Lithium-ion Battery Fire Testing with F-500 EA®

Since 2008

Executive Summary

From consumer electronics and electric vehicles to industrial equipment and energy storage systems, lithium-ion batteries can be found everywhere. At the same time, steel is being replaced with lighter alloys, such as aluminum, magnesium, and titanium. This trend is creating new challenges for industry leaders and first responders who are faced with new and unique hazards associated with modern manufacturing practices.

A lithium-ion battery fire, presenting Class A, Class B, and Class C hazards, typically occurs due to thermal runaway. Thermal runaway occurs when a lithium-ion battery cell overheats, sparking a chain reaction that ignites adjacent cells. The hazardous vapors released during this process add fuel to the fire, creating a catastrophic incident without proper intervention.

The following events have led to F-500 Encapsulator Agent, commonly referred to as F-500 EA®, becoming the agent of choice for lithium-ion battery fire suppression.

Michael Greiner
President of Hazard Control Technologies, Inc.

Table of Contents

Table of Contents

2008 - 2009

Bosch

Bosch is a German multinational engineering and technology company headquartered in Gerlingen, Baden-Württemberg, Germany.

In 2008, Bosch is provided with F-500 EA® concentrate to conduct lithium-ion battery fire suppression testing at their facility.

In 2009, Bosch concludes their fire testing comparing the results of water, foam, powder, and F-500 EA® on burning lithium-ion batteries, nickel-metal hydride batteries, and other production parts. Hazard Control Technologies Europe was invited to Bosch headquarters where F-500 EA® was recognized as their agent of choice for extinguishing lithium-ion battery fires. It is at this time that Bosch became our official reference customer.

2009

VDA

VDA is an interest group of the German automobile industry, both automobile manufactures and automobile component suppliers.

In 2009, Bosch communicates their findings to VDA. This results in VDA promoting F-500 EA® both nationally and internationally for lithium-ion battery fire suppression within the automotive industry.

Baden-Württemberg
LANDESFEUERWEHRSCHULE

2011

2011 GUIDELINE

Baden-Wurttemberg

Baden-Württemberg State Fire School in Bruchsal, Germany trains more than 6,500 fire department specialists every year.

In 2011, Bosch communicates their findings to Baden-Wurttemberg State Fire School, resulting in the publication of an application guideline referencing F-500 EA® for lithium-ion battery fire suppression.

BRANDSchutz

2011 - 2012

2011 ARTICLE

2012 ARTICLE

BrandSchutz Magazine

BrandSchutz Magazine is a German publication reporting on Fire-fighting Training and Fire Service News.

In 2011, a publication appears in BrandSchutz Magazine discussing the use of F-500 EA® for high-voltage vehicle hazard mitigation.

In 2012, another publication appears in BrandSchutz Magazine reporting that, in addition to lithium-ion batteries, F-500 EA® can mitigate other specialty hazards. This includes magnesium, titanium, rubber tires, gasoline, diesel, ethanol, and ethanol-blended fuels.

49,000
Employees

188
Locations

60
Countries

2012

2012 REPORT

Dekra

Dekra, based in Berlin, Germany, is the world's largest private TIC expert, inspecting 28 million vehicles worldwide every year.

In 2012, Dekra issues a press release announcing their fire testing activities and releases a final report containing an opinion letter that confirms their recommendation of F-500 EA®.

2012

2012 ARTICLE

Formula 1

Formula 1 is the highest class of international racing for open-wheel single-seater formula racing cars.

In 2012, BrandSchutz Magazine describes an incident at the Barcelona Formula 1 Grand Prix that prompted the Hockenheim Circuit to test and accept F-500 EA® as their agent of choice, replacing foam.

BRANDSchutz

2013

2013 ARTICLE

BrandSchutz Magazine

BrandSchutz Magazine is a German publication reporting on Fire-fighting Training and Fire Service News.

In 2013, BrandSchutz Magazine condenses and publishes DEKRA's final report, reiterating F-500 EA®'s outstanding performance while combating modern automotive fire hazards.

2013

2013 REPORT

SAE International

SAE International is a global standards development association with over 128,000 engineers and technical experts in mobility.

In 2013, DEKRA, Daimler, and Deutsche present DEKRA's findings in Detroit, MI at the SAE International Conference, receiving attention from the NFPA and the United States automotive industry.

