

CALACT 2023

Spring Conference & Expo

Presentation by

Jay Taylor



BUS FIRE

PREVENTION SPECIALISTS LLC

Over 50 years combined
experience in the Bus/Vehicle Fire
Protection Industry.

Involved with over 20 live bus fire
tests and over 100 simulated bus
fires on a test rig.



PREVENTION SPECIALISTS LLC

Work Experience in the Bus/Vehicle Fire Protection Industry

- **Kidde Dual Spectrum**. Originally founded in the 70s as a joint venture between the military and Howard Hughes Industries. In 1986 they entered the transit bus industry protecting LACMTA Methanol fueled buses.
- Joey worked for **Kidde** for approx. 30 years, and Jay worked for **Kidde** approx. 20 years.
- In April 2014, Joey joined **SP Fire Research** in Sweden as a Senior Consultant for approximately 2 years.
- March 2017, Joey accepted the position as CEO for **Dafo North America** (a leading Vehicle fire suppression manufacture Europe and Asia) based in Sweden.
- October 2020, Jay accepted a position as Business Manager with **Dafo North America** and retired the end of December 2022.
- January 2023, started (**Bus Fire Prevention Specialists LLC**).





Industry associations, panels, and certifications.

-
- Currently serving on the **Transportation Research Board (TRB)** “Lithium –Ion Battery Transit Bus Fire Prevention and Risk Management” committee.
 - Have served on **APTA’s** Fire Working group committee and current member of **APTA’s** Safety committee and ZEF Committee.
 - Hands on Vehicle Live Fire Investigation training/certification, and Fire Pattern training/certification by the **Public Training Council**.
 - **Fire in Vehicles (FIVE)** world research and training with regards to Car, Trains, Truck, Electric Hybrid and Hydrogen vehicles, and buses. Since 2012 Joey and I have both been an active member.
 - **NFPA** training & certifications for Electric/Hybrid Passenger
 - International Association of Arson Investigators (IAAI)
 - Transportation Safety Institute.

Consulting services provided for buses in the transit, paratransit, microtransit, shuttle, school, autonomous, and motor/luxury coach industry.

Support for other vehicles such as mining, container handling, agriculture, forestry, waste & recycling as well as diesel powered generators.

Services offered

- Risk Management (Fire Risk Identification & Hazard Analysis)
- Assist Transit agencies in pilot bus inspections and after delivery inspections
- Training for drivers and maintenance personnel (can help meet allocated funding for EV bus training)
- New and existing fleet inspections
- OEM certifications (if specified by transit agency)
- Assistance in design proposal and function description of fire suppression systems
- Recommended practice for fire safety
- Independent Fire Investigations (by Joey Peoples)
- Recommended resources for service and installation of fire suppression systems
- Recommended resources for other fire protection services such as facility risk management review

