



Linda Chen <lc28@princeton.edu>

EHS Approval Process of HV Batteries

13 messages

Linda Chen <lc28@princeton.edu>

Thu, Oct 26, 2023 at 8:00 AM

To: Stanley Howell <schowell@princeton.edu>, Madison Hutchinson <mh0168@princeton.edu>

Cc: David Radcliff <radcliff@princeton.edu>, Daniel Simone <dsimone@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>

Hello,

My name is Linda, one of the officers of [Princeton Racing Electric](#). We are a student-led engineering project team that designs, builds, and races EVs in an intercollegiate competition called [Formula Hybrid + Electric](#). For our next generation vehicle, we plan on upgrading our battery to be 540V nominally. In order for us to be able to safely test our parts, we would like to work with you to develop robust safety regulation and equipment in place to help prepare us for this transition to a high voltage battery, which also includes a high voltage/powered tractive and charging system for the car.

Due to the complexity of the matter, I would love to set up a meeting to discuss how the university can support us and how we can start this process. Please reply to this email on suggestions with a time and location to meet.

I am more than happy to answer any questions or concerns you may have, and look forward to working with you!

Sincerely,
Linda Chen

Stanley C. Howell <schowell@princeton.edu>

Thu, Oct 26, 2023 at 8:51 AM

To: Linda Chen <lindachen@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>

Cc: "David E. Radcliff" <radcliff@princeton.edu>, "Daniel J. Simone" <dsimone@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>

Hello Linda,

Thanks for reaching out about this plan to upgrade the battery system on the PRE vehicle. Let me know if you can send over some cut sheets of the battery and charging system you are considering. Infrastructure considerations will typically be driven by the type of battery, charge capacity, charge density, and quantity of batteries as well as the electrical considerations of the charging system (that will need to be a UL-listed or NTRL-tested charging system). If this is adapting an commercial EV battery platform (I recall earlier discussions suggesting that Tesla battery modules were being considered), this should be fairly straightforward as the manufacturer should already be implementing the industry-standard safe-design practices. User safety considerations will largely track with the infrastructure considerations, but at 540V arc fault protection will likely need to be addressed.

Once we have a better sense of the battery system being considered, It would be helpful to find a time for a more detailed discussion.

Regards,

Stanley Howell, Ph.D.

Program Manager for Chemical Safety

Environmental Health and Safety

Princeton University

P: (609) 258-2711

E: schowell@princeton.edu



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David E. Radcliff <radcliff@princeton.edu>

Thu, Oct 26, 2023 at 8:53 AM

To: "Stanley C. Howell" <schowell@princeton.edu>, Linda Chen <lindachen@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>

Cc: "Daniel J. Simone" <dsimone@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>

Although all these students are ECE, I have no involvement PRE or any other student groups.

Radd

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Linda Chen <lc28@princeton.edu>

Fri, Oct 27, 2023 at 10:46 AM

To: "Stanley C. Howell" <schowell@princeton.edu>

Cc: "Daniel J. Simone" <dsimone@princeton.edu>, Linda Chen <lindachen@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>

Removing Ratcliff from cc.

Hi Stanley,

Attached to this email are the following things:

- Datasheet on the cells inside of the 540 V battery, they are 21700-P42 Molicels and were donated to us by Tesla
- Presentation on our Powertrain design
- As for the charger, most collegiate electric vehicle teams use the Elcon ([HK-LW-540-12](#)) or the [Dilong DA3K3M17-540CA](#). I personally was planning on designing a custom charger as my senior thesis, but may pivot my thesis to focus on adding on a more robust safety loop and firmware/controls with an already IP rated off-the-shelf part, so I would love have your input.

Let me know if you need anything else from me!

Sincerely,
Linda

2023-04-03 - LC - MK3 Powertrain PDR

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INR21700P42A-V4-80092.pdf

448K

Linda Chen <lc28@princeton.edu>

Tue, Oct 31, 2023 at 8:46 AM

To: "Stanley C. Howell" <schowell@princeton.edu>

Cc: "Daniel J. Simone" <dsimone@princeton.edu>, Linda Chen <lindachen@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>

Hi Stanley,

Hope all is well! Just wanted to follow up on what your thoughts were on the design of the high voltage system, what our next action items are, and if there is anything else you need from me!