2015 - 2016

2015 SPECIFICATION

General Motors

General Motors is a multinational automotive company known for owning and manufacturing Chevrolet, GMC, Cadillac, and Buick.

In 2015, General Motors invites Hazard Control Technologies Europe to their headquarters to test F-500 EA® on lithium-ion battery hazards before specifying F-500 EA® for their battery abuse lab.

2016

Tesla

Tesla is a multinational automotive and clean energy company designing, manufacturing, and selling electric products and services.

In 2016, Tesla specifies F-500 EA® and installs the first F-500 EA® powered fire suppression system engineered and designed for charging stations at the Tesla Giga Factory in Sparks, NV.

2016

Jaguar

Jaguar is the sports car and luxury vehicle brand of Jaguar Land Rover, a multinational British car manufacturer.

In 2016, Jaguar invites Hazard Control Technologies Europe to perform lithium-ion battery fire testing at their United Kingdom facility and standardizes on F-500 EA® for lithium-ion battery fires.

4,300
Employees

100
Locations

40
Countries

2017

2017 VIDEO

2017 REPORT

Kiwa

Kiwa is a multinational Dutch TIC company providing consultancy and training services across various markets.

In 2017, Kiwa's fire testing facility in the Netherlands concludes that F-500 EA® is the most effective agent for lithium-ion battery fires when compared to foams and dry chemicals.

2017

2017 REPORT

Con Edison

Con Edison is one of the largest investor-owned energy companies in the United States, generating over $12 billion in annual revenue.

In 2017, Con Edison set out to test the return current back through the stream created by a hose line when fighting fires within a lithium-ion battery rack storage system while looking at the variables of voltage and distance to the source. Various fire suppression agents were tested to establish safe standoff distances while manually extinguishing these fires.

The results show that F-500 EA® is safe to use at both 3% and 6% from a 10-foot standoff distance on a 2 kV source. This 10-foot standoff distance also complies with the OSHA standard for unqualified personnel on a 1 kV source.

2017

2017 ABSTRACT

Nanjing Tech University

Nanjing Tech University in China ranked among the top 1% in the world for their Chemistry and Materials Sciences programs.

In 2017, Nanjing Tech University publishes an abstract for the 8th International Conference on Fire Science and Fire Protection Engineering summarizing studies on lithium-ion battery fire suppression with F-500 EA®.

30,000
Employees

7,000
Students

76
Institutes

2019

Fraunhofer

Fraunhofer is a German research organization with 76 institutes spread throughout Germany focusing on applied science.

In 2019, Fraunhofer HHI in Goslar, Germany evaluates the performance of F-500 EA® on lithium-ion battery fires at their battery and sensor testing center.

1,100
Employees

3,000
Students

33
Institutes

2020

2020 REPORT

TU Clausthal

The Clausthal University of Technology in Germany regularly ranks among the Top German Universities in Engineering.

In 2020, TU Clausthal in Clausthal-Zellerfeld, Germany concludes testing that reveals using a 2% solution of F-500 EA® to extinguish lithium-ion battery fires is significantly superior to using plain water.

30,000
Employees

7,000
Students

76
Institutes

2021

2021 VIDEO

2021 REPORT

Fraunhofer

Fraunhofer is a German research organization with 76 institutes spread throughout Germany focusing on applied science.

In 2021, Fraunhofer HHI in Goslar, Germany conducts an additional series of sprinkler tests focused on using F-500 EA® for lithium-ion battery fire suppression.

31,000 Standards **800 Committees** **5,000 Members**

2021

2023 REPORT

NEN

NEN manages over 31,000 international (ISO, IEC), European (EN), and national (NEN) standards accepted in The Netherlands.

In 2021, NEN publishes NTA 8133, the first Dutch standard of its kind, testing a fire extinguisher's performance when applied to small-scale lithium-ion battery fires. Requirements were prepared by a working group comprised of an inspection body, manufacturers, and other experts. Numerous trial tests were performed to determine the final test protocol.

Test protocol for NTA 8133 states that as of yet, there are no known extinguishing agents that can effectively stop thermal runaway. However, there are extinguishing agents that can effectively stop the propagation of thermal runaway. This standard seeks to identify and certify fire extinguishers that meet these requirements.

