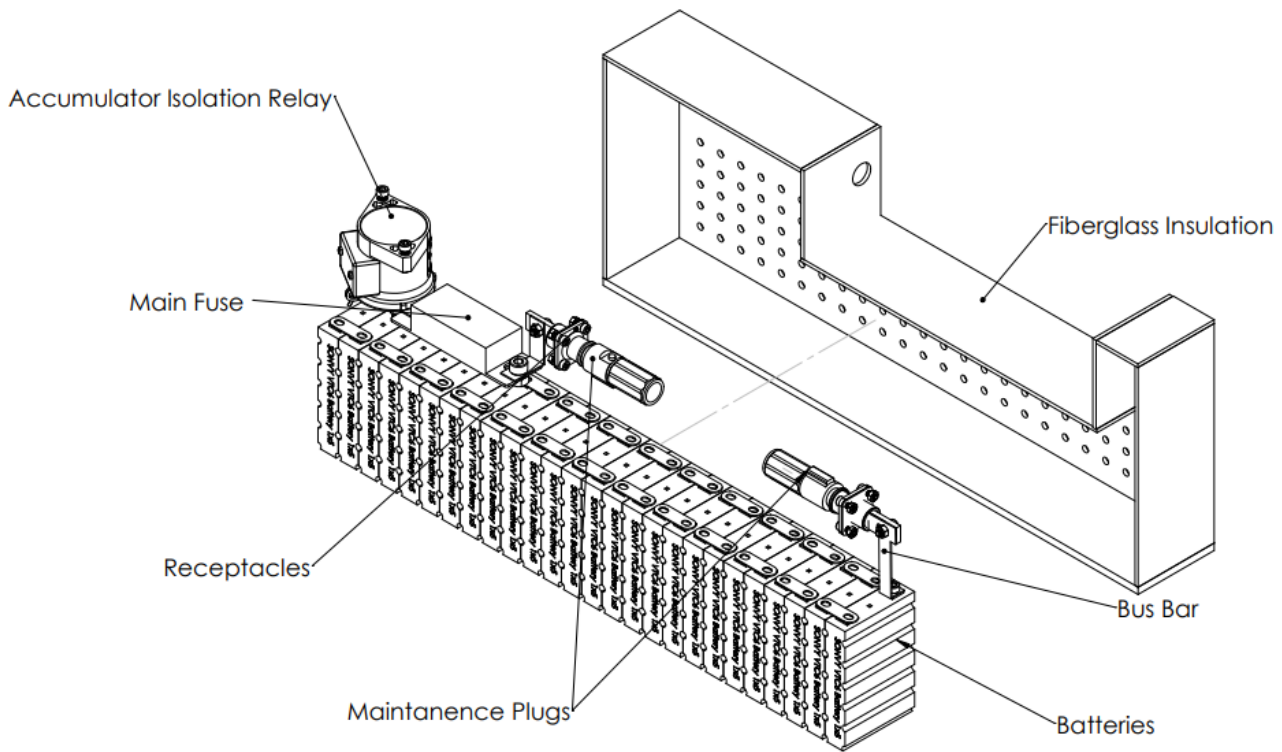


- electrically insulating class 00 gloves
- nonconductive safety glasses
- [insulated tools](#)
- long sleeve shirt & pants
- closed toed shoes
- [electrically insulating mat](#)



- arc-flash face shield
- Workspace
  - As mentioned above, ensure that no non-insulated tools can fall across battery terminals or be accidentally used (remove all non-insulated tools that are magnetically attached above the workbench)
  - Workspace and ground should be covered with electrically insulating mats
  - No machining of metals should occur while battery segment terminals are exposed
- Machining Fiberglass
  - Machining fiberglass can produce fine resin and glass particles that can be harmful if inhaled
    - Keep particles contained in CNC router enclosure
      - Use vacuum attachment
    - Wear masks
    - Wipe up particles often

