



**COMPLETE SYSTEMS FOR
BUSES AND COACHES**



**MARKET AND PRODUCT
INFORMATION**

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Background Information

Fire Risk Assessment

Considering an average life time of approximately 10 years for buses, which are running all day long, the **initial decisions are key**.

Indeed, Fleet Operators have to deal with several challenges including risk management, maintenance and cost management.

When it comes to fire, statistics are clear: **1% of the fleet is burning every year**.

Reported Bus Fires		
	UK (1)	Sweden (2)
Number of buses	41 900	13 710
Fires / year	560	129
Percentage	1.34%	0.93%
Average Property Damage	Between 44 KEUR and 123 KEUR	N.A
Percentage of buses encountering fire 1999-2009	N.A.	10%

(1) UK Department of Statistics and Local Government, European Commission Enterprise & Industry, and FMCSA

(2) SP Research Institute

Fire causes

Studies from the NFPA, SP and the Department of Transport in the UK show that the most part of these fires are non-collision related and **70% start in the engine compartment**.

Stringent demands for **low noise levels** imply to encapsulate the engine compartment. The permissible **emission levels** are lowered, so service temperatures in engine components are warmer in order to increase the combustion efficiency.

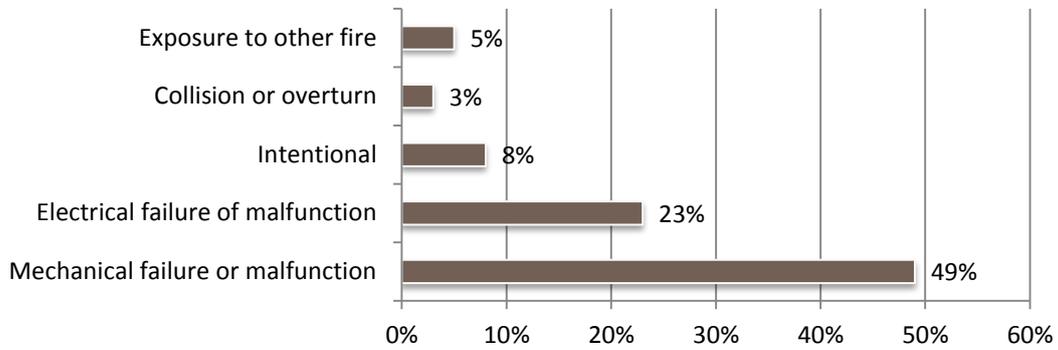
These demands and regulations leads to a significant **rise of engine compartment temperatures**.

Moreover, buses and coaches are heavily used and thus have **little maintenance time**.

Overall Statistics

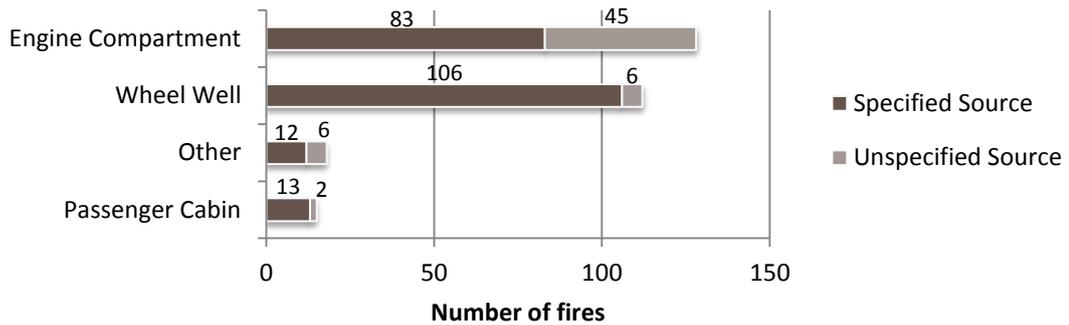
Repartition of Fires Causes (2003-2007)