Sincerely,
Linda

Sent via [Superhuman](#)

On Fri, Oct 27, 2023 at 10:46 AM, Linda Chen <lc28@princeton.edu> wrote:

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Let me know if you need anything else from me!

Sincerely,
Linda

**2023-04-03 - LC - MK3 Powertrain PDR**

On Thu, Oct 26, 2023 at 8:51 AM Stanley C. Howell <schowell@princeton.edu> wrote:

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Regards,

Stanley Howell, Ph.D.

Program Manager for Chemical Safety

Environmental Health and Safety

Princeton University

P: (609) 258-2711

E: schowell@princeton.edu



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Stanley C. Howell <schowell@princeton.edu>

Tue, Oct 31, 2023 at 10:57 AM

To: Linda Chen <lindachen@princeton.edu>

Cc: "Daniel J. Simone" <dsimone@princeton.edu>, Linda Chen <lindachen@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>

Hello Linda,

Thank you for stopping by this morning to discuss the PRE HV batteries. I mentioned during the meeting a few docs that we would typically want to see for batteries, most of these docs are easily accessible from MoliceL. The attached UN and UL certificates would be good to keep on file and represent some of the key documents that Li-battery manufacturers should have readily available for their products (if they don't or are unwilling to furnish at least the UN test certificate – it behooves you to find another vendor). I do not see a problem for using these MoliceL batteries.

At first pass, I am not seeing too much information readily available on either the Elcon or Dilong chargers. If you have already been in communication with these vendors, see if they can provide some testing/certification info on their products. Ideally, the charger should already be UL-tested (or tested by another Nationally Recognized Testing Laboratory – NRTL). If not already tested, some indication of the standards to which the device has been constructed and tested can provide useful insight as to whether the device would pass independent NRTL testing (that would be required for this electrical device).

For battery storage, a proper lithium battery storage/containment device can be quite expensive. An intermediate storage option would be a metal job site or welder's box (these can typically be found 48"L x 24" D x 25-30" H for a few hundred \$). In the event of a fire, the non-combustible structure will help contain the fire. Box should be grounded to prevent a short accidentally energizing the metal box.

If there are design requirements outlined in the competition guidance, please send over a copy. Once we have had a chance to review, it would be helpful to have a follow-up meeting to let the PRE team discuss the design standards

that are being factored into the accumulator design. As mentioned during the meeting, there are a number of design standard (and industry standard practice) that are invoked when an ESS is designed for commercial/consumer applications – particularly for EV applications.

As the accumulator assembly moves forward, we will review the need for shock and arc-flash protection (and available PPE) and arrange a training session for anyone working with or around the energized ESS.

Feel free to reach out if you have any additional questions.

With regards,

Stanley Howell, Ph.D.

Program Manager for Chemical Safety

Environmental Health and Safety

Princeton University

P: (609) 258-2711

E: schowell@princeton.edu



From: Linda Chen <lc28@princeton.edu>

Sent: Tuesday, October 31, 2023 8:46 AM

To: Stanley C. Howell <schowell@princeton.edu>

Cc: Daniel J. Simone <dsimone@princeton.edu>; Linda Chen <lindachen@princeton.edu>; Madison Hutchinson <mhutchinson@princeton.edu>; Stephane Morel <sm3109@princeton.edu>; Tim Gubskiy <timgubskiy@princeton.edu>; Vivian Chen <vivianchen@princeton.edu>

Subject: Re: EHS Approval Process of HV Batteries

Hi Stanley,

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Sincerely,

Linda



Sent via [Superhuman](#)

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Removing Ratcliff from cc.

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Let me know if you need anything else from me!

