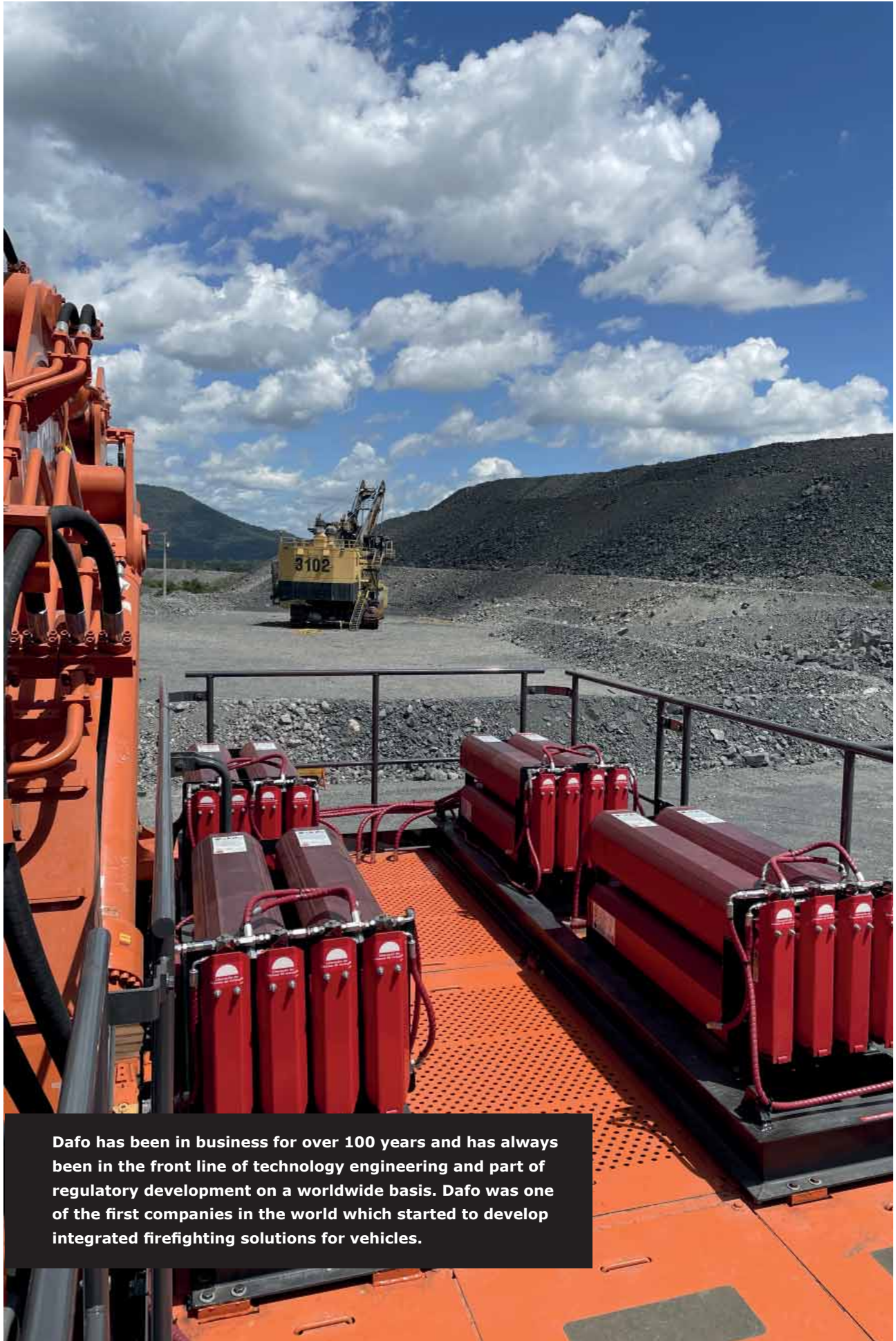


FIRE PROTECTION SYSTEMS FOR HEAVY-DUTY MINING VEHICLES





Dafo has been in business for over 100 years and has always been in the front line of technology engineering and part of regulatory development on a worldwide basis. Dafo was one of the first companies in the world which started to develop integrated firefighting solutions for vehicles.