Jay Taylor

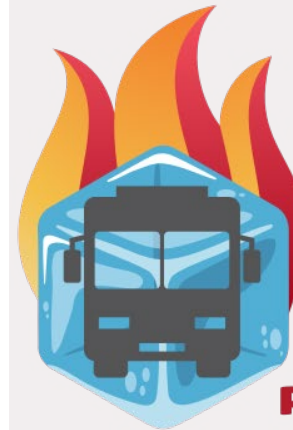
Cell:916-837-6227

Email: jaytaylor317@gmail.com

Joey Peoples

Cell: 919-608-3878

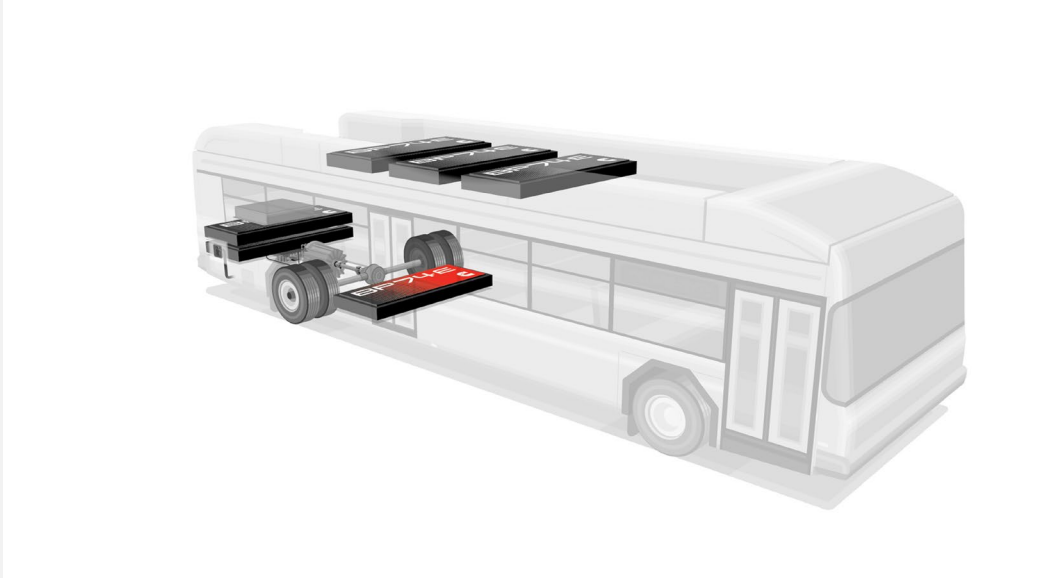
Email: busfireguy@gmail.com



BUS FIRE

PREVENTION SPECIALISTS LLC

Electric Bus Fire Protection & Risk Management.