Sincerely,

Linda

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2 attachments



2201-UN-INR21700P42A-ATC-R6A1RL3021-20190712.pdf
933K



MH27672-V2S5-Certificate-20190716.pdf
814K

Linda Chen <lc28@princeton.edu>

Tue, Oct 31, 2023 at 1:42 PM

To: "Stanley C. Howell" <schowell@princeton.edu>

Cc: Linda Chen <lindachen@princeton.edu>, "Daniel J. Simone" <dsimone@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>

Hi Dr. Howell,

Thank you for getting back to me and for approving the Molicels. My team and I are looking for ways to store the batteries properly.

I am also requesting the necessary certification and documentation for the chargers. However, from the website, there is the chance that they are unable to provide standard UL documentation or NRTL. While not as established as Molicel, they are the standard among collegiate EV racing teams to use for charging the batteries for their reliability. We have previously used an Elcon charger on our lower voltage (100V) battery system safety. I am more than willing to ask officials and other teams from the competitions to vouch for the charger. Would you be able elaborate on the exact specifications we should be asking the company to qualify ourselves? One idea would be to prioritize which UL requirements are deemed necessary and evaluate the charger ourselves through a teardown, but that would be the worst case.

EV racing teams compete in two competitions: **Formula Hybrid + Electric** and **Formula SAE Electric**. We design in rules compliance with Formula Hybrid + Electric since we compete in that competition, but also design to Formula SAE rules for further clarity and hope that we can eventually attend that competition (which is more competitive and has higher barriers for entry). The rules update each year, and I have attached both to this email thread. In the documentation the battery is referred to as the accumulator and most rules fall under the EV sections.

Please let me know whether I should coordinate with you or another person about setting up a timeline for reviewing the need for shock and arc-flash protection (and available PPE) and arrange a training session for anyone working with or around the energized ESS. Otherwise we will reach out to you once we have finalized on a design.

Let me know if you have any other questions or concerns. I am more than happy to answer them, and appreciate your support on this!

Sincerely,
Linda Chen
[Quoted text hidden]

2 attachments

 **FSAE_Rules_2024_V1.pdf**
1622K

 **2024 Formula Hybrid+Electric Rules_v1.2.pdf**
4100K

Linda Chen <lc28@princeton.edu>
To: Nathan Gage <ngage@princeton.edu>

Tue, Oct 31, 2023 at 10:21 PM

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2 attachments

 **FSAE_Rules_2024_V1.pdf**
1622K

 **2024 Formula Hybrid+Electric Rules_v1.2.pdf**
4100K

Linda Chen <lc28@princeton.edu> Thu, Nov 2, 2023 at 12:06 PM
To: "Stanley C. Howell" <schowell@princeton.edu>, Daniel Simone <dsimone@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Nathan Gage <ngage@princeton.edu>






[+Nathan Gage, another lead engineer, to the thread.]

Hi Dr. Howell,

I hope this email finds you well. Attached are the specification sheets and certifications from both chargers. When you have the time, please let me know if these certificates would suffice, or if this warrants a further discussion on approving the chargers and the high voltage system.

Sincerely,
Linda
[Quoted text hidden]

5 attachments

-  **Elcon M.2022.206.C78070.pdf**
40K
-  **Elcon 6.6kw_Spec Manual.pdf**
1731K
-  **Dilong ZKT-2103120700C-OBC_ D Series_CE-EMC.pdf**
779K
-  **Dilong ZKT-2103120699C_OBC_ D Series_CE-LVD.pdf**
761K
-  **Dilong DA3K3M17E-600C V1.0 Spec Manual.pdf**
2131K

Linda Chen <lc28@princeton.edu> Wed, Nov 8, 2023 at 2:13 PM
To: "Stanley C. Howell" <schowell@princeton.edu>, Daniel Simone <dsimone@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Nathan Gage <ngage@princeton.edu>

Hi Dr. Howell,

Just wanted to follow up on two action items:

- Whether you approve the Elcon or Dilong charger to be used for the 540 V system.
- Your thoughts of the safety regulation of the competition.
- Following up on the second point, any times you would be available to do a safety review with our team and the design.