Mining, both surface and underground, is a complex operation that needs large off-road vehicles/ heavy duty mobile equipment (HDME) and processing equipment that operate at remote locations 24/7. In addition, these machines operate under challenging and demanding conditions in environments with many potential fire hazards as the HDMEs often carry a lot of flammable liquids in pressurized fuel lines close to hot engines and transmissions.

When a fire breaks out on a mining vehicle the results can be dramatic. Expensive repair or replacement of valuable equipment are the obvious consequences. Extensive downtime and business interruption can result in even greater expenses as this equipment often takes many months to repair or replace. Further on and most importantly a fire on a mining vehicle can mean serious injuries to the machine operator, miners in some cases, also lead to geological instability, especially in the underground operation.

Dafo Vehicle offers the most reliable and effective fire suppression systems for HDME designed to survive challenging working environments and secure safety of operations. The systems are designed to mitigate losses due to fire and reduce the impact on investment, reducing downtime and securing business continuity and increasing the productivity of the end users. Dafo Vehicle's robust system not only protect individual hazards within the vehicle such as leaking fuel, hydraulic fluid, and/or lubrication, built up flammable deposits, but it is also a system with low life cycle costs.

In order to secure that Dafo Vehicle's fire suppression systems are fit for purpose in the challenging environments, the systems are thoroughly tested for fire performance ability and environmental durability such as Electromagnetic Compatibility (EMC), vibration, corrosion and temperature extremes according to international automotive standards to ensure the highest performance.

Dafo Vehicle fire suppression system fulfill the requirements of NFPA, Australian Standard AS 5062 and SBF 127:17 and among other certifications and approvals of the industry.

With more than 300 000 vehicle systems sold worldwide knowhow and experience ensure our customers to have the latest technology combined with proven reliability. The current solutions are being used worldwide as integrated solutions at the OEM production lines as well as retrofit installations at the end user in the mining industry.

Dafo Vehicle's systems are easy to maintain and refill on site which reduce downtime and operational costs when machines many times operate in remote places.



Dafo Vehicle Fire Protection continuously work with sustainability, meaning environmental sensitivity without compromising safety. A potential fire in a mining environment would have a significant impact on the working- and public environment. Dafo is measuring and mitigating impacts from manufacture to end-of-life and by choosing a Dafo system our customers can rest assured that it favorable contributes with added value in their own sustainability work.

Our system

The Dafo fire suppression system is a well-integrated and effective solution which is based on thorough Risk Assessment, design, installation, documentation with subsequent, training and related services.

The Dafo fire suppression system consists of four integrated elements; **Detection, Alarm, Suppression and Control** which work together in a coordinated, fast and efficient way to suppress fires.

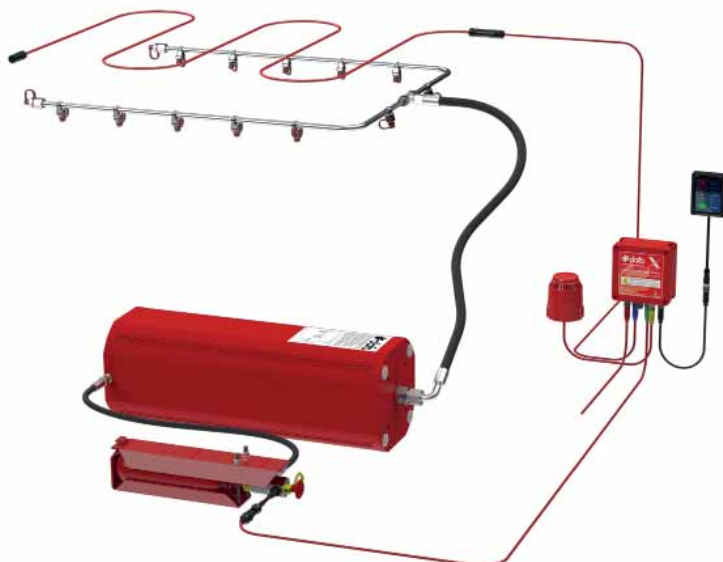
Detection: The detection system consists of an ultra-reliable Linear Heat Detection Cable routed throughout all high-risk areas inside the engine compartment to ensure early detection of a fire.

