Brisbane Transport
Pyrogen IPEX Fire Suppression System
Full-Scale Bus Engine
Compartment Fire Test

Test Report

Volvo MK2 Bus - Middle Engine Compartment

Carried out at:

Brisbane Transport Workshops &
Queensland Combined Emergency Services Academy
Australia

31st August 2010

Test Report Ref. No: PGAus: 1/10

Pyrogen Technologies (AUST) Pty Ltd

TEST REPORT ON TESTS CARRIED OUT TO EVALUATE PYROGEN IPEX FIRE SUPPRESSION SYSTEMS FOR THE PROTECTION OF PASSENGER CARRYING BUSES

DATE: 31ST August 2010

VENUE: QUEENSLAND COMBINED EMERGENCY SERVICES ACADEMY
BRISBANE, QLD, AUSTRALIA

WITNESSED BY:

Brisbane Transport
ALS Laboratory Testing Services
Department of Community Safety, Qld
Pyrogen Technologies (AUST) Pty Ltd

TEST CONDUCTED BY:

ALS Laboratory Testing Services

1.0 PURPOSE OF TEST

A Full-Scale Live Fire Extreme Testing in accordance to the test protocol specified by CSIRO Australia for Brisbane Transport was a mandatory requirement for the Fire Suppression Systems participating in the Tender T100188-09/10 “Supply and Installation of Bus Engine Bay Fire Suppression System” by Brisbane City Council.

2.0 BUS FIRES – RISK ASSESSMENT

Engine fires in passenger transport buses pose a potentially serious threat to human lives.

In most cases of bus fires a fire starts in an engine bay and develops very rapidly. The main fire load in engine bay is generally plastics, rubber, oil and fuel, usually present in large quantities. All those materials are easily ignitable and provide a large amount of energy to sustain the fire in a relatively small confined space.

Another problem is a spillage of diesel or hydraulic oil on the ground, which, most likely, would cause a fire re-ignition even if a fire in the actual engine compartment had been suppressed. Spillage fires on the ground require an engineered system that would ensure not only a complete extinguishing of fire in the engine compartment, but additional supply and distribution the extinguishing agent for the ground area underneath the engine.

The fire suppression system that can be recommended for such difficult application must exhibit a fast responding detection system, a rapid establishing of the design concentration and an extremely high extinguishing efficiency. The system must also be compact in size considering small and congested engine compartments in buses.

3.0 BRIEF OF PYROGEN IPEX TECHNOLOGY

IPEX Impulse Powder Extinguisher is a non-pressurized self-contained metal canister delivering a dry chemical and gaseous extinguishing medium into a fire zone ***within a few seconds*** from the commencement of the discharge.

The impulse discharge is achieved due to a special cold gas generator incorporated into the canister containing the extinguishing powder. Upon activation of the system the gas generator operates releasing gases. The gases rapidly build up an internal pressure and aerate the extinguishing powder resulting in an impulse gas-powder delivery through a specially designed discharge outlet.

Implementation of the gas generator achieves two major results – provision of an ***astonishing rate of powder delivery*** and ***prevention of powder caking***, thus resulting in ***extremely high performance of the system***.

IPEX features the following unique performance parameters.

- **Rapid system discharge** – instantaneous extinguishment, low agent consumption, minimum damage to the enclosure, vehicle or/and equipment;
- Reliability in aggressive environments – wide operation temperature range from - 50°C to **up to 95°C**, resistance to vibration (**no caking**) & high humidity, resistance to corrosive and salty atmospheres;
- Approved for mobile equipment;
- Easy installation – **no pressure cylinders**, no liquids or gases, easy replacement;
- **No maintenance for the actual extinguishing modules** (only electrical monitoring for a complete system where installed);
- Choice of operation modes – can be operated automatically or manually;

