National Transportation Safety Board

Office of Highway Safety

Washington, DC 20594

FACTUAL REPORT OF INVESTIGATION - HAMDEN, CONNECTICUT
HWY22FH011

REPORT OF INVESTIGATION

July 12, 2023

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A. INCIDENT

Location: Hamden, Connecticut

Date: July 23, 2022

Time: 0339 EDT

0839 UTC

Transit Bus: 2021 New Flyer Xcelsior Battery Electric Transit Bus

B. PARTY MEMBERS

Group Chair / IIC	Brian Bragonier National Transportation Safety Board Washington, DC
Party Coordinator	Sergeant Paul Makuc Connecticut State Police Hartford, Connecticut
Party Coordinator	Garrett Eucalitto Connecticut Department of Transportation Hartford, Connecticut
Party Coordinator	Robert Staff First Transit Management Hamden, Connecticut
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C. SUMMARY

On Saturday, July 23, 2022, at about 3:39 a.m. eastern daylight time, a 2021 New Flyer Xcelsior battery electric 40-foot transit bus, operated by CT Transit, began emitting smoke from the rear compartment while parked inside a maintenance facility in Hamden, New Haven County, Connecticut.[1]

The bus's electric battery had previously been charged on Wednesday July 20, but the bus failed to power up when the ignition was turned on the morning of July 21st. As a result, the bus was placed out-of-service and stored in the maintenance facility to await warranty service by the bus manufacturer.

The event began 2 days later, on July 23rd, when CT Transit maintenance personnel observed smoke and heard crackling and hissing coming from the rear of the bus. A timeline of the sequence of events is provided in Section D of this report. A maintenance technician called the Hamden Fire Department, who responded to the scene. Upon their arrival, fire department personnel did not observe any visible flames, and the bus was pushed to the maintenance facility's parking lot using a service truck, where the bus was isolated from other vehicles and structures. As a result of relocating the bus, two CT Transit maintenance workers were transported to an area hospital where they were treated for smoke inhalation.

Later that day, at about 7:32 a.m., the Hamden Fire Department responded to another call to the maintenance facility as the bus was again emitting smoke, and fire was observed coming from the rear of the vehicle. The fire commander decided to let the bus burn in the controlled environment. The fire remained active for several hours and fully consumed the vehicle (figure 2). Following the departure of fire personnel, the bus continued to smolder while remaining isolated in the parking lot.

On Monday, July 25, 2022, 2 days after the initial event, smoke and an orange glow were observed emanating from the right rear wheel well of the burned bus. The Hamden Fire Department (HFD) responded and extinguished the hot spot.

D. DETAILS OF THE INVESTIGATION

1.0 Emergency Response

Timeline of Events (more detail in subsequent sections):

[1] CTtransit is the Connecticut Department of Transportation (CTDOT)-owned bus service.

July 23, 2022

3:39a.m. – CT Transit maintenance personnel notice the bus "popping and smoking"

3:40a.m. – 3:43 CT Transit facility evacuated and HFD called

3:44a.m. – HFD receives the alarm

3:49a.m. – HFD arrives

3:50a.m. – 4:08a.m. – Buses surrounding the involved bus are moved by CT Transit maintenance personnel

4:09a.m. – At the direction of the HFD, the involved bus is removed from building by CT Transit maintenance personnel using a service truck to push it.

4:35a.m. – HFD clears the scene

7:30a.m. – HFD called back to the scene for bus fire

7:34a.m. – HFD arrives, bus fully involved.

3:30p.m. – Last HFD unit clears the scene

July 25, 2022

3:31a.m. – HFD called back to CT Transit facility

3:37a.m. – HFD arrives and applies water to a hotspot on the bus

3:57a.m. – Last HFD unit clears the scene

1.1 Connecticut State Police

A Connecticut State Police (CSP) Detective from the Fire and Explosion Unit arrived on scene at 10:30 a.m. It was determined that the state police would take the lead on the investigation. Sergeant Makuc, Commander of the Fire and Explosion Unit, arrived at 11:00 a.m.

CSP placed the burned bus and all additional battery electric transit buses (BETBs) into evidence on the day of the fire. Subsequent inspections and meetings regarding the BETBs were coordinated by the CSP with input from interested parties such as CT Transit, New Flyer and the NTSB.