New Risks

CALACT

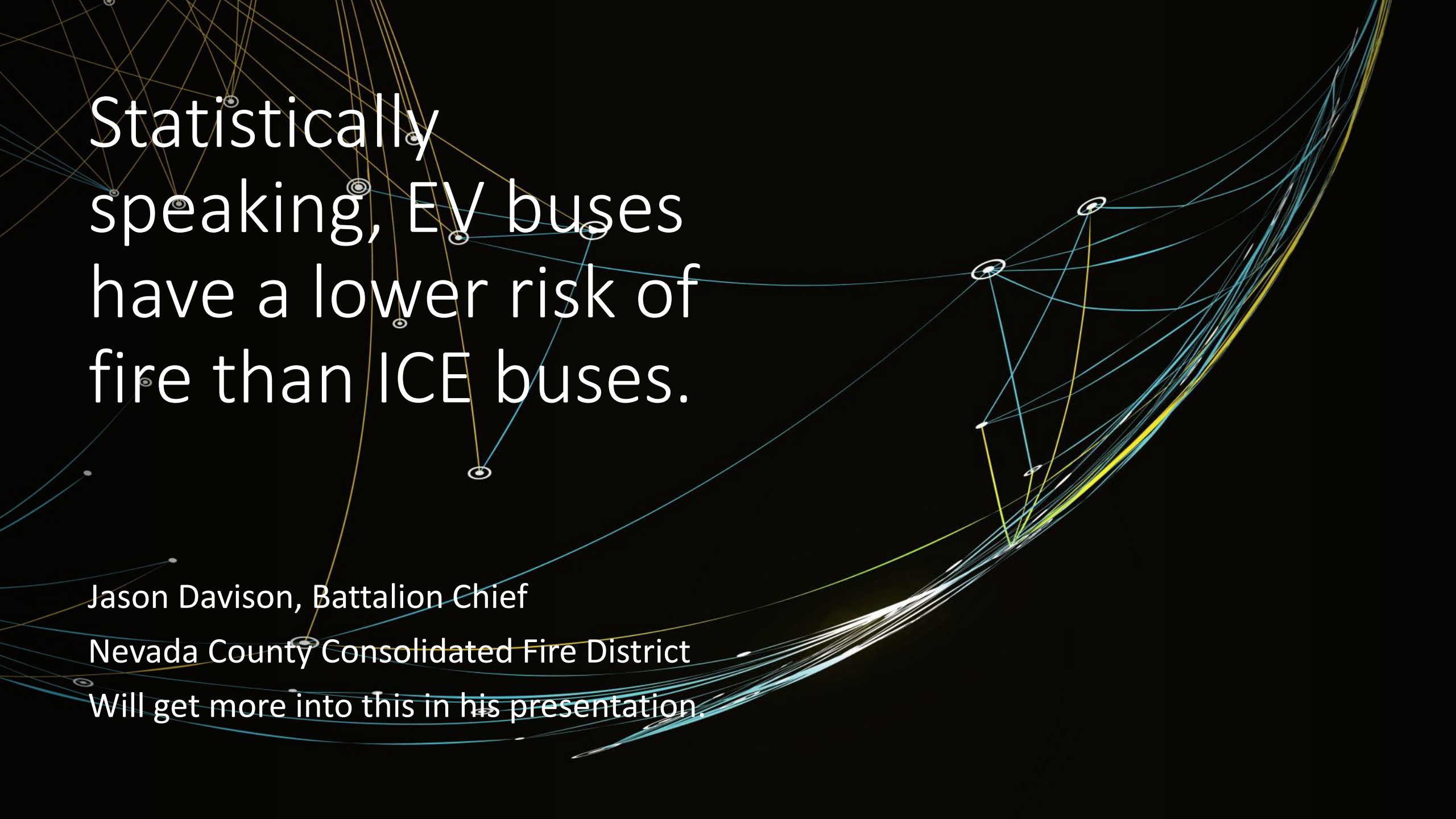
2023

Spring Conference & Expo

Olympic Valley, CA

April 17th - 20th





Statistically speaking, EV buses have a lower risk of fire than ICE buses.

Jason Davison, Battalion Chief

Nevada County Consolidated Fire District

Will get more into this in his presentation.

Posts of EV fires flood the internet daily. Many are misleading.

In a Houston subdivision, a 2019 Tesla Model S jumped the road and collided with a tree.

First responders attempted to put the fire out, it kept reigniting, burning continuously for over four hours despite the use of nearly 30,000 gallons of water to extinguish it.

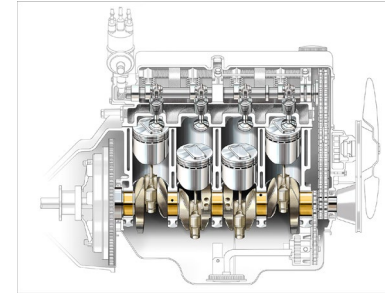
A Chevrolet Volt caught fire three weeks after a routine crash test, May 2011.

Global
projected
growth of
EV buses
by 2027

A March 2022 report found the global electric bus market to grow from 112,041 units in 2022 to 671,285 units by 2027.

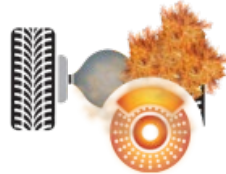
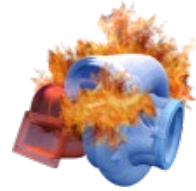
**REMEMBER THESE
NUMBERS WHEN
JASON REVIEWS HIS
PRESENTATION WITH
YOU AND THEN YOU DO
THE MATH.**

Internal Combustion Engine



Ignition of Fuel(s) on Hot Surface

- fuels can be separated from heat source
- Risk reduced when not in operation
- Visual inspection can identify potential risk



Arcing/Shorting of Cables

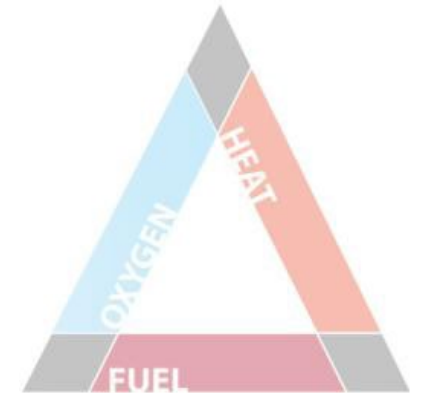
- Electrical energy can be isolated
 - Fuses/circuit breakers, battery disconnect switch
- Designs have improved to minimize known issues (abrasion etc.)
- Visual inspection can identify potential risk



Fire Suppression

Fire suppression methods focused on removal, separation or reduction of one of the components of the fire triangle.