4.0 TEST VEHICLE ENCLOSURE

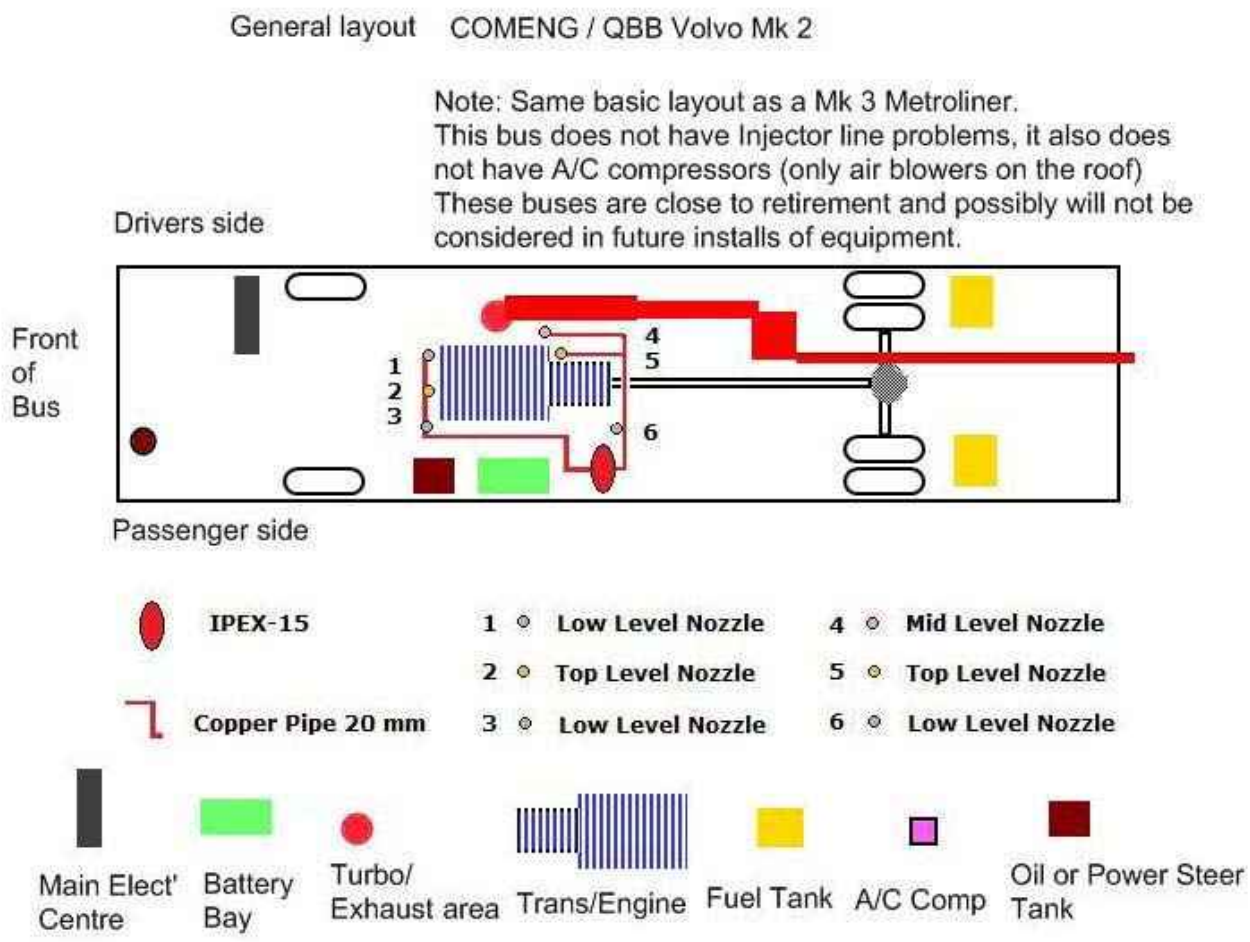
Brisbane Transport has chosen a COMENG Volvo Mk2/3 (chassis), QBB (body) route bus. This route bus has been in a frontal accident and is deemed unsuitable for repair for road use. The vehicle has a damaged front, however is fully mobile and functions well with all dash instruments being operational. The bus has a middle engine compartment, the size being approximately 2.3m(L) x 1.3m(W) x 0.5m(H). The engine compartment is split into nearly three smaller separate compartments by two vertical beams (chassis frame).

5.0 IPEX FIRE SUPPRESSION SYSTEM DESIGN

The proposed IPEX engineered system has been specifically designed for a COMPLETE protection - both engine compartment (engine fires) and a ground area underneath the engine (spillage fires).

IPEX system consisted of 1IPEX-15T module equipped with 6 nozzles to provide an adequate coverage for all three sections of the engine compartment.

A schematic of the engine compartment and IPEX-15T system layout is shown below in Fig.1



A complete automatic detection, warning and activation system was installed for testing and evaluation of its performance parameters, which was conducted prior to the fire test.

In the actual fire test IPEX system was activated MANUALLY at the end of 30s pre-burn time period.

6.0 TEST FIRE PROCEDURE

6.1 Main Fire Test – Manual Discharge of IPEX fire suppression system (CSIRO Test Specification)

The test protocol was specified by CSIRO and represented the “worse-case” scenario as requested by Brisbane Transport.

A few video cameras were installed at various levels and angles outside the tested bus. There was no video camera inside the engine compartment.

a) Fire Loads

The following fire loads were used in the test.

- 2L of dry sawdust/wood chips mixture;
- Liquid: 50% diesel oil, 25% hydraulic oil, 25% used lubricating oil;
- 3L of dry sawdust/wood chips (50/50 mixture) saturated with 2.75L of liquid, the mixture was prepared 24 hrs before the start of the test;
- 200g of twisted cotton waste soaked (for at least 5 min) with liquid;

b) Test Sequence

- Bottom Fire. 2L of the dry sawdust/wood chips mixture was placed in the tray 500x500x25mm made of 2mm steel. Approximately 1.5 L of Liquid was then poured onto the sawdust/wood chips mixture in the tray. The tray was placed underneath the engine. The tray with the specified fire loads imitated spillage fires on the ground.
- Top Fire. 3L sawdust/wood chips mixture saturated with Liquid was poured into the engine compartment to form an even (approximately 5mm) layer. 1L of Liquid was poured (using watering-pot) onto the mixture. Cotton waste was then placed on top of the fire load.
- Engine started and run idle for 15min followed by 5min at 1700-1800rpm.
- 1.5L of Liquid was poured onto the engine.
- Cotton waste was ignited to start the fire in the engine compartment (Top Fire).
- The fire loads in the tray underneath the engine were ignited to start the “spillage” fire (Bottom Fire).
- Count down of the pre-burn time (30s) started.
- Engine compartment was closed.
- The engine was stopped after 28s pre-burn.
- The IPEX system was manually activated after the end of 30s pre-burn.