CSP gathered documentation regarding the manufacture and maintenance of the BETBs and interviewed maintenance personnel involved.

1.2 Connecticut Department of Transportation

Connecticut Department of Transportation (CTDOT) was notified of the incident at 4:57 a.m. A CTDOT representative arrived on scene at 8:30 a.m. with additional personnel arriving at 9:45 a.m.

1.3 CT Transit

Maintenance personnel noticed smoke and heard popping noises from bus #2102 at 3:39 a.m. Due to smoke, they were unable to switch the power to the bus off using the battery disconnect located in the engine compartment. The Hamden Fire Department (HFD) was then notified, and the building was evacuated.

Upon arrival, the HFD recommended removing the bus from the building. Several additional buses were parked in front of and to the rear of the smoking bus, #2102. CT Transit staff moved all surrounding buses, and at 4:09 a.m., 2102 was pushed out of the building by a service technician using the front bumper of a service truck aligned with the rear bumper of the bus. The bus was then parked outside in an area of the parking lot approximately 100-feet from the building and not in the vicinity of fuel tanks. There was a wooded area with a pond on the east side of the bus and open parking lot to the north, west and south sides of the bus.

At approximately 7:20 a.m. on July 23rd, a CT Transit employee arriving for work noticed smoke coming from the rear parking lot where the bus was located. Upon investigation it was discovered that a fire had ignited at the rear of the bus. The HFD was again called to the scene.

On July 25th, a maintenance employee of CT Transit noticed that smoke as emiting again from the bus and the fire department was called at 3:30a.m. The HFD responded and extinguished the fire.

1.4 Hamden Fire Department

The Hamden Fire Department was notified of the first incident, smoke emanating from the rear of a transit bus, at 3:44a.m. and arrived on scene at 3:49a.m. Upon arrival, the fire department advised CT Transit they should remove the bus from the building. CT Transit staff pushed the bus out of the building, and the fire department cleared the scene at 4:35 a.m. after seeing no additional smoke or fire activity.

At 4:45 a.m., Hamden Fire/EMS was called by CT Transit to return to the scene facility to evaluate two CT Transit personnel exposed to smoke inhalation during the bus removal process. Both were transported to the hospital for further evaluation.

At 7:32 a.m., HFD was notified by CT Transit that the bus had flared back up and was fully involved. Two fire engines were dispatched and upon arrival, it was determined that the battery cells were burning. The on-scene incident commander had previously received CT Transit/New Flyer first responder BETB training. An assessment was made that since there was no danger to structures, they would use a defensive mode of firefighting, meaning that they would allow the bus to burn in a controlled manner. Due to concerns about toxic runoff affecting a nearby water source, the fire department limited the use of water and diked storm drains to limit runoff. Connecticut Department of Energy and Environmental Protection responded, tested the water runoff and determined it was not hazardous. The dikes were then removed, and the water drained from the area.

After the majority of the bus had burned, an attempt was made to extinguish the remaining fire. The rear of the bus, where two of the six energy storage systems (ESS) were located, continued to flare up for the next several hours. After the fire was stabilized, the HFD cleared the scene leaving a small crew to watch for additional flare ups. At 8:30 p.m., no flare ups had been seen for five hours and the fire watch was ended. CT Transit agreed to have one of their personnel check on the bus regularly.

On July 25, 2022, at 3:31a.m. the HFD again responded to the maintenance facility for a report that CT Transit personnel had seen the rear battery area of the bus smoldering. Approximately 15 gallons of water were applied to the smoldering area and the fire department cleared the scene.

2.0 CT Transit

2.1 Organization

CT Transit was the Connecticut Department of Transportation (CTDOT) owned bus service. Several companies were under contract with CTDOT to operate transit services in metropolitan areas throughout Connecticut.

HNS Management, a subsidiary of First Transit, was the company under contract to manage CT Transit for CTDOT in the Hartford, New Haven and Stamford Divisions. CT Transit was New England's second largest public transit system with a total fleet of almost 600 buses. HNS employed over 1,500 bus operators, maintenance employees, and administrative personnel and served over 27 million

passengers annually. Most of the employees at the facility located in Hamden worked for HNS Management.