- Cooling
- Suffocation
- Chemical Reaction



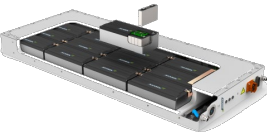
Electric

Multiple battery paks located on the roof, under the bus and/or the traditional engine compartment.



Store a huge amount of energy in a very small space.

Each battery pak can contain numerous battery cells packed together.



Battery paks are sealed and require special tools and training to inspect internal components.

The electrical current (voltage/amperage) that remains inside of a battery even when its completely disconnected from everything is referred to as **STRANDED ENERGY**

Driving the bus discharges the batteries and then they must be recharged.

Heat and voltage changes occur. The Battery Management System (BMS) ensure the energy (heat/voltage) is taken out in a controlled method.

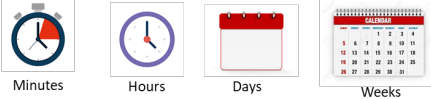
@ Risk Vehicle



Over Charge
Over Discharge



Crush /Penetration
External Fire
Water Ingress



TOWING PROTOCOL



ISOLATION PROTOCOL



INSPECTION & MONITORING PROTOCOL



Voltage Drop

Joule Heating

Electricity passing through causes heat, and you cannot get rid of the heat as fast as you are generating it.

- ❖ Spacing (between buses, building, etc.)
- ❖ Park front to rear to limit radiated heat from fire
- ❖ Consider use of fire blanket to cover bus
- ❖ Can SOC be safely reduced

- ❖ Determine Risk Level
- ❖ Security Camera Coverage

Fire Challenge

The electrical current (voltage/amperage) that remains inside of a battery even when its completely disconnected from everything is referred to as **STRANDED ENERGY**

Each battery pak can contain **numerous battery cells tightly packed together.**

Battery cells/pak chemistry can produce **OXYGEN**

@ Risk Vehicle



Over Charge
Over Discharge



Crush /Penetration
External Fire
Water Ingress

Voltage Drop

Joule Heating



Electricity passing through causes heat, and you cannot get rid of the heat as fast as you are generating it.



Minutes



Hours



Days



Weeks

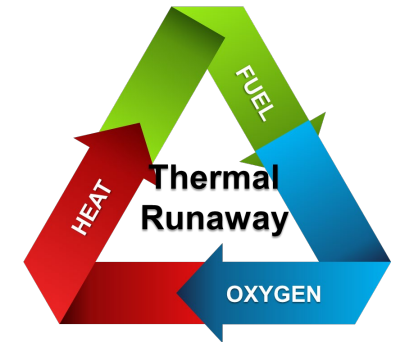


HF (hydrogen fluoride)

Internal Short

Joule + Chem Reaction
Massive Heat Release

Ignition, or in some cases even explosion



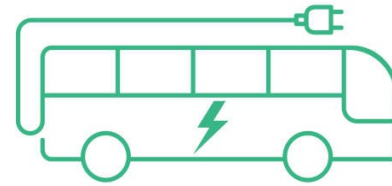
fire condition passes to cells that are nearby

ICE



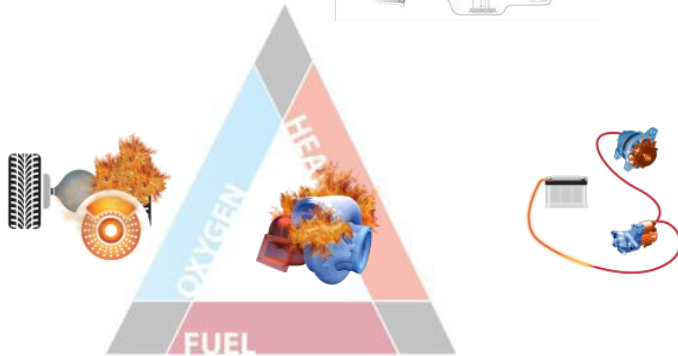
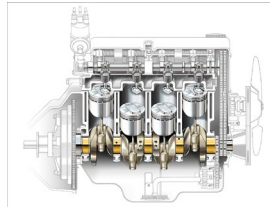
Electric

