

FORMAN

A division of Ardent Limited

ZERO EMISSION SAFETY SOLUTIONS

**SAFETY, ACCESSIBILITY AND PASSENGER
EXPERIENCE, AND FIRE PROTECTION SOLUTIONS**

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About Us

For over 30 years, our mission has been to inspire public confidence in buses and coaches by making them safer for everyone. Throughout this time, we have installed over 21,000 fire suppression systems and 84,000 electronic systems in countries around the world. In 2019, we joined the Ardent group, allowing us to serve our customer's needs even better.

As part of Ardent, we have been able to bring our fire protection expertise to over 50 countries around the world. As a group, we specialise in making high-risk sectors safer, including electric vehicles and plant, waste and recycling, mining and quarrying, electrical panels, and more.

Today, at a time when a more sustainable Net Zero future is at the top of the global agenda, that mission has never been more important. If the bus industry is to play its part in this global change, then two things will inevitably need to happen.

First, more people will need to be persuaded to leave the car at home and use public transport. This can only happen if operators and OEMs increase confidence in public transport by providing better, higher-capacity reliable services that are faster and more comfortable.

The second is that public transport must itself become greener. That means zero emission electric vehicles (ZEVs) will have an increased presence on our roads in future.

While ZEVs will help operators keep up with eco-driven funding schemes such as Zero Emission Bus Regional Areas (ZEBRA) and the Bus Service Improvement Plan (BSIP), they come with new risks. When it comes to dealing with these risks in what is an ever-evolving field, experience and expertise are crucial.

There is no more experienced partner to meet this challenge than Forman.

The Challenge

There are different categories of ZEV. Each one comes with its own challenges that are quite different from ICE vehicles. These are the vehicles that OEMs and regional operators around the world will need to use to drive us into a cleaner future.

BEV Battery Electric Vehicles

BEVs typically use Li-ion battery packs combined with an electric motor. They often contain multiple batteries and sensitive components located in various areas of the bus, meaning the risk of fire is not confined to the battery pack. Batteries are often placed in front of the bus under the driver's cab, on the roof and in the engine compartment at the rear of the vehicle.

FCEV Fuel Cell Electric Vehicle

FCEVs use a hydrogen fuel cell system to generate the electricity required to drive the vehicle. The only byproducts of this process are heat and water vapour, which makes them one of the cleanest options available. FCEVs are a rapidly maturing technology. As such, they require innovative solutions to ensure they remain safe for OEMs and service operators.

Hydrogen can be extremely combustible in the event of a leak. Its molecules are light, so they disperse rapidly into the atmosphere which mitigates much of the fire risk, but it does still pose some risk at the point of the leak from the fuel cell. It is a colourless and odourless gas, so detecting leaks in a vehicle is impossible without specialist equipment and automatic early warning systems.

The Forman Solution

At Forman, we offer universal solutions that fully protect all fire hazard locations within any ZEV. Below, you can see the full range of protection that we offer, designed with driver and passenger safety in mind. These cutting-edge safety systems can be built into a new vehicle specification or retrofitted into an existing fleet.

