FIRE INVESTIGATION REPORT

Channel Tunnel Fire
Folkestone, England to Coquelles, France
November 18, 1996

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1.0 Introduction

This report was prepared by NFPA’s Fire Investigations Department to document the fire that occurred on November 18, 1996 in the railway tunnel that connects Folkestone, England with Coquelles, France. NFPA’s Chief Fire Investigator, Ed Comeau, conducted a 4-day on-scene investigation of the incident. This included site visits to the Folkestone terminal, inspection of standard rolling stock apparatus, and interviews with personnel who responded to this incident. These interviews included United Kingdom and French command officers, Kent Fire Brigade fire fighters and staff and Eurotunnel staff.

In light of the fact that NFPA currently has no documents that directly apply to rail tunnels and these types of passenger and freight trains, an analysis of this incident was not done. The scope of this report is limited to the facts that were available during the on-site visit and any made available during the subsequent report production. It is not NFPA’s intent to determine the cause and origin of the incident, nor to attempt to place responsibility for any of the events, conditions, or actions leading up the fire and during the period following. NFPA’s objective is to present the incident in order that others may gain some insight from the “lessons learned” that have emerged out of this significant fire.

This investigation was conducted in conjunction with a team of investigators sent from the Metropolitan Fire Brigade of Melbourne. This team was comprised of Fire Safety Engineer Nabeel Kurban and Senior Station Officer Dexter Hayes.

The on-scene investigation was made possible through the cooperation and assistance of the Kent Fire Brigade. NFPA appreciates the assistance provided by Chief Fire Officer Jeremy Beech of the Kent Fire Brigade in facilitating access to the site, equipment, and personnel. NFPA would also like to extend its thanks to the command officers, the fire fighters, and staff of both the Kent Fire Brigade and the French Fire Brigade stationed at the terminal in Coquelles, who provided invaluable information and assistance.
2.0 Executive Summary

The fire occurred on a 29-car shuttle traveling from France to the United Kingdom on Monday, November 18, 1996 at 8:45 p.m., UK time. (NOTE: There is a 1-hour time difference between Folkestone, UK and Coquelles, France. For consistency, all times quoted will be UK time.