low environmental emissions and pollution

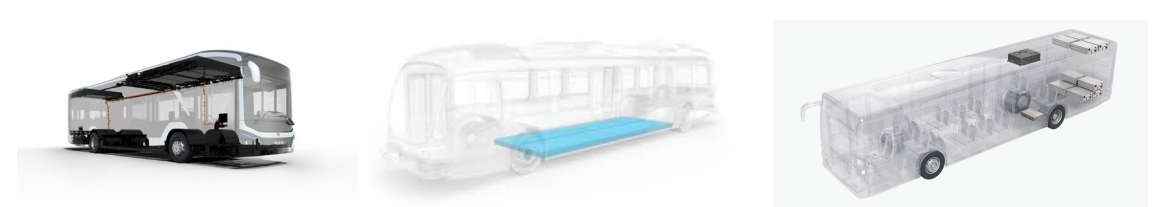


- high energy density
- high power density
- long cycle life
- low self-discharge rate
- no memory effects

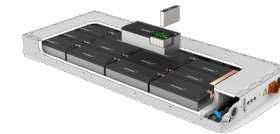
Fire Risks



- fuels can be separated from heat source
- Electrical energy can be isolated



can store a huge amount of energy
in a very small space



Fuel, Heat and in some cases, oxygen are stored
(stranded) in numerous cells/paks

Identifying Risks

Fire Zones, Detection Methods, flame spread, toxic by products, passenger safety



Design –

FMEA - Identify fire risks and mitigation (detection methods, prevention of spread from module to module and toxic byproducts into passenger compartment)



Pilot Bus -

Require risk assessment by known fire risk person with background in electric vehicles and transit operations.

Development of training materials specific to bus build



Routine Inspection

Unlike ICE engines battery packs/enclosures are sealed and visual inspection requires opening the enclosure and servicing by specially trained personnel.

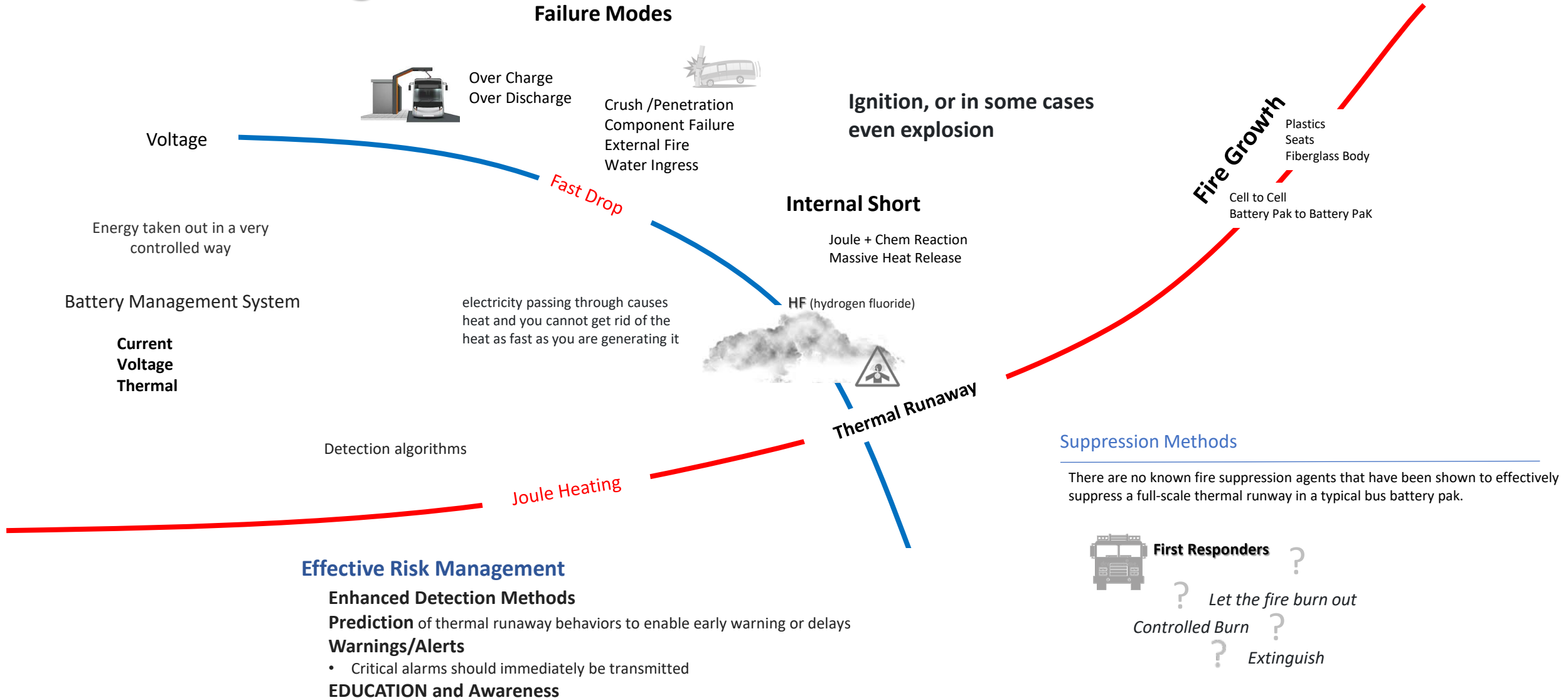
Diagnostic tools (sensor data review, thermal imaging camera)