Sincerely,
Linda
[Quoted text hidden]

Linda Chen <lc28@princeton.edu> Fri, Nov 10, 2023 at 10:05 AM
To: "Stanley C. Howell" <schowell@princeton.edu>, Daniel Simone <dsimone@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Nathan Gage <ngage@princeton.edu>

Hi Dr. Howell,

Just wanted to follow up and understand if you are currently available to discuss the design of the high voltage system. I completely understand if you are busy, so please let me know what would work best for you!

Sincerely,
Linda

Sent via [Superhuman](#)

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From: Linda Chen <lc28@princeton.edu>

Sent: Tuesday, October 31, 2023 8:46 AM

To: Stanley C. Howell <schowell@princeton.edu>

Cc: Daniel J. Simone <dsimone@princeton.edu>; Linda Chen <lindachen@princeton.edu>; Madison Hutchinson <mhutchinson@princeton.edu>; Stephane Morel <sm3109@princeton.edu>; Tim Gubskiy <timgubski@princeton.edu>; Vivian Chen <vivianchen@princeton.edu>

Subject: Re: EHS Approval Process of HV Batteries

Hi Stanley,

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Sincerely,

Linda

||

Sent via [Superhuman](#)

On Fri, Oct 27, 2023 at 10:46 AM, Linda Chen <lc28@princeton.edu> wrote:

Removing Ratcliff from cc.

Hi Stanley,

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Let me know if you need anything else from me!

Sincerely,

Linda

[Quoted text hidden]

Linda Chen <lc28@princeton.edu>

Wed, Nov 29, 2023 at 2:05 PM

To: "Stanley C. Howell" <schowell@princeton.edu>, Daniel Simone <dsimone@princeton.edu>, Madison Hutchinson <mhutchinson@princeton.edu>, Stephane Morel <sm3109@princeton.edu>, Tim Gubskiy <timgubski@princeton.edu>, Vivian Chen <vivianchen@princeton.edu>, Nathan Gage <ngage@princeton.edu>

Dear Dr. Howell,

On behalf of [Princeton Racing Electric](#) (PRE), I would like to invite you to attend our **MK3 Design Review on Monday, December 4th at 5:00-7:30 PM in Friend 006**. Our student-run team has been simultaneously building our 2024 competition vehicle, MK2B, and designing our 2025 competition vehicle, MK3. Before we finalize our designs and begin manufacturing for MK3 next year, we would greatly appreciate any technical feedback for our high-level architectural designs, especially with regards to the necessary safety considerations to get the design approved. Each presentation will be followed by an open Q&A session. From 6:30-7:10 pm we plan on discussing the high voltage architecture of the system. The schedule is as follows:

- 5:00 PM** - Light Dinner Reception (in Lower Atrium outside Friend 006)
- 5:30 PM** - "Overview of PRE & MK3 Vehicle Design" *Presenter: Vivian Chen '25*
- 5:35 PM** - "Chassis Design" *Presenters: Alexander Haywood '24 and Noah Stein '25*
- 5:55 PM** - "Vehicle Dynamics" *Presenters: Sullivan Meyer '24, David Fu '25, and Noah Stein '25*
- 6:25 PM** - Break
- 6:30 PM** - "High Voltage Architecture" *Presenters: Stephane Morel '25 and John Matters '26*
- 6:50 PM** - "Battery Design" *Presenter: Stephane Morel '25*
- 7:10 PM** - "Custom AC Battery Charger Design" *Presenter: Linda Chen '24*
- 7:20 PM** - "Vehicle Control Unit Architecture" *Presenter: Daniel Simone '24*

Please let us know if you will be able to attend by **December 1st**, even if you can only partially attend. If you are attending the dinner reception and have any dietary restrictions, please let me know. If you are unable to attend, please let us know if you would still be interested in invitations to future design reviews, touring our garage, or other PRE events.

If you have any other questions or concerns, I would be happy to answer them. Thank you so much for your time and consideration.

Best regards,
Linda

Sent via [Superhuman](#)

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Reminder <reminder@superhuman.com>
To: lc28@princeton.edu

Thu, Nov 30, 2023 at 8:00 AM

Reminder returned

Go to Superhuman 