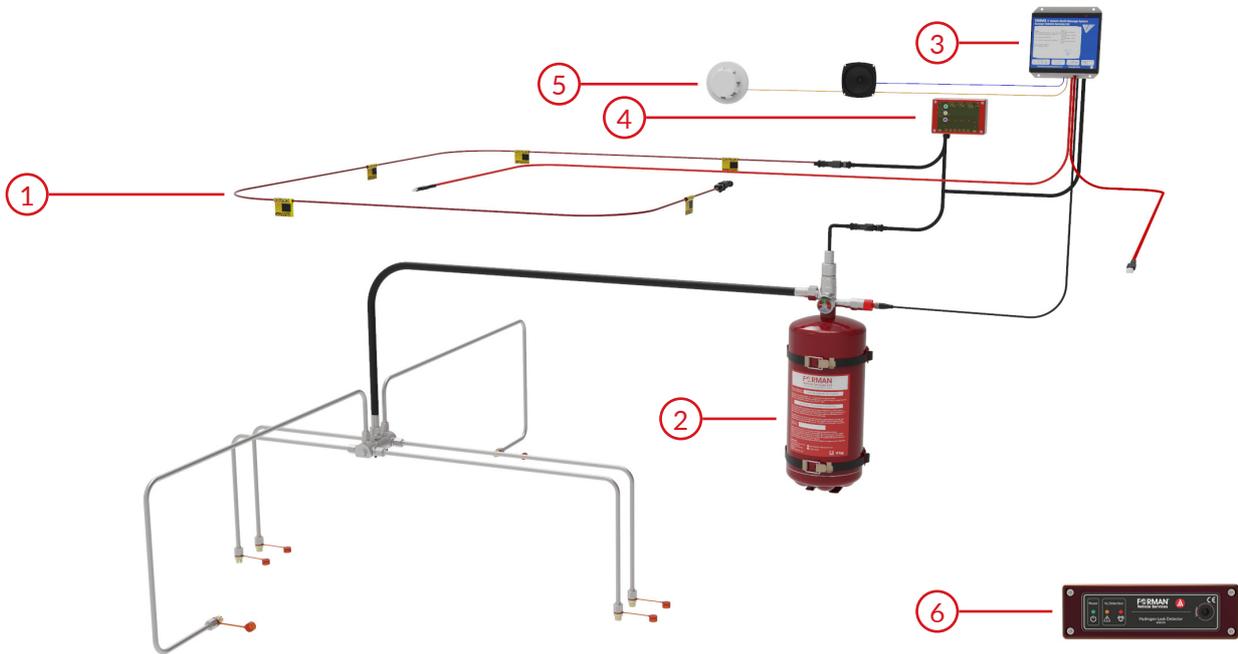


Image for visual representation only.

- ① Linear Heat Detection Cable**
We use an R107 approved Linear Heat Detection (LHD) cable. This cable is made of conductors surrounded by a heat-sensitive polymer. When exposed to high temperatures, the polymer melts, creating a short circuit that signals the control module to activate the suppression system. It is easily routed around every fire hazard in the vehicle for complete coverage.
- ② Fire Suppression Tanks and Agent**
Our systems use a tank of a dry chemical agent – a powder – which is released when a fire is detected. Within seconds the powder is discharged through a network of pipes and out of critically-located nozzles aimed at identified fire hazards.
- ③ Optional Vehicle Multi-Message System (VMMS)**
The VMMS delivers audio messages directly to the driver or passengers when warnings, alarms, or safety measures are triggered. We are experts in developing audio feedback systems for electric vehicles, having previously created the AVAS (Acoustic Vehicle Alerting System) and PAF (Pedal Acoustic Feedback System).
- ④ Control Module**
VCM Mk2 is our most advanced control module yet. Featuring an LCD screen, it provides intuitive visual feedback on the status of your fire suppression system.
- ⑤ Optional Smoke Detector**
This unit is recommended for the upper deck of double-decker buses. It can link to the VMMS system to alert the driver if smoke is present on the top deck of the bus.
- ⑥ Hydrogen Leak Sensors**
This module, designed for FCEVs, uses advanced catalytic sensors which can detect even minute amounts of hydrogen. It can detect from 0-100% of the lower flammability limit (LML), communicating this to the driver.

UNECE Regulation 107 Compliant

The United Nations Economic Commission for Europe (UNECE) Regulation 107 governs the installation of automatic fire suppression for class I, II, and III vehicles. The regulation aims to reduce the number of catastrophic bus fires starting in the engine bay. While most ZEVs do not have engine bays as such, R107 remains a valuable regulation in several ways and shouldn't be dismissed.

Our fire suppression systems have passed extensive testing at the Research Institute of Sweden (RISE). Our installation process is designed to go above and beyond these stringent regulations, with independent risk assessments carried out on all your vehicles to identify potential hazards.

Our Process

We have a thorough five-step process to ensure your needs, the needs of your staff, and the needs of your passengers are all met.

Step 1

We set up an on-site meeting with our engineering team. We will complete a full risk assessment for each vehicle type and review the location of any hazardous components.

Step 2

We send a detailed dossier laying out the system design and component location to the vehicle manufacturer for approval.

Step 3

We deliver a first kit on-site. We go through all the necessary training and support needed to complete an initial installation with your production engineers.

Step 4

We will provide further training if required and will return to sign off the second installation. Once this is done, our contract is completed and signed off.

Step 5

We have the largest network of field engineers across the UK and offer 24 hour VOR response.



Choosing Your Fire Suppression Agent

While there are many different fire suppression agents including water-based, foam-based, powder-based, gaseous, or aerosol agents, not all of these are suitable for use on electric buses. We are entirely led by fire hazard analysis and are not committed to one particular solution. Fire suppression is not a one-size-fits-all problem.