Alarm: The alarm panel placed inside of the operator cabin, will alarm the machine operator upon detection. The machine operator can also release the system manually from the panel. An external alarm, protected but in plain sight, will alarm the machine operator and the staff around the machine by sound and flashlight. If needed, the fire alarm can also be seen from the control room for each machine and the control room operator can release the fire suppression system from this location.

Suppression: The distribution network is composed of flexible fire resistance hydraulic hoses, stainless steel pipes with direct spray and full cone nozzles that will protect all areas or specifically locations with many potential fire hazards such as turbo charger, catalytic converter, pumps, fuel lines, generators, transmission belts, filters and hydraulic package.

Control: freshly released family of Dafo's new generation control units has following key features:

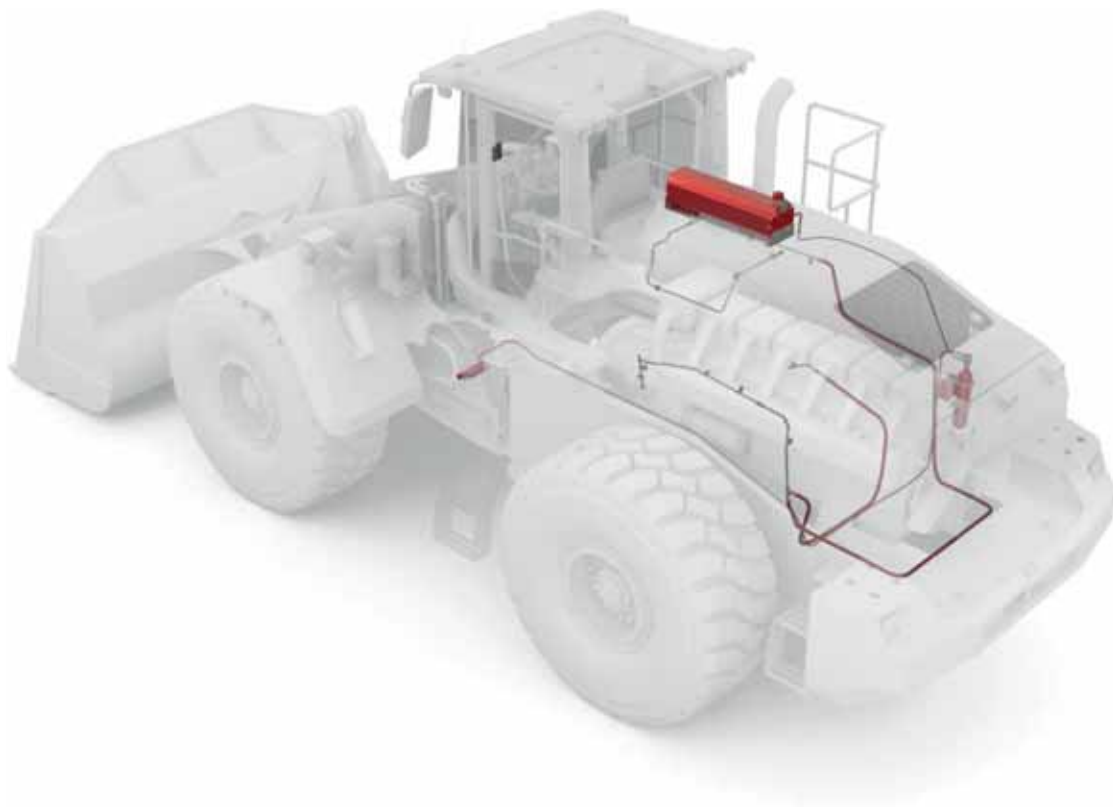
- Back-up power and no need to replace batteries
 - Real Time Clock and Event Log
- Allows access to full historical data in order to analyze historical events
 - Full compatibility with Dafo's upcoming solutions, including multi-zone CO-detectors
 - Model dependent features include:
- 1, 2 or 3 detections and suppression Zones
- 1 or 2 CANbus networks (SAE J1939)
- Up to 4 analogue inputs and 2 digital outputs
- M12 or MX150 connectors



Dafo Forrex™

The basis of Dafo Vehicle's system is the suppression agent Forrex which is specially developed to suppress fires in combustible engines. Forrex is highly effective on flammable liquid fires like petrol, diesel and hydraulic oils. The system combines the features of liquid and dry chemical, includes unique and propriety tailormade solutions and offers outstanding flame knockdown and unique protection against re-ignition as it will cool down the overheated engine parts in case of a thermal event.