An F-500 EA® fire extinguisher exceeds these requirements and is certified by NTA 8133 for lithium-ion battery fire suppression on hazards of 600 Wh or less.

5,800
Employees

43,000
Students

37
Institutes

2021 - 2022

2021 REPORT

2022 REPORT

Beijing Institute of Technology

Beijing Institute of Technology in China has constructed 21 national-level scientific and technological innovation platforms.

In 2021, Beijing Institute of Technology in Beijing, China publishes an experimental study in conjunction with The State Key Laboratory of Explosion Science on using F-500 EA® for lithium-ion phosphate battery fire suppression with a focus on rapid heat reduction.

In 2022, Beijing Institute of Technology publishes another experimental study in conjunction with The State Key Laboratory of Explosion Science and Technology and the Department of Engineering Physics at Tsinghua University. This study investigates the fire suppression mechanics of a spherical micelle as well as the effectiveness of using F-500 EA® for lithium-ion battery fire suppression.

300
Standards

260
Committees

50,000
Members

2022

NFPA

NFPA is a global nonprofit organization devoted to eliminating death, injury, and loss with more than 300 codes and standards.

In 2022, for the first time in history, the NFPA speaks directly to the use of water additives, including Encapsulator Agents, in NFPA 18A, Standard on Water Additives for Fire Control and Vapor Mitigation.

To be recognized as an Encapsulator Agent by the NFPA, a water additive must pass the Spherical Micelle Stability Test outlined in NFPA 18A Section 7.7. This section covers the test protocol used to evaluate the ability of a water additive solution to form and maintain stable spherical micelles capable of encapsulating fuel (polar and non-polar), rendering flammable liquids nonflammable, nonignitable, and nonexplosive, and maintaining that encapsulation in the presence of high heat over an extended period of time.

F-500 EA® exceeds these requirements and is verified by NFPA 18A Section 7.7 testing conducted under the supervision of UL Solutions.

300
Standards

260
Committees

50,000
Members

2022

NFPA

NFPA is a global nonprofit organization devoted to eliminating death, injury, and loss with more than 300 codes and standards.

In 2022, for the first time in history, the NFPA recognizes Encapsulator Agents conforming to NFPA 18A Section 7.7 for extensive third-party fire testing conducted by independent institutions.

NFPA 18A Annex 4.3 references over fifteen years of controlled, scientific, and highly instrumented lithium-ion battery fire testing documenting a history of successful fire suppression and fire containment. This lithium-ion battery fire testing illustrates the ability of an Encapsulator Agent conforming to NFPA 18A Section 7.7 to stop the propagation of thermal runaway, encapsulate flammable electrolyte, cease the production of explosive vapors, and reduce the concentration of toxic vapors encountered by humans.

F-500 EA® is acknowledged by several leaders in Testing, Inspection, and Certification (TIC) for lithium-ion battery fire suppression.

SAPIENZA
UNIVERSITÀ DI ROMA

2022

2022 REPORT

Sapienza University of Rome

Sapienza University of Rome, abbreviated simply as Sapienza, is an Italian public research university.

In 2022, an experimental investigation of Encapsulator Technology for lithium-ion battery fire suppression is published by The Department of Chemical Engineering, Materials and Environment at Sapienza University of Rome, Systems and Technologies for Mobility and Accumulation Laboratory, ENE DTE-PCU-STMA, CR Casaccia, Central Directorate for Prevention and Technical Safety, and the National Fire Brigade of Rome, Italy.

PORT AUTHORITY NY NJ
AIR LAND RAIL SEA

2022

2022 VIDEO

2022 VIDEO

Port Authority of NY and NJ

The Port Authority of NY and NJ was established in 1921 through an interstate compact authorized by the United States Congress.

In 2022, testing is conducted on both a lithium-ion battery pack fire as well as a fully involved hybrid vehicle fire at the Port Authority of NY and NJ. A drastic decrease in flammable, explosive, and toxic off-gases as well as a rapid drop in temperature is recorded while extinguishing these fires, resulting in the Port Authority of New York and New Jersey implementing the use of F-500 EA® for lithium-ion battery fire suppression.

12,000
Employees

18
Locations

2023

2023 REPORT

NIOSH

NIOSH is the United States federal agency responsible for conducting research aimed to prevent work-related injury and illness.