2.2 Facility

The building located at 2061 State Street in Hamden, Connecticut served as one of the maintenance facilities for CT Transit. Buses were serviced, fueled, charged, and stored here. Also housed in this building were some of the administrative offices for HNS Management.

This was the first CT Transit facility to have electric vehicle charging infrastructure established. This includes new electrical equipment to accommodate increased electrical loads, and upgrades to existing fire suppression systems such as pumps capable of handling larger volumes of water.

At the time of the fire, the facility had 10 ABB branded charging stations for BETBs installed. NTSB investigators were told by staff that only 5 stations could be used at one time due to electrical grid constraints. ABB is a provider of electric vehicle charging infrastructure.

2.3 Battery Electric Bus Program

The BETBs were first received by CT Transit in September 2021. The buses began revenue service for CT Transit in Hamden by January 2022. At the time of this incident, there were 12 BETBs in service. An additional 49 buses are currently on order. The funding for the initial purchase of 12 buses came from a combination of Federal Transit Administration (FTA) funds, state matching funds and money from a trust administered by the Connecticut Department of Energy and Environmental Protection (CTDEEP). The 12 BETBs in service at the time of the event were purchased from New Flyer through a competitive bid process. ABB is supplying the charging equipment. The stated goal for CT Transit is to have all 600 buses electric in the next 12 years, by 2035.

Additional funding to upgrade the facilities was provided by the FTA through a bus and bus facilities program grant. The Hartford and Stamford maintenance facilities were scheduled for upgrades to enable BETB servicing.

2.4 Federal Transit Administration

The FTA's Public Transportation Agency Safety Plans (PTASP) regulation (49 CFR Part 673), requires an agency's Safety Risk Management process to identify hazards and the consequences of hazards, establish methods and processes to assess the safety risks associated with identified safety hazards, and to develop and monitor the effectiveness of safety risk mitigations. These measures could address the

parking and storage of battery electric buses to reduce the possibility or severity of an accidental fire. Requirements regarding building fire mitigation, such as sprinkler systems, would be established by the local authorities, such as the State or local fire marshal.

The FTA does not require buses purchased with their funding to have onboard fire suppression systems, however, all buses purchased with FTA financial assistance are required to comply with NHTSA's FMVSS safety regulations. Although the FMVSS does not require fire suppression systems at present, a transit agency may, as part of its Safety Risk Management process, consider installing onboard fire suppression systems aboard its vehicles.

The FTA requires transit agencies to develop a comprehensive safety training program for all employees and contractors who are directly responsible for safety. This training program could include training specific to battery electric buses. Transit agencies serving an urbanized area with a population of 200,000 or more are required to include maintenance personnel in their safety training program.

FTA does not have specific guidance or requirements addressing BETB specific training due to the wide range of products in the marketplace. However, transit vehicle and component manufacturers routinely provide customer support to train operators and mechanics on how to safely use and efficiently maintain their particular products.

The FTA provides resources including the Low and No-Emission Vehicle Federal Technical Assistance Center jointly operated by the US Department of Transportation and Department of Energy. The Zero-Emission Fleet Transition Plan is available to applicants in the Grants for Buses and Bus Facilities Competitive Program. FTA also offers bus testing reports which provide information on the configuration of, and components used in battery-electric (and other) buses and document any safety and reliability issues that occur during testing.

FTA has funded research programs and projects to assist transit agencies transitioning to BETB fleets. For example, FTA's Transit Vehicle Innovation Deployment Center program established a resource center for transit agencies to learn about best practices in next-generation vehicle deployment and BETBs. FTA's Standards Development Program has completed research and studies in BETBs and expects to publish two reports soon, including a guidebook for deploying BETBs.

The FTA's Office of Program Oversight monitors recipients of FTA funding to ensure that vehicles, equipment, facilities, and components are kept in good operating condition. The FTA conducts triennial reviews to ensure that maintenance plans are reviewed, and maintenance records are inspected to verify that the

recipient is following its maintenance schedules and that preventive maintenance work is completed on time. For subrecipients of FTA funds, FTA requires that recipients monitor their sub-recipients for compliance.

2.5 Electric Vehicle Safety Training and Procedures

2.5.1 First Responders

New Flyer has provided CT Transit with Emergency Responder Guides (ERG) and a copy was stored behind the driver's seat on every BETB. This ERG included information on the location of each battery enclosure, and the location of all battery disconnects and high voltage interlock switches.