- **Proprietary blend** - The Forrex is Dafo's own proprietary blend. The included surfactants improve the fluidity and fire-extinguishing performance of Forrex.
- **Effective Flame Knockdown** - Forrex is discharged through overlapping fields of spray which coats all areas of the engine and cutting off the fuels' oxygen supply.
- **High penetration capability** - Forrex spray droplets are slightly coarse but still small enough to create area liquid film cooling layer which absorbs the radiant heat. Forrex is also extremely effective at following the outline of the engine components in the risk area to ensure it reaches every part where the fire may be. This is particularly important for flammable liquid fires.
- **Excellent cooling** - Forrex effectively reduces the temperature on any super-heated surfaces below the ignition points of any flammable liquid.
- **Prevents reignition** - increased heat absorption with ability to cling on 3-dimensional surfaces and exclude oxygen.
- **Clean up after discharge** - In case of discharge it is easy to clean off with water.



The Dafo detection system is designed to activate an alarm (sound and flashlight), adjust the vehicle operation (shutting down the cooling and ventilation fans as well as shutting down the fuel line to reduce the spread of fire) and activating the automatic fire suppression system.

Linear heat detector is used in the engine compartments and is a fixed temperature sensor meaning that an alarm signal is triggered when the activation temperature of 180 °C is reached. The sensor cable consists of two steel conductors, each insulated with a heat sensitive polymer. At the activation temperature of 180 °C the heat sensitive polymer will melt and the conductors will short circuit initiating an alarm.

The insulated conductors are covered by an outer jacket made from flame retardant vinyl fluoropolymer (FR). This ensures good performance for most installations featuring low moisture absorption, good resistance against many common chemicals as well as excellent low temperature flexibility.



Large heavy-duty mining vehicles have large engine compartments. It is therefore important that the engine compartments are protected with additional suitable detection systems in addition to the linear heat detector which then provides the vehicle maximum fire protection.

Flame Detectors. For large engine compartments flame detectors are more suitable for detection. Flame detectors operate in the harshest environmental conditions and offer a solution for virtually any application where there is a fire risk to personnel and high value plant and capital equipment We offer flame detection solutions with fast response times, the best area coverage, the highest immunity to false alarms and all the performance and safety approvals you need.

Smoke detectors are used for early warning of fires in electrical cabinets. The performance and suitability is good with both black white smoke. The amount of the false alarms is significantly decreased by the stability of the detector which is reliable and customizable to the changes triggered by the changes of the surroundings environment. The stability of the detector and low false alarm rate is further ensured by the use of algorithms to decide when the detector should change to alarm state. This removes the likelihood of a detector triggering an alarm as a result of smoke and particles from other non-fire sources.

Multizone temperature detection for large vehicle coverage – technology that can indicate excess temperature in multiple zones.



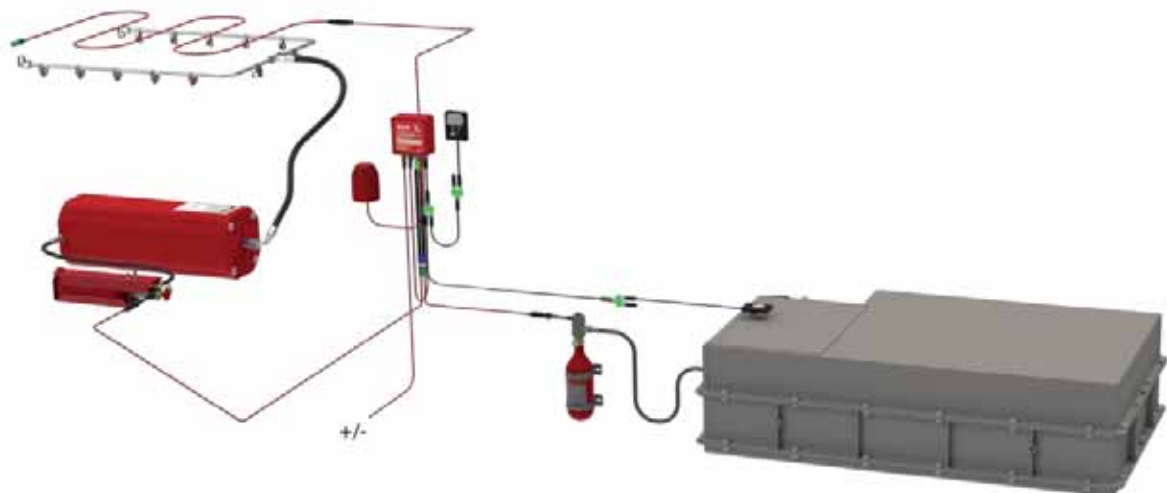
Electrical cabinets in heavy-duty mining vehicles are a well-known source of fires as it can generate enough energy required for the ignition. It also provides the combustible material needed for spreading of the fire. Fires originating from the electric system account for a relatively large proportion of the total number of fires.