Source: NFPA



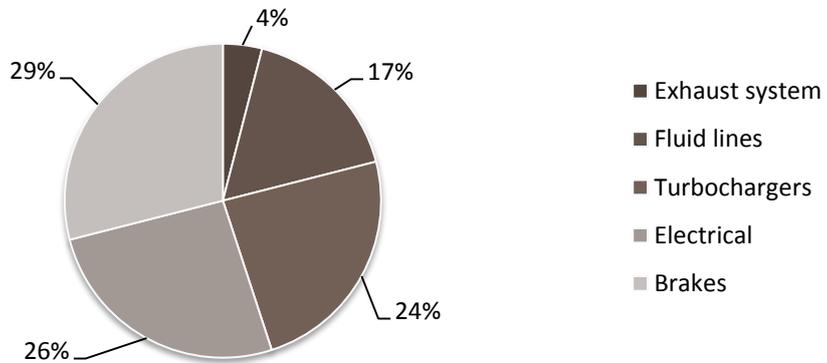
Repartition of Fire Causes in Buses

Source: 2008 Motorcoach fire analysis - FMCSA



Repartition of Specified Sources Fire

Source: 2008 Motorcoach Analysis - FMCSA



SPCR 183 Certification

SPCR 183 was officially presented to the **United Nations Economic Commission for Europe (UNECE)** in April 2013. based on the fact there was no complete international test standard for automatic fire suppression systems for engine compartments (approx 70% of the fire causes) in buses and coaches.

The objective was to design a test standard so that the firefighting performance of different suppression systems can be evaluated in a **well-defined, objective and comparable way**.



This project was led via an important group of experts from all over the world: local authorities, safety transport associations, bus manufacturers and fire suppression systems manufacturers. (See list in Appendixes)

Large variety of tests for buses and engines but not reliable enough

Defined on State-of-the-art, SPCR 183 is based on the best practices of all the related standards, and oversteps weaknesses identified for other testing method.

Extinguishing systems for buses:

- **SBF 128:1:** Sweden "Guidelines for fixed automatic fire suppression systems on buses and coaches"
*Test Weakness:– Well defined tests of components but **no test on system level**.*
- **AS 5062-2006:** Australia "Fire protection for mobile and transportable equipment"
Weaknesses: - Tests on a bus approved by SBF. Participation of SBF-approved controllant. No spray fire in this test.
- **Bus Fire Safety, SP Report 2008:41, Chapter 6:** "Test method concept for engine compartment fire extinguishment systems"
Weaknesses: - Downscaled test (1:3) for development purposes.

Extinguishing systems for heavy vehicles and machinery spaces can also provide valuable ideas:

- **UL 1254:** "Pre-engineered Dry Chemical Extinguishing System Units", Test method for Off-the-Road Vehicle Protection System
- **SBF 127:** "Guidelines for fire suppression systems on vehicles and forest machines"
- **MSC/Circ. 1165:** "Revised guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump-rooms"
- **RINA Doc. 3.13:** "Rules for the Type Approval of Clean Agent Fixed Fire-Extinguishing Systems in Machinery Spaces"
- **SP-method 2377:** "Fire test procedures for water spray fire suppression systems in small machinery spaces"

SPCR 183: A stringent methodology of performance tests

Fire Tests in accordance with SP Method 4912:

Fire testing is performed in a test apparatus made up of a full scale engine compartment mock-up containing parts representing some typical engine features and complemented with obstructions. **Five types of fire sources are combined into 11 different fire test scenarios**, which differ from each other with respect to fire source type, severity and location, grade of obstruction, number of the fire sources used at the same time and forced air flow rate applied through the apparatus.



Component tests:

The focus is on environmental durability testing with respect to vibration, shocks, temperature variations and corrosion:

- **Vibration and shock testing combined with temperature cycle**, in accordance with ISO 16750-3, a standard for environmental testing of electric/electronic equipment for vehicle;
- **Corrosion resistance testing**, in accordance with ISO 21207, Test Method B.3, which is an accelerated corrosion test **simulating 14 years of service in a more severe industrial or traffic environment**;
- Enclosure of electrical/electronic equipment of the suppression system should at least fulfil **IP65 degree of protection** in accordance with IEC 60529:1989/A1:2009/COR3:2009.