The ERG contains additional information regarding battery fires, fire detection, exposure hazards, battery spills, first aid measures, the fire suppression system, and a summary of how to fight lithium-ion battery fires. A list of the hazards associated with high voltage systems is also in the ERG.

CT Transit and New Flyer developed a training program to familiarize first responders with BETBs. The first three training sessions were held in January and February 2022, in Hartford, New Haven, and Stamford. Between the three locations, over 100 first responders attended the training. Fire Departments represented included Stamford Fire, Stony Hill Fire, Glenbrook Fire, Norwalk Fire, Wilton Fire, Hamden Fire, East Haven Fire, North Haven Fire, Cheshire Fire, Woodbridge Fire, Wallingford Fire, and Hartford Fire. In addition to the fire department personnel, first responders from several police departments attended. This training was intended to be a train the trainer program, and the attendees were expected to disseminate the information to others within their organization.

As noted above, the incident commander for the second fire response on July 23rd at 7:32a.m., for the fully engulfed BETB had received this in person training.

2.5.2 Transit Bus Operators

All CT Transit bus operators are provided with guides from New Flyer outlining the operating procedures of the BETB. Operators are also provided with a two-page BETB operating checklist which outlines the operation of the bus as well as emergency battery shutdown procedures. This includes the location of the high voltage interlock switch and the battery disconnect, along with a warning to ensure the orange high voltage cables are never cut. The checklist is also located in each BETB behind the driver's seat, along with the ERG. This BETB specific training is in

addition to emergency training given to all operators of any bus in the fleet. Each operator is required to acknowledge that this information was received.

2.5.3 Maintenance Personnel

Maintenance personnel are provided a 30-minute class on BETBs and what to do in an emergency. Only designated and trained maintenance personnel are permitted to charge the BETBs. Each day, a battery electric bus charge sheet is completed. Data on the sheet includes the number of the bus being charged, which charger they were connected to, the time they were connected, and the current state of charge. The mileage of the bus is documented as well as the employee identification indicating who plugged it into the charger. There is space to record any defects noted or make comments.

The New Flyer BETBs in the CT Transit fleet are currently under warranty. CT Transit personnel perform preventative maintenance and limited-service procedures on the buses, such as tire replacement. All repairs involving the electrical system of the bus are performed by New Flyer field service technicians in the CT Transit facility.

3.0 Vehicle

3.1 2021 New Flyer Xcelsior Battery Electric 40 Foot Bus

VIN[2]:	5FYB8FJ18MC076033
Unit:	2102
Traction Motor:	Siemens Electric Permanent Electromagnetic Motor
Rated Power:	282 HP (210 kW) @ 1500 rpm & 986 ft-lbs. (1337 Nm)
Control:	Arens 2nd Generation push buttons
Energy Storage:	6 Energy Storage System (ESS) Enclosures
Dimensions:	41′ length, 8′6″ width
Wheelbase[3]:	23′8″
Front Axle GAWR[4]:	15,000 lbs.
Rear Axle GAWR:	28,484 lbs.

[2] Vehicle Identification Number (VIN) is used by the automotive industry to identify individual motor vehicles

[3] Wheelbase measured from center of front axle to center of rear axle.

[4] Gross Axle Weight Rating (GAWR) is the maximum weight a given axle is designed to carry as specified by the manufacturer of the axle

GVWR[5]:	43,484 lbs.
Vehicle Weight:	33,570 lbs.
Suspension:	Air springs with shock absorbers, front and rear
Brakes:	Air disc brakes with ABS[6] and ATC[7] on all wheels

The bus was configured as a transit bus with a front entry door and a middle exit door, both on the right side. The bus has a driver seat with a 3-point lap/shoulder belt and fiberglass seating for 40 passengers with no seatbelts. The ESS battery enclosures were located on the roof (4), and at the rear (2). The electric motor drove the rear wheels.