As part of the Ardent Group, we have access to a wide range of agents, which we use to provide the best protection for a particular application. However, a recent study commissioned by the Fire Protection Research Foundation compared the extinguishing times of various fire suppression agents and found that a dry chemical powder-based solution extinguished a fire the fastest while using the least amount of agent. If an electrical fire breaks out, every second counts, so we predominantly focus on using dry chemical solutions for ZEV applications.

Table 2 - Summary of Fire Exposure Test Data ⁽²⁾

Test Number	Extinguishing Agent	Extinguishing Time (sec)	Extinguisher Discharge Time (sec)	Agent Discharged (kg)
1B	ABC Dry Chemical	3	33	4.5
2B	Water Mist	6	88	9.0
3B	Halotron I	3	13	7.0
4B	FE-36	4	14	6.0

⁽²⁾ Scheffey, J.L. and Forssell, E.W., "Measuring the Impact of Fire Extinguisher Agents on Cultural Resource Materials – Final Report," Fire Protection Research Foundation, Quincy, MA, February 2010.

One issue with lower-quality powder is that it can become compacted when stored for long periods, requiring agitation of the tanks. This is why we use a formulation of high-quality powders so the agent stays loose without the need for agitation. This ensures it is rapidly dispersed when required. It is highly effective against Class A, Class B, and Class C fires.

We also use clean gaseous agents when dealing with enclosed fire hazards such as electrical panels. This is because gas can be discharged from the extinguisher very quickly and its extinguishing time is comparable to that of dry chemicals.



Powder agents are non-conductive and safe for use in applications involving live electrical equipment.

Accessibility and Safety Solutions

We have created many innovative accessibility and safety systems throughout our three decades of existence, working in close collaboration with bus operators and transport authorities. Operators have a responsibility to make sure their services are equally accessible to all – a responsibility that will affect OEMs, too. Ensuring disabled people can travel independently is high on the government's agenda, so these features should be non-negotiable for any new vehicle specs.

V-IS Information System

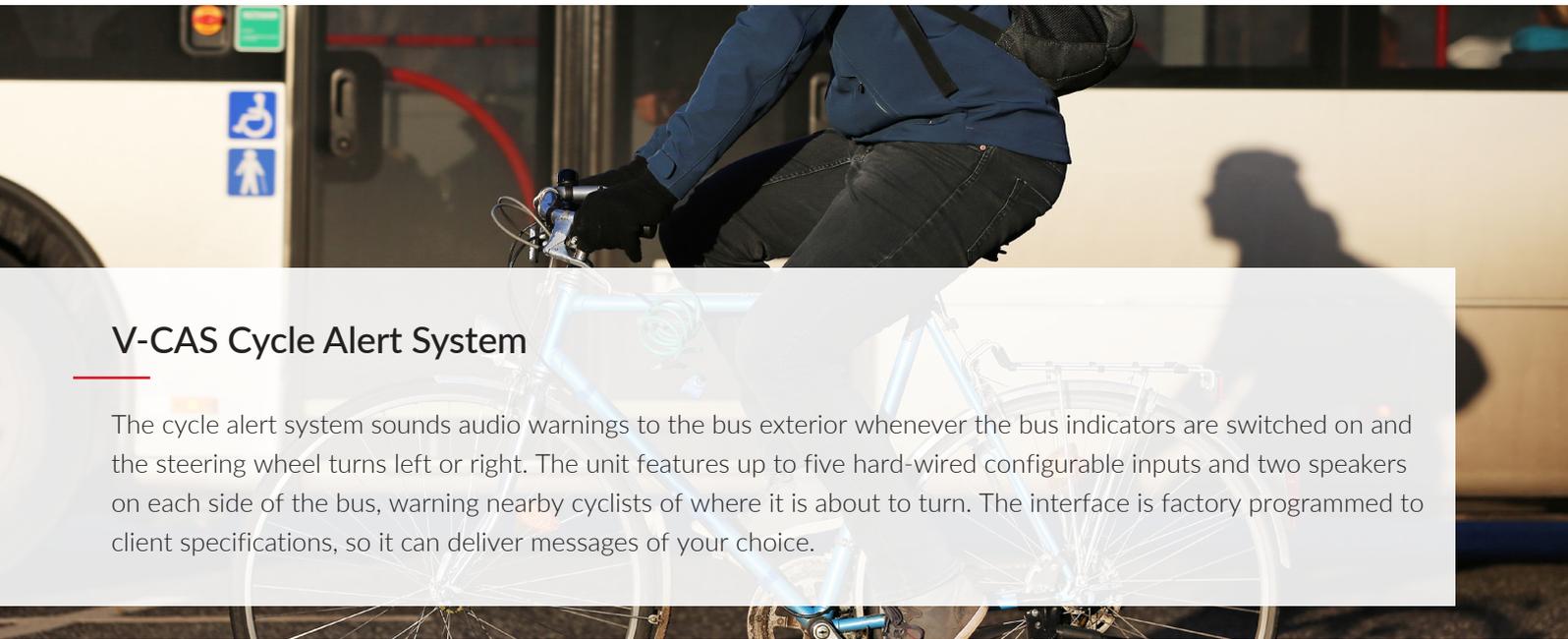
The Vehicle Information System delivers important information about the status of various vehicle systems directly to the driver and passengers via speakers in the cab and saloon. These messages can range from general safety reminders to specific alerts when integrated with fire suppression systems and AVAS. Operators can program in custom messages and sounds if required.