Operations

- Training FIRST/SECOND RESPONDERS – MAINTENANCE – SECURITY - DISPATCH
- Methods and Protocols to Identify @ Risk Vehicles
- Towing and Storage of @ Risk Vehicles

FIRE Risk Stages



@ Risk Vehicles



Minutes



Hours



Days



Weeks

Thermal Runaway

Mode

Revenue Service

Out of Service (parked)

Maintenance Line

TOWING PROTOCOL



INSPECTION &
MONITORING PROTOCOL

ISOLATION PROTOCOL



- ❖ Spacing (between buses, building, etc.)
- ❖ Park front to rear to limit radiated heat from fire
- ❖ Consider use of fire blanket to cover bus
- ❖ Can SOC be safely reduced

- ❖ Determine Risk Level
- ❖ Security Camera Coverage

- ❖ Do vehicle sensors remain active
- ❖ Flash Bus Lights and Horn to identify alarm



U.S. Fire Administration
Working for a fire-safe America

<https://www.usfa.fema.gov/blog/ig-102022.html>

Guidance for EVs flooded with salt water

The NHTSA emphasizes first identifying any flooded electric vehicles and then moving them at least 50 feet from any structures, other vehicles or combustibles.

NHTSA's 2014 guidance for [first responders PDF](#) and [second responders PDF](#), developed in collaboration with the U.S. Fire Administration, National Fire Protection Association (NFPA) and others, was revised after the 2012 flooding from Hurricane Sandy submerged several hundred EVs in salt water, leading to several fires in Fisker EVs. The 2014 bulletins now incorporate response guidance related to hazards from flooded EVs.

Also, the International Association of Fire Chiefs (IAFC) has a [webinar](#) (available free of charge after registration) on response to EV battery fires associated with salt water submersion.

The potential problem extends beyond flooded EVs

In all occurrences, EV battery fires can be very time- and resource-intensive for responders. There are safety risks for responders related to the emission of toxic and flammable gases from damaged batteries, and the unpredictability of thermal runaway and re-ignition. Resources for dealing with EV fires include:

- [NFPA training for responders on alternative fuel vehicles](#).
- [Fire Department Response to Electrical Vehicle Fires](#) from the IAFC. The bulletin includes guidance for responders pre -, during and post-incident.



Researchers at Missouri S&T are working with mine operators and firefighting agencies to plan for and mitigate EV fire risks

E-TOX project provides increased knowledge in the formation of toxic products in EV fires

Test Method for Thermal and Mechanical Performance of Battery Enclosure Materials

UL Alternative Document
2596, Edition 1

1 Scope

1.1 These requirements cover **tests for thermal and mechanical performance of battery enclosure materials** in response to **stresses representative of thermal runaway of lithium-ion cells used in electric vehicles**.