## Battery Segment Design



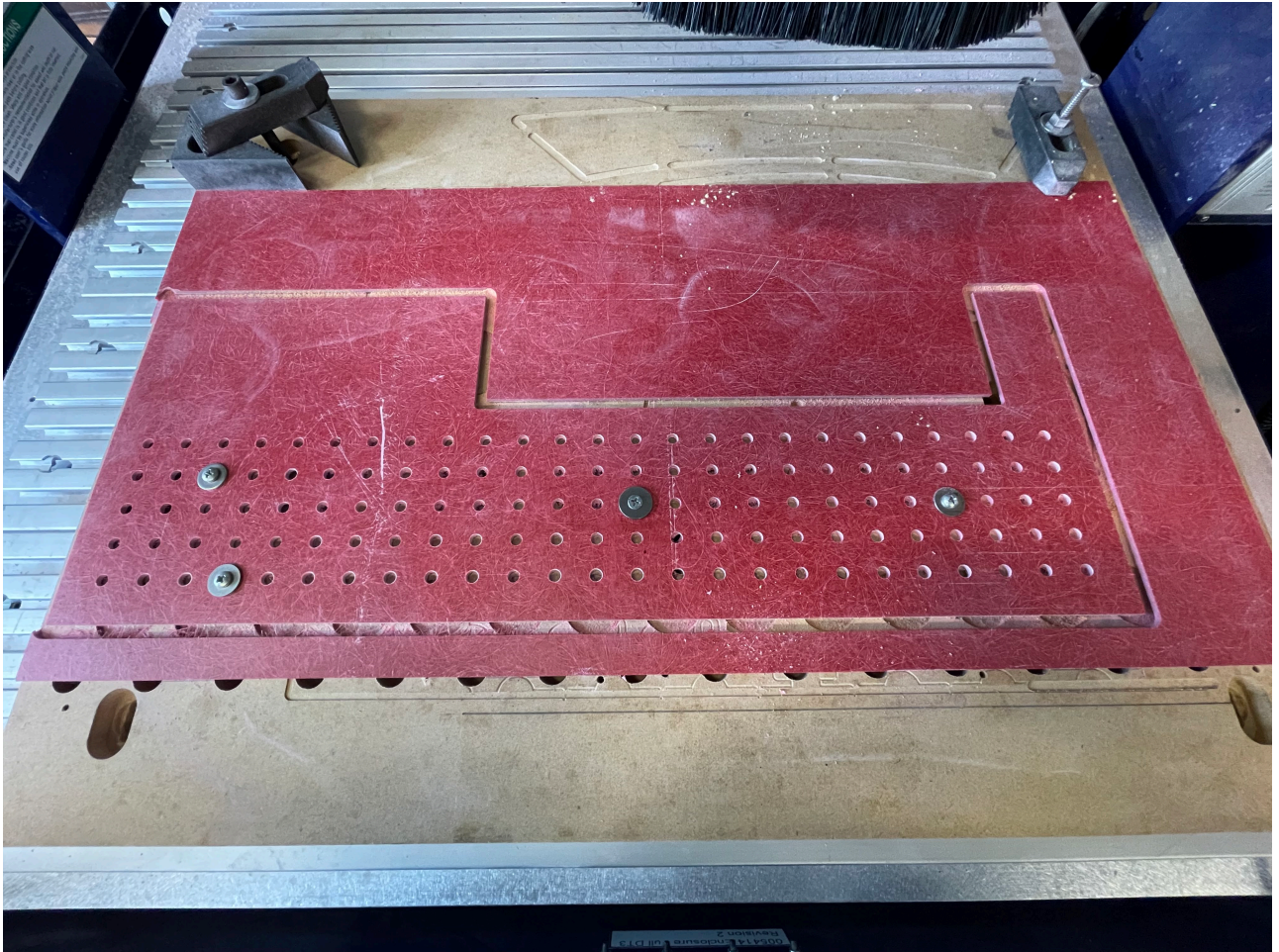
26s5p li-ion cells per segment comprised of Enepaq 1x5p Sony VTC6 modules

## Necessary Materials, Tools, and Equipment

- Electrical Insulating PPE
  - Referencing this [Electrical Insulating PPE Guide](#) and [NFPA 70E PPE](#), working with electric potentials between 50-750VDC (GR23 battery segment is 110V max voltage, entire battery pack is 546V max voltage) requires:
    - electrically insulating class 00 gloves
    - nonconductive safety glasses
    - insulated tools
    - long sleeve shirt & pants
    - closed toed shoes
    - electrically insulating mat
    - arc-flash face shield
- Drill bits & end mills for insulation panel machining
- Epoxy for assembling panels
- Wires & solder

## Machining of insulation panels

1. Fixture panels, program cam, and set up tools on ShopBot Router referencing [ShopBot SOP](#)



- Set up vacuum attachment and wear masks to minimize inhalation of fine fiberglass particles
2. File edges of panels to remove sharp glass fibers

## Assembly of Enepaq modules within insulation

1. Use epoxy to bond base and side panels of segment
2. **Wear proper PPE (listed in safety considerations section); those without PPE should remain five feet away** and connect modules together using bolts and busbars
  - **Cover work surface and ground with electrically insulating mat and use insulated tools**
  - Attach voltage taps under bolt heads using solder if necessary (onto copper washers)
  - Attach temperature sensing wires to module xr connector
3. Route wires through holes in top panel
4. Bond top panels to enclose segment

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