3.1.1 Damage Description

The BETB sustained severe fire damage to all areas of the bus. All windows were missing, and the fiberglass cladding was consumed, exposing the steel frame of the bus. All tires were consumed leaving only the wheels. At the rear of the bus, the upper fiberglass door covering the heating and cooling (HVAC) system and the lower door covering the rear battery storage area were consumed, exposing the remnants of both the HVAC system and the batteries. **Figure 1** shows an exemplar bus and **Figure 2** shows the post-fire bus.

[5] Gross Vehicle Weight Rating (GVWR) is the total weight a vehicle is rated to carry as specified by the manufacturer

[6] Anti-lock Braking System

[7] Automatic Traction Control

Figure 1: Exemplar New Flyer Xcelsior as viewed from the left rear corner.

Figure 2: Burned New Flyer Xcelsior as viewed from the left rear corner.

3.1.2 Bus Battery

The New Flyer's energy storage system (ESS) is composed of six storage enclosures. There are two enclosures at the rear of the bus, and an additional four enclosures on the roof. The ESS enclosure is a sealed fiber-reinforced composite enclosure containing seven high voltage battery packs containing 24, 3.7-volt cells. The packs are connected in a series. The six enclosures are connected in parallel to build energy capacity. In addition to the battery packs, the enclosure contains other components used to control, monitor the batteries voltage, conduct thermal management, and eliminate moisture. The enclosures are all identical and interchangeable within the system. The ESS provides high voltage energy to the vehicle's propulsion system and electrically driven accessories.

3.1.2.1 Energy Storage System Specifications

The ESSs were located on the roof and rear of the bus as previously described. All ESS enclosures, were mounted in a flat position lateral to the bus.

Battery system:	Xalt Xpand
Battery model:	XMOD125E (HE) Gen3
System nominal voltage:	621.6 V
System capacity:	845 Ah
System total energy:	525 kWh
Cooling:	Liquid cooled
ESS enclosure weight:	1241 lb. (Each)

3.1.2.2 Fire Suppression System

When the CTDOT ordered the New Flyer BETBs, they specified that the buses be equipped with a Fogmaker automatic fire suppression system. CTDOT has previously added fire suppression on all orders for transit buses, electric or combustion engine driven buses.

The fire suppression system control panel is located over the driver's seat. While the system is designed to activate automatically even if the bus is not powered up, there is also a manual actuator switch on the panel, which allows the operator to initiate the discharge of the extinguishing agent, as well as system status indicators. Included in these are lamps that illuminate when the system is nominal, when service is required, and during active fire suppression. There is an alarm buzzer that will sound when extinguishing. A button located on the panel tests the operation of the indicator lights and the alarm. This will additionally reset the alarm.

There is a fire detector and multiple fire suppressant discharge nozzles in the rear ESS compartment. An extinguisher cylinder located in the interior bulkhead supplies the discharge nozzles. When the system activated, the cylinder will discharge an extinguishing agent to the area of the fire via the nozzles. The spray nozzles for this system are pointed towards the rear enclosures as well as forward toward the rear seats of the bus. The system is designed to cool the enclosures, protect auxiliary systems such as the HVAC system, and increase the amount of time passengers have to evacuate in the event of a fire.

The solution contained within the cylinder is a mixture of water, a foaming agent, and nitrogen gas propellant. This is the same solution in Fogmaker systems used on combustion engine buses.

Due to the fire damage sustained by the bus, it is undetermined if the suppression system engaged during this fire event.

3.2 Battery Investigation

3.2.1 Damage Description

All six fiber-reinforced composite ESS enclosures on the bus were partially or fully consumed in the fire, exposing some of the individual battery packs within. Two of the four ESS enclosures on the roof partially collapsed into the interior of the bus. The two partially consumed ESS enclosures on the rear of the bus remained in their steel mounting bracket. **Figure 3** shows the roof mounted ESS storage enclosures on an exemplar bus. **Figure 4** shows the same enclosures on the involved BETB post-fire. **Figure 5** shows the rear mounted ESS enclosures on the exemplar bus and **figure 6** shows the fire damaged rear enclosures.

Figure 3: Polyester and fiberglass energy storage enclosures on exemplar bus roof

Figure 4: Post-fire rooftop energy storage enclosures

Figure 5: Rear mounted energy storage enclosures on exemplar bus

Figure 6: Post-fire rear mounted energy storage enclosures

3.2.2 Battery Forensic Teardown

Post-fire, the bus remained in the parking lot of the Hamden CT Transit facility. On August 22, 2022, the rear ESS mounting bracket was exposed by removing the remaining fiberglass and door frames. The entire steel bracket containing both ESS's was then cut away from the frame of the bus and removed using a forklift. **Figure 7** shows the bracket containing the rear ESS containers upon removal from the bus.