1.2 The performance characteristics of a material determined by this test method shall not be assumed to correlate with its performance in the end-use application. The actual response of materials to thermal and mechanical stresses depends upon the size and form of the material, as well as the end-use application of the product using the material.

1.3 Tests conducted on a material under the conditions specified are intended to provide information when comparing the relative performance characteristics of different materials, or assessing any change in performance characteristics prior to or during use.



UL 94 Classification and Flame-Retardant Thermoplastics

Plastic's propensity to either extinguish or spread a flame once ignited. Factors evaluated include:

- Whether the material ignites when exposed to a flame ignition source
- Whether the flame spreads after ignition, and how quickly
- Whether the material releases flaming particles as it burns

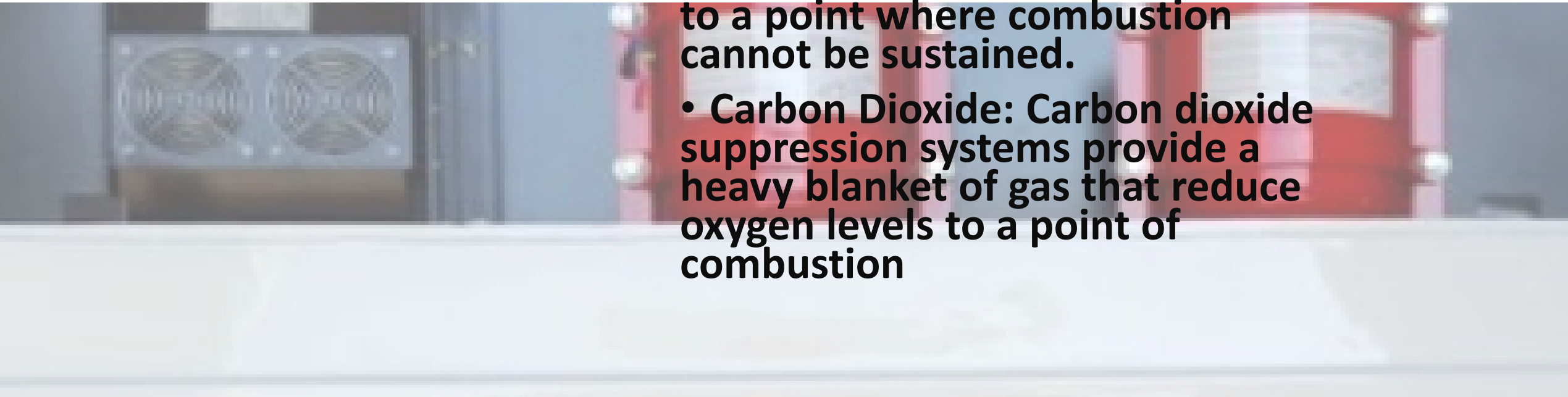
UL 94 RATING	DEFINITION OF RATING
HB	Slow burning on a horizontal part
V-2	Burning stops within 30 seconds on a part allowing for drops of vertical flammable plastic.
V-1	Burning stops within 30 seconds on a vertical part allowing for drops of plastic that are not inflames.
V-0	Burning stops within 10 seconds on a vertical part allowing for drops of plastic that are not inflames.
5VB	Burning stops within 60 seconds on a vertical part not allowing for drops of plastic that are not inflames. Test specimens may have a burn-through (a hole may be present).
5VA	Burning stops within 60 seconds on a vertical part not allowing for drops of plastic that are not inflames. Test specimens may not have a burn-through (no hole).

- **Wet and Dry chemical Agents:** Chemical agents work to smother and extinguish fires, preventing oxygen from reacting with the fuel.

- **Water Mist:** Acts by reducing the temperature while the water vapor mist expands providing a blanket over the fire.

- **Inert gases:** Such as nitrogen and argon reduce oxygen levels to a point where combustion cannot be sustained.

- **Carbon Dioxide:** Carbon dioxide suppression systems provide a heavy blanket of gas that reduce oxygen levels to a point of combustion



Questions



BUS FIRE

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