Rotarex has been the first suppression system manufacturer who passed all the tests with success and got the P-mark for its vehicle engine suppression system.

See SP's website:

www.sp.se/en/index/services/certprod/certprodprofil/skydd/brandbuss/sidor/default.aspx

Compact Line System

Technical Advantages

Cylinder technology

FireDETEC Compact Line systems use a **unique technology**, which gives it lots of advantages. Both technology and design result of years of development and tests.

The Compact Line System is different from other fire suppression systems: it is **flexible and safer**.

It is rather **small and light** (55cm - 20kg) and can be mounted vertically or horizontally, depending of the configuration and the space available. It is easy and quick to install and maintain.

As the dual-chamber cylinder is made from extruded aluminium alloy, it is extremely **strong and resistant to corrosion**. The complete system passed successfully a corrosion test to get the **SPCR 183 certification**. This is significant for vehicles due to rough conditions, including shocks, vibration, dust, oils, and heat.

During normal operation the Compact Line external chamber containing the extinguishing agent is not pressurized and serves as additional protection against out damages for the internal chamber for 200 bar nitrogen gas.

Two burst discs protect the external chamber and the internal one from over pressure damage.

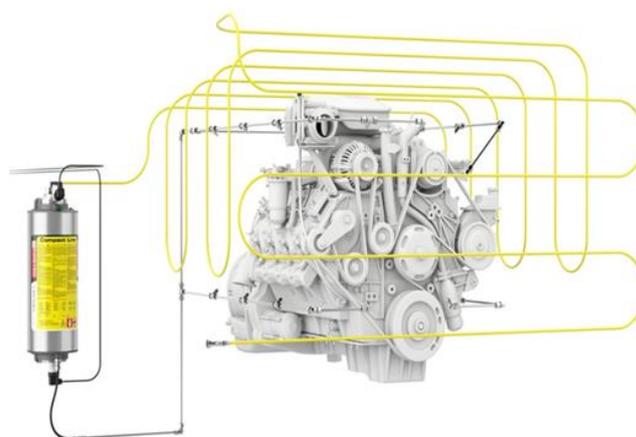
FireDETEC Thermal Detection Tube

For more **safety**, the FireDETEC system is equipped with a special **heat-sensitive tube**. The FireDETEC sensor tubing is connected to cylinder and pressurized with 16 bar nitrogen gas. It reacts to fire and extreme temperatures and must be installed in the fire hazard area. It bursts at approximately 175°C. The bursting of the FireDETEC tube triggers the fire extinguishing process.

FireDETEC sensor tubing enables a continuous linear detection, and requires **no external power** source to function. It will not discharge the extinguishing agent accidentally.

The unique yellow sensor tubing has been specifically developed for vehicle engine and has many benefits, as it adapts to the machine: it is totally flexible and thus **easy to install**. So, it enables to **reduce installation and maintenance costs**.

FireDETEC thermal sensitive tube is **resistant to oil and dust**. The use of this kind of detection also **avoids false alarms** because it does not react with smoke, which is often produced by engine.



Monitoring through Dashboard

Pressure switches can be installed on the system and enable secondary electronic operations. The advantage of the pressure switches remains in the installation of a **control unit dashboard** for bus drivers.

A pressure switch (160 bar) is installed on the Compact Line cylinder and measures the cylinder pressure. When a pressure drop is detected, the error signal will light on.

Another pressure switch (5 bar) is installed at the end of the detection line. When the tube bursts and the pressure is suddenly released, the orange error signal is activated.

The control unit dashboard displays status information of the system to the bus driver.