In 2023, a detailed experimental study is conducted at the National Institute for Occupational Safety and Health (NIOSH) Pittsburgh Mining Research Division (PMRD). Water mist with different flow rates, ABC powder, type D dry chemical, and water mist with F-500 EA® additive are compared for lithium-ion battery fire suppression. Multiple thermocouples are installed on the battery packs to measure temperature evolution during the tests. The results indicate that water mist with F-500 EA® additive is the most effective suppressant among the fire suppression agents tested.

26,000
Employees

95
Locations

68
Countries

2023

2023 CERTIFICATION

2023 VIDEO

Applus+

Applus+ is a world leader in TIC, safeguarding market operations and improving environmental impact in more than 65 countries.

In 2023, HCT's complete Diamond Doser® fire protection system powered by F-500 EA® was assessed at Applus+'s facility in Madrid, Spain.

To receive an Applus+ certification, six parameters must be met during the 60-minute test.

1. The battery must be brought to a 90%-100% charge.
2. Thermal runaway must be confirmed 6 minutes into the test.
3. The system must be activated manually 9 minutes into the test.
4. Temperatures in the evacuation corridor must not exceed 60°C.
5. The fire must not spread to the adjacent vehicle at any point.
6. Temperatures 2.5 meters from the ceiling must not exceed 70°C.

The successful testing trial resulted in an international certification under ETI 23/32306438.

49,000
Employees

188
Locations

60
Countries

2024

2024 CERTIFICATION

Dekra

Dekra, based in Berlin, Germany, is the world's largest private TIC expert, inspecting 28 million vehicles worldwide every year.

In 2024, DEKRA recommends F-500 EA® for use in fire suppression systems to protect lithium-ion battery hazards, such as electric vehicles and charging stations, following Applus+'s approval.