V-AVAS Acoustic Vehicle Alerting System

AVAS emits an artificial sound so those with visual impairments will be aware of it when close by. This is vital as electric vehicles will run almost silently at lower speeds. Several AVAS configurations are available, with more advanced models offering extra features including visual alerts, configurable inputs, and remote updates.

V-PAF Pedal Acoustic Feedback System

PAF (pedal acoustic feedback) intuitively signals to the driver when they are pressing the accelerator by playing a tone that shifts in pitch as the pedal is depressed. It is useful in ZEVs as it simulates the tone shift of an ICE motor. The system also plays warnings when excessive force is applied to the accelerator, or when both accelerator and brake pedals are pressed at the same time, reducing the risk of pedal applications errors.

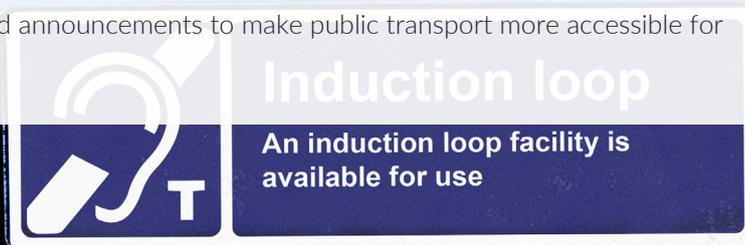
A photograph showing a person in a blue jacket and dark pants riding a bicycle. The person is positioned in front of a white bus. On the side of the bus, there are blue accessibility icons: a person in a wheelchair and a person with a white cane. The background is slightly blurred, showing the bus and some urban elements.

V-CAS Cycle Alert System

The cycle alert system sounds audio warnings to the bus exterior whenever the bus indicators are switched on and the steering wheel turns left or right. The unit features up to five hard-wired configurable inputs and two speakers on each side of the bus, warning nearby cyclists of where it is about to turn. The interface is factory programmed to client specifications, so it can deliver messages of your choice.

V-ILS Induction Loop System

The Forman audio-frequency induction loop system allows hearing aid users to receive important information directly into their hearing aid. It can pick up separate signals from the driver's microphone in the cab and the VMMS system, as well as alerts from compatible systems in the saloon. It can be fully integrated with audio-visual systems, providing synchronised automated announcements to make public transport more accessible for hearing aid users.



VARU Audible Request Unit

The audible request unit offers up to five hard wired configurable inputs. It can be programmed with bespoke messages or sound effects to be played through separate speaker outputs in the cab and passenger area, making for clearer communication between passengers and drivers. It can play any customer-specified sound or message to replace multiple bell and buzzer combinations – for example, separate top and bottom deck bells, wheelchair ramp requests, medical emergency alerts, and more.

Assault Alarm

Our assault alarm presents a simple solution to a serious problem, offering extra protection to bus drivers. When activated, the alarm sounds an alert message to the bus exterior, alerting nearby road users of danger to the vehicle. Operators can choose between a male and female voice.

V-IU Cab Intercom Unit

The intercom unit allows for clear two-way communication between the bus driver and their passengers as they walk on and off the bus. It means the driver's cab is as secure as possible without compromising on communication. The system is available in push-to-talk or hands-free configurations and features adjustable volume in the event background noise levels change.

V-IS Handbrake Message System

The Handbrake Message System alerts drivers if the handbrake system is left disengaged when the doors are open, eliminating the risk of the bus rolling when it should be stationary. It can be supplied as a standalone unit with a speaker, or as part of a full speaker kit with two outputs. Both outputs are independent of one another, allowing for separation between the driver and passenger areas. Each unit is supplied configured to your requirements, meaning it can play additional warnings and bespoke alerts.

To find out how we can help you
enhance the safety and accessibility
of your vehicles, call us on

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