Causes of Fire:

- Short circuit - This is a rare occurrence in an electric installation conforming to international standards since the safety devices (circuit breakers or fuses) immediately will be triggered.
- Surcharge - In this instance the conductors heat up without safety devices being triggered.
- A contact resistance - Heating occurring between two elements causing electric arcing.

PFK system – The PFK system combines fire suppression abilities with environmental sustainability.

The PFK system agent FK-5-1-12 is pressurized in the agent tank with nitrogen. The FK-51-2-12 which is a colorless and odorless gas suppresses fires through cooling and suffocation by removing the heat energy and interrupting the combustion process. The clean agent leaves no residue, requires no cleanup is non-conductive and non-corrosive. FK-5-1-12 agent quickly evaporates without harming any valuable assets.



Advantages

- Fast and reliable fire protection.
- Suppresses a fire in seconds, reducing equipment damage and downtime.
- Penetrate even complex environments quickly.
- Easy to install in any electrical cabinet onboard on HDME.
- Clean suppression agent requires no post-discharge cleanup.
- Harmless for people, equipment and the environment.
- Does not interfere with installation or maintenance of equipment.
- Clean agent which will not damage electronic equipment even when energized.



Dafo^{CLOUD}

The Dafo^{CLOUD} is a cloud-based risk management system to provide full overview of lifecycle of Fire Detection and Suppression System (FDSS).

The Dafo^{CLOUD} provides access to the full history and genealogy of sub-systems of the FDSS and the complete information is seamlessly accessible and updatable by relevant stakeholders.

The restricted access database contains information about the whole life cycle of each FDSS:

Manufacturing

- The electrical sub-systems of FDSS are always individually tested, programmed and configured by using equipment connected to Dafo^{CLOUD} which enables full control and visibility about detailed test reports but also firmware files, settings and configurations used over the time.

Installation

- The FDSS-specific installation documentation is accessible for technicians via Dafo^{CLOUD}.

Maintenance

- Both planned and unplanned maintenance activities, including associated time-stamped reports, photos/videos and reminders for next actions will be stored and handled by Dafo^{CLOUD}.
- Historical event logs of Control Units can be accessed from Dafo^{CLOUD} for in-depth analysis

The Dafo^{CLOUD} is the basis for reducing and controlling the total cost of ownership with keeping maximized safety in focus.



Service



Spare Parts



Quality
Records



Diagnostics

Safe with Dafo



Active fire protection is an integral part of systematic and effective fire prevention. Together with Dafo Vehicle Fire Protection, you'll always get the most effective solution so that you can limit fire damage, reduce downtime and increase productivity.

Since the start back in 1919, Dafo has developed into a modern, high-tech company committed to offer the very best solutions to our customers.

Dafo Vehicle Fire Protection has three main business areas: Integration (Fire suppression systems integration into OEM production line, Retrofit (Fire suppression systems installed at final customer) as well as Service & Maintenance.

Dafo group today consist of several subsidiaries and Dafo dealers – Dafo Oy (Finland), Dafo US, Dafo Deutschland, Dafo Russia, Dafo Asia, Dafo Spain, Dafo UK & Ireland, Dafo Brasil, Dafo Middle East, Dafo South Africa, Dafo Vehicle Peru. & Dafo Chile.

Do not compromise safety – contact Dafo Vehicle Fire Protection already now!

