TO: LFEV Team

FROM: Drew Jeffrey

DATE: 10 May 2014

SUBJECT: TSV/AIR FEV Compliance Memo

ABSTRACT:

This memo details how the analysis requirements relating to the TSV and AIRs have been met in our system's final design. This document outlines how requirements EV 3.3.7, EV 4.5.11, EV 4.9.2 and EV 5.1.1 have or have not been met by the current design.

REQUIREMENTS:

EV 3.3.7 - The accumulator voltage indicator (see EV3.3.6) must be directly controlled by voltage being present at the connectors using hard-wired electronics. (No software control is permitted). Activating the indicator with the control signal which closes the Accumulator Isolation Relays (AIRs) is not sufficient.

The current pack design does not have an accumulator voltage indicator on it, so this requirement will not be met by our current pack. However, to meet this requirement and all others which require use of the accumulator voltage indicator, all that needs to be added to the current pack is an analog voltage meter which can measure between the poles of the pack and be attached to the side of the pack for viewing.

EV 4.5.11 - All tractive system connections must be designed so that they use intentional current paths through conductors such as copper or aluminum and should not rely on steel bolts to be the primary conductor. The connections must not include compressible material such as plastic in the stack-up.

The discharge path of our battery pack has been designed to eliminate joints and reduce the overall resistance. Most of the usage of steel bolts is attaching the aluminum conductive bars to each battery cell. At each terminal of the battery cell, there are 4 M4 screws. The screws combined have a surface area of 50.3mm^2. The terminal pad (21.9mm * 21.9mm) has a total area of 479.4 mm^2. Since the steel bolts not only have a higher material resistivity than aluminum (6.9e-7 Ωm for stainless steel vs 2.82e-8 Ωm for aluminum) but also a much lower surface area of conduction, the resistance of the

steel bolts is much higher than the resistance of the aluminum bars on the battery terminals. As such, most of the current will flow through the aluminum as the primary conductor and not the steel bolts, so this requirement is met.

EV 4.9.2 - It is allowed to pre-charge the intermediate circuit for a conservatively calculated time before closing the second AIR. A feedback via measuring the current intermediate circuit voltage is not required.

No pre-charge circuitry is present in the current design of the battery pack, so this requirement does not pass. Other pre-charge related requirements were waived earlier in the project, but this one was not caught until now.

EV 5.1.1 - The shutdown circuit must directly carry the current driving the accumulator isolation relays (AIRs).

The safety controller is responsible for shutting down the system whenever the safety loop is broken. The safety controller produces a 24V signal which is attached directly to the AIRs within each accumulator container. The 24V signal is removed whenever the safety loop is broken which will then cause the AIRs to open and the system to shutdown, meeting EV 5.1.1.