Parken aktuell

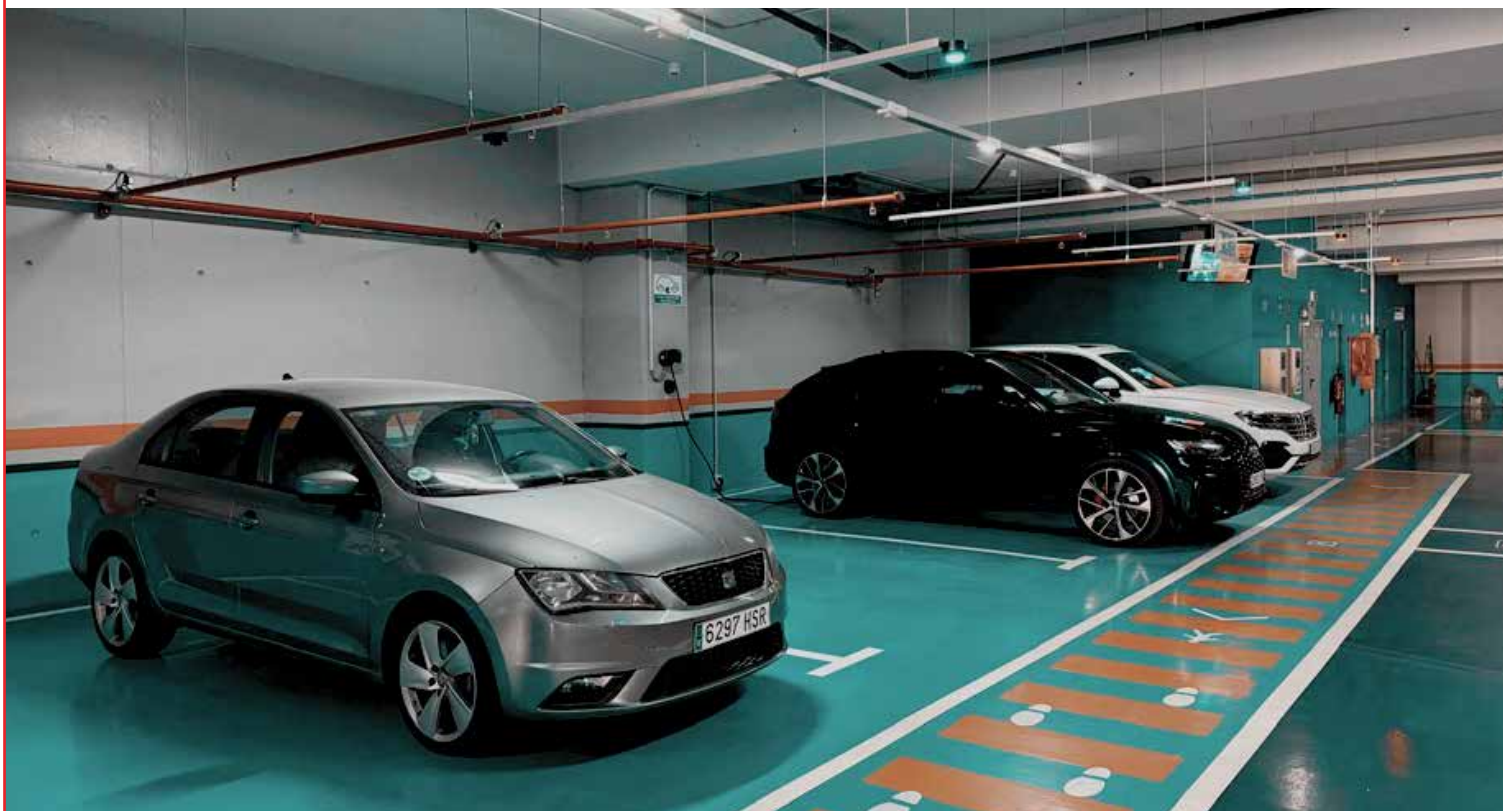
2024

2024 ARTICLE

Parken Aktuell Magazine

Parken Aktuell Magazine is the industry's leading publication, providing crucial parking garage news and more across Europe.

In 2024, Parken Aktuell Magazine publishes a synopsis of Applus+'s testing, evaluation, and certification of HCT's Diamond Doser® fire protection system powered by F-500 EA®.



BRANDSchutz

2024

2024 ARTICLE

BrandSchutz Magazine

BrandSchutz Magazine is a German publication reporting on Fire-fighting Training and Fire Service News.

In 2024, BrandSchutz Magazine publishes an article focusing on EMT Madrid's specification of HCT's Diamond Doser® fire protection system powered by F-500 EA® for their growing electric bus fleet.

FES
Fire Engineering Service

2024

2024 ARTICLE

FES Solution

FES Solutions is South Korea's specialist in firefighting and fire protection for engineering, procurement, and construction.

In 2024, several devastating fires involving both lithium batteries and lithium-ion batteries make headlines in South Korea. Following these disasters, the South Korean government and HCT's South Korean distributor, FES Solution, are motivated to find a viable fire protection solution for battery hazards.

After months of research, FES Solution reached out to HCT for support in their upcoming fire testing efforts. A full-scale electric vehicle fire test was conducted at the Fire Protection Testing and Research Institute under the Korea Fire Insurance Association to verify the performance of F-500 EA®. The test featured a Kia Ray EV, equipped with a lithium-ion battery boasting a capacity of 16kWh. At the time of the test, the battery was 100% charged. FES Solution's fire brigade extinguished the fire within 5 minutes by applying a 3% solution of F-500 EA®. The battery contains 16 modules with 5 cells. Following testing, the status of each module was evaluated. A thorough inspection revealed that just 4 modules were completely burned through, confirming F-500 EA® halted the propagation of thermal runaway.

2024

2024 CERTIFICATION

2024 VIDEO

FILK

Fire Insurers Laboratories of Korea (FILK) is a leading fire safety testing institution with a KOLAS accredited laboratory.

In 2024, HCT supports South Korean distributor, FES Solution, in overseeing an Electric Car Fire Suppression Test at FILK's facility. F-500 EA® is now FILK-certified after extinguishing a Hyundai Kona Electric possessing a 64 kWh battery in 8 minutes and 30 seconds.

FIRE ENGINEERING®

2024

2024 ARTICLE

Fire Engineering Magazine

Fire Engineering Magazine is an American publication providing training and education for fire and emergency services personnel.

In 2024, Fire Engineering Magazine publishes an article recounting Nye County Emergency Services' experience extinguishing a fire on I-95 in Nevada involving 31,000 pounds of lithium-ion batteries with just 5,500 gallons of an F-500 EA® solution.

Hazard Control Technologies, Inc.
150 WALTER WAY, FAYETTEVILLE, GEORGIA 30214
+1 770 719 5112 / INFO@HCT-WORLD.COM / HCT-WORLD.COM