Figure 7: Rear mounted ESS bracket after removal

The bracket was then placed in a container for storage and subsequent shipment to a laboratory in Natick, Massachusetts, along with an exemplar Xalt Energy XMOD 125E liquid cooled battery. Additionally, a damaged Siemens controller mounted on the roof of the bus was removed by a Siemens employee and transported to a laboratory in Natick, Massachusetts. No data was able to be recovered from the damaged controller.

On October 25 – 27, 2022 a laboratory examination of the rear batteries was conducted. This examination, along with additional testing and inspections indicated evidence of water or coolant damage in the ESS enclosure. After this laboratory examination was completed, the root cause investigation was transferred by the CSP Fire and Explosion Unit to New Flyer and Xalt for continued analysis.

Additional examinations did discover battery fault codes in two different ESS enclosures on two of the remaining BETBs. The Xalt fault code was #145, which indicated battery cell undervoltage. Due to this fault, these ESS's could not be used until the affected battery packs were replaced. Two additional batteries that had been seized as exemplar batteries for the forensic examination were ultimately used to replace the defective packs.

4.0 Post Event Activities

At the writing of this report, CT Transit is working with New Flyer to reintroduce the remaining 11 BETBs to service. They have revised BETB training protocols and standard operating procedures, providing additional training to first responders and and additional week of training to CT Transit maintenance personnel. They conducted 200-mile road tests using the remaining buses with additional battery monitoring. No problems were detected during this testing. Currently they are hoping for an August 1, 2023 soft rollout using the BETBs. Following is a summary of the work completed as of February 2023.

4.1 First Responder Training

After the fire, additional, enhanced training was provided to all local first responders in the Greater New Haven Area. The training material was provided by New Flyer. This training will be provided bi-annually on an ongoing basis.

4.2 Maintenance Training

An additional 40 hours of training was provided to maintenance personnel at all three CT Transit divisions. These training courses were taught by New Flyer instructors on how to diagnose and respond to problems within the different electric bus configurations, fault codes, and charging issues. A maintenance training curriculum and catalog was also compiled as a minimum standard of required training for all transit agencies in Connecticut. This will provide a baseline training minimum before deploying battery electric buses, as well as courses and exercises for continued training and development.

4.3 Operator Training

Working in collaboration with New Flyer, a more detailed training program was developed to further educate bus operators on BETB technology, optimum driving techniques, and emergency preparedness. The multimedium training program is comprised of classroom, physical demonstrations, employee handouts, and internal media campaigns. 30 CT Transit instructors participated in New Flyer's train the trainer program to obtain the necessary material and procedures to implement during relaunch training as well as new hire training for the CT Transit Operator Academy

4.4 Charger Training

The charger manufacturer ABB provided a 2-day training for DOT and CT Transit staff that covered specific details on the following topics: daily charger operations, charger trouble shooting, personal protective equipment (PPE), and safety procedures for working in and around charger cabinets and switchgears. Specific details were provided about the PPE required to work in the charger cabinets and switchgears.

4.5 Charging Strategy

A charging strategy was developed that focuses on a scaled deployment of BETBs. In the first phase, which would last 3 to 6 months, charging will be done in the daytime so that technicians are nearby and available to monitor the process. Buses will also be spaced out during charging with a maximum of 4 buses charging at any one time. A maximum of 2 to 4 BETBs will be on the road at any time.

4.6 Arc-Flash Training

Through collaboration with other agency partners as well as guidance from the manufacturers, CT DOT developed baseline tooling and PPE for the maintenance technicians working on the BETBs at CT Transit facilities. Diagnostic tools, Thermal Cameras, Arc-Flash personal protective equipment and insulated rescue hooks, designed to remove a person incapacitated by electrical shock from a hazardous location, are among the items to be procured for fleet maintenance personnel.