It can indicate:

- **OK signal (Green):** the system is armed and under pressure
- **Error signal (Orange):** the system has detected a leakage or other problems...
- **Alarm/Discharge signal (Red):** a fire is occurring and the system discharges

The system is **100% automatic**, but it can be combined with a **manual actuator if needed**. Bus drivers simply have to pull the yellow safety device and push the handle push the button in order to activate the system.

Fire Extinguishing Agent

Finally, the system uses TS55 agent, a **non-toxic** and **eco-friendly** extinguishing agent, it is completely safe for human and environment. TS55 is a very efficient fire extinguishing agent with **freeze protection** down to -55°C. The agent is especially adapted to high-pressure fog systems. TS55 is also recognized by the **Swedish National Testing and Research Institute**, since it has better properties compared to other agents.



12 liters Compact Line

The compact line will soon be available in another size: 12 liters. This provides a better extinguishing effect when protected spaces are wider.

Compact Line Cylinder Specification

- **Dimensions:** 60 x 19 x 19 cm
- **Weight (empty):** +/- 25 kg
- **Material of construction:** Aluminum
- **Working temperature:** -30°C to +80°C
- **Volume of agent:** 7 liters (Soon 12 liters)
- **Type of extinguishing agent:** FireDETEC™ TS-55 ea
- **Propellant gas:** Nitrogen at 200 bar
- **Cylinder approval:** π
- **Optional solenoid actuator**

References Compact Line

Last Installation of Compact Line Systems

Car Postal Suisse SA

Installation of compact line system on a bus fleet

December 2013



Other References

Rotarex Compact Line is **trusted worldwide**: many companies, using vehicles in rough conditions, work with us.

	Clients	Country
Trenitalia		Italy
Terex		US / Italy
Caterpillar		France
Bouygues		France
Normandie Manutention		France
Liebherr		Germany
Wiss		Poland
ØVeraasen		Poland
DAF		Switzerland

<p>Rotarex Company Profile</p> <p>World Leader in Specialty Cylinder Valves For High and Ultra High Purity, Medical, Cryogenic, Fire Suppression, Oxygen Pipeline and Industrial Applications.</p> <p>Six Specialized Business Units Deeper Expertise - Better Focus – Applied Solutions. CEODEUX / EQUIPMENT / FIRETEC / AUTOMOTIVE / SRG-LPG / MEDITEC</p> <p>A Global Service Infrastructure A global team of 1400 specialists across 26 offices and service centers, 10 factories and 6 R&D centers.</p>	<p>Company name: ROTAREX S.A.</p> <p>Privately held company Family owned business</p> <p>Established: Since 1922</p> <p>Number of employees: 1400</p> <p>Turnover: 150 000 000 EUR</p>
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Appendixes

FireDETEC[®] Sensor Tubing Tests

Description of the tests realized on red and black tubing as part of the FM & UL approval tests for certifying entire FireDETEC pre-engineered systems.

Leakage Rate

The FireDETEC[®] Sensor Tubing passed the FM Approvals *One Year Leakage Test*. Six FireDETEC[®] indirect systems were filled with HFC 227ea and pressurized to the nominal working pressure, 240 psi (16.5 bar). Samples were weighed initially and then placed in a secure storage area for a period of one year. None of the systems leaked in excess of the allowed 0.25% of charge weight over the period of test. Discharge tests were then performed successfully, and post-discharge inspection revealed not a single sign of the tube deterioration.

Aging Test

FM Approvals and UL 2166 *Air-Oven Aging Test* was performed with one 2 ft. (0.6 m) sample of FireDETEC[®] Sensor Tubing. The tube was subjected to air-oven aging at a temperature of 212°F (100°C) for 180 days. Following the test, the sample exhibited no signs of any cracking temperature. A hydrostatic test was then performed on the tubing: the sample was pressurized to six times the nominal operating pressure, 900 psi (62.1 bar), for a period of one minute. No signs of damage were observed.