c) Observations

- Bottom Fire was extinguished prior to the end of IPEX system discharge.
- 1 min after the end of IPEX system discharge the engine compartment was open for observation. Top Fire was extinguished with no signs of smouldering.
- The engine compartment was then closed for another minute, following which the engine compartment was open again and left open.
- No re-ignition of both Top and Bottom Fires was observed.

6.2 Additional Fire Test – Automatic Electrical Detection and Activation System Performance (outside CSIRO Test Specification)

A live fire test of the automatic electrical detection and activation system (Control System) has also been requested by the Tender team to demonstrate the performance of the Control System in the actual fire situation. The CSIRO test as detailed in section 6.1 requires testing of a delivery system only (Manual Discharge of IPEX fire suppression system).

A complete automatic detection, warning and activation system was installed.
The system performance test was conducted on 26th August 2010, prior to the main test.
Video documentation was taken.

a) Test Loads

Test loads were as described above in section 6.1. Only engine compartment fire (Top Fire) was set for the purpose of the test.

b) Test Sequence

- Top Fire. 3L sawdust/wood chips mixture saturated with Liquid was poured into the engine compartment to form an even (approximately 5mm) layer. 1L of Liquid was poured (using watering-pot) onto the mixture. Cotton waste was then placed on top of the fire load.
- Engine started and run idle for 15min followed by 5min at 1700-1800rpm.
- 1.5L of Liquid was poured onto the engine.
- Cotton waste was ignited to start the fire in the engine compartment (Top Fire).
- At 13s after the ignition of the fire the hatch was closed.
- At 15s after the ignition of the fire, the fire was detected by the Linear Heat Detector (XCR-M type, fixed temperature 180ºC)
- At 47s after the ignition of the fire IPEX fire suppression system was automatically discharged.

c) Observations

Automatic electrical detection, warning and activation system operated as intended

7.0 TEST PHOTOGRAPHS

7.1 Layout of Pyrogen IPEX-15T module prior to test

7.2 Top Fire – Engine Compartment

7.2.1 Ignition of Fire Load

7.2.2 IPEX Activation

7.2.3 Engine Compartment opened at 1.5 min after the end of IPEX discharge

7.3 Bottom Fire – "Spillage Fire" Underneath the Engine

7.3.1 Pre-burn

7.3.2 IPEX Activation, Commencement of Discharge

7.3.3 Fire Extinguished Prior to end of IPEX discharge

7.3.4 End of IPEX discharge

7.3.5 Post Extinguishment - 15 s after the end of IPEX discharge

8.0 TEST RESULTS

The full-scale live fire test protocol represented extremely difficult conditions including:

- multiple class fire loads - sawdust/wood and twisted cotton of class A fires as well as diesel/hydraulic/used lubricating oils of class B fires;
- two fire zones - Top Fire in the engine compartment (engine fire) as well as Bottom Fire in a ground tray (spillage fire).

Both video and visually recorded results on both fires were as follows.

Bottom(Spillage) Fire

Time	*Test sequence/result*
0-4s	Ignition of fire load in the tray
30s	30s pre-burn
34s	Engine shut-down
36s	IPEX system activation
40s	Fire extinguishments
44s	End of IPEX system discharge

Top (Engine) Fire

Time	*Test sequence/result*
0-17s	Ignition of fire load (6 cotton patches) in the engine
30s	Hatch is closed
49s	Engine shut-down
51s	IPEX system activation
59s	End of IPEX system discharge
149s	Hatch opened and closed for visual observation – fire extinguishment
224s	Hatch opened second time and left open – no fire re-ignition

The test results showed that both Top Fire (engine fire) and Bottom Fire (spillage fire) were rapidly and completely extinguished with Pyrogen IPEX fire suppression system.

The video recorded results on Bottom (Spillage) Fire show that the fire had been completely extinguished even prior to the end of IPEX system discharge within just 4 seconds from IPEX system activation.

The visual observation of the Top (Engine) Fire (no video recording in the engine compartment) revealed a complete extinguishment of fire when the engine compartment was opened at 1.5 min after the end of IPEX system discharge.

Additional fire test to evaluate the performance parameters of the Control System (automatic electrical detection, warning and activation system) demonstrated that the Control System operated as intended.

9.0 CONCLUSION

Based on the results of a full-scale live fire test conducted on a COMENG/QBB Volvo Mk2/3 route bus it can be concluded that a Pyrogen engineering IPEX-15T system satisfies the specified test performance criteria and is suitable for a bus complete protection against fires in engine compartments as well as against spillage fires on a ground area underneath the engine.

Report by,

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