4.7 Battery Temperature

The New Flyer Connect system software program has been updated on the buses to send out automatic emails to CT Transit personnel when the battery temperature reaches a minimum threshold of 35°C/ 96°F.This preemptive battery temperature monitoring will occur while the bus is turned on (either driving or idle).

This system is designed to rapidly notify staffers of temperature irregularities in the battery system that could result in a potential safety issue. This is in addition to existing battery alert system already being displayed on the bus as shown below:

Condition	An Operator Will See	A Technician Will See
Any battery module temperature exceeds 35*C	Vehicle remains drivable, but with reduced available power	ESS Overtemperature Warning DTC will be visible when connected to the XALT Service Tool
Any battery module temperature exceeds 40*C	Amber HIGH BATT TEMP indicator displayed on dash. Vehicle remains drivable, but with reduced available power	Amber HIGH BATT TEMP indicator displayed on dash. ESS Overtemperature Alarm DTC will be visible when connected to the XALT Service Tool
Any battery module temperature exceeds 45*C	Amber HIGH BATT TEMP indicator displayed on dash. Vehicle power will fully derate and the vehicle will not be drivable	Amber HIGH BATT TEMP indicator displayed on dash. ESS Overtemperature Error DTC will be visible when connected to the XALT Service Tool Open contactor DTCs will be visible when connected to the XALT Service Tool

4.8 Energy Storage System Inspection

The remaining 11 BETBs in the CT Transit fleet have been stored outside in the parking lot, away from buildings, with approximately 15-feet of space between each bus since the incident. All six ESS enclosures on all buses were checked for signs of liquid contamination and none was found. All wires, cables, electronic equipment, sensors, and connections were also inspected in each ESS enclosure and no issues were discovered.

4.9 New Flyer

During the investigation of a subsequent BETB thermal event which occurred on a similar bus model that was parked at another operator's location, it was discovered there was liquid in the ESS. This liquid was confirmed to be coolant.

On February 15, 2023, New Flyer issued a recall notice (23V-083) for all 2021 – 2023 XE35, XE40, and XE60 buses. The defect noted that liquid may accumulate in the ESS and not be detected. While New Flyer was unable to determine the cause of the coolant leak, they are addressing the issue by, as an interim action, asking purchasers/operators to check the enclosures for liquid via the desiccant canister cap if the bus has been parked for more than three days. In addition, if coolant is added to the system, they are instructing maintenance to diagnose the leak and repair it rather than just top off the system with additional coolant. On May 3, 2023, owners were notified of a remedy involving adding four ports in each enclosure with automatic activating drain valves in each port. When liquid contacts the valve, the valve will open allowing the liquid to drain out. The valves are chemically-activated and the bus does not need to be operating or powered up for the valve to open. If a coolant leak has occurred that is significant enough to activate the valve, the driver

will be notified through warning lights on the dash. Valves must be replaced once they are activated, and a service technician will inspect the ESS to determine the cause of the activation when replacing the valve.

There have been recalls by other manufacturers for liquid in battery packs. In July 2022, Gillig, LLC recalled certain 2019 – 2022 low floor vehicles equipped with certain battery packs. It was discovered that the battery packs may develop a coolant leak internally, causing the battery pack to short circuit. Gillig's remedy for the issue is to tighten the coolant fittings and to replace the coolant.

In December, 2022, Proterra recalled certain 2017-2019 electric vehicles that have one or more Battery Packs that may allow liquid to leak into and accumulate in the Battery Pack enclosure. The remedy has not yet been finalized.

In April, 2023, Nova Bus (US) Inc recalled certain 2022-2023 electric buses where it was discovered the coolant line in the high voltage battery pack may not be fully seated and locked, which can result in the loss of coolant and an electrical short circuit. Nova Bus's remedy is to inspect and replace the battery packs as necessary.

E. LIST OF ATTACHMENTS

Attachment – National Fire Incident Reporting System (NFIRS) Reports
Attachment – CT Transit – Hartford Operator's Guide Xcelsior Electric 40FT Transit Bus
Attachment – New Flyer Xcelsior Electric Bus Check Sheet and Emergency Shut Down Procedure
Attachment – New Flyer Emergency Response Guide
Attachment – CT Transit Electric Bus Safety Pamphlet
Attachment – FTA Response to NTSB FTA Funding Questions

Submitted by:

Brian Bragonier

Lead Investigator