30-Day Extreme Temperature

Leakage Test

According to FM Approvals *30-Day Extreme Temperature Leakage Test*, twelve FireDETEC[®] indirect systems were filled with HFC 227ea and pressurized to the nominal working pressure, 240 psi (16.5 bar). Six samples of these systems were conditioned to the maximum operating temperature, 130°F (54°C), for a period of 30 days, while six other sample were conditioned to the minimum operating temperature, 32°F (0°C),

for the same period. All samples were weighed before and after the test period. None of the assemblies leaked in excess of the allowed 0.021% of charge weight over this time. Discharge tests were then performed successfully, and post-discharge inspection revealed no signs of deterioration.

Corrosion – Salt Spray

Two pressurized systems and separate components were subjected to a 240 hour, 20 percent salt fog corrosion test per ASTM B117, *Standard for Salt Spray Testing*. Components, including the FireDETEC[®] Sensor Tubing, were then examined to verify they exhibited no corrosion, galvanic action, loss of legibility of markings, or separation of protective coatings that would impair future functionality. Every sample passed the test. Furthermore, Discharge tests were performed on each system successfully.

ROTAREX Quality Control

Applying 90 years expertise, ROTAREX products are manufactured with the highest quality standards to ensure consistent reliable performance even in the most severe conditions. The entire FireDETEC range is designed and produced in Europe to meet the most stringent requirements in terms of quality.

For the FireDETEC[®] Sensor Tube, Rotarex focuses on all the steps of the supply chain. This level of rigour is a key point for such a high value-added product.

FireDETEC is a trademark of the CEODEUX Extinguisher Valves Technology S.A., part of the group ROTAREX S.A.

Group of experts from all over the world who worked on SPCR 183

A project led via a taskforce of transit authorities, insurance companies, bus associations & bus manufacturers, fire suppression systems manufacturers

ACAF Systems, Inc.	Los Angeles County Metropolitan Transportation Authority
Aerojet	LPG Técnicas en Extinción de Incendios, S.A
AFEX Fire Suppression Systems	LVT Fire
Amerex	MAN
American Bus Association	MCI
Americoach Systems Inc	Metropolitan Transit System (Sand Diego)
APTA	Motor Vehicle Fire Research Institute
AQUASYS Technik GmbH	NIST
ATK	Nobina
Auto Fire & Safety Consultants, Inc.	One Seven
BAM	Optare
BCTransit - British Columbia	Otokar Turkey
Busguy	PreventTec
Bussbranchens Riksförbund	Prevost, Division of Volvo Group Canada
Comil Ônibus S.A	Public Transport Authority of Western Australia - Transperth System
CPT – Conf. of Passenger Transport UK	Pyrogen Technologies (AUST) Pty Ltd
CTA - Chicago Transit Authority	Reflex
CVSA - Commercial Vehicle Safety Alliance	Rotarex
Dafo	SAE Fire Safety Committee
Daimler Buses North America	Salgrom Technologies
Evobus	São Paulo Transporte S/A.
Federation of the European Union Fire Officers Associations	Startransbus
Fire & Safety Systems Australia	Scania
Fireaway - Statx	Serco
Firedect (Fogtec)	SOLARIS
FirePro	State Transit Authority - Sydney buses
Firetrace Ltd	SÄRF
Firstgroup (Greyhound)	Temsa Global
Fogmaker	Thermax
Fogmaker North America	Topaz Fire Systems Pvt Ltd
Foothill Transit	Toronto Transit Commission
German Federal Ministry of Transport	Transport for London
Gillig	Transportstyrelsen - The Swedish Transport Agency
Gottwald Engineering	Tyco - Ansul
Greyhound	Ultra Fog AB
Halsey King And Associates Inc.	USA Pro-Safecraft
Israel Fire Commissioner	UMA - United Motorcoach Association
Jewelsaffire	Veolia Transport
Just-In Case Fire Ltd. (FireCaddy)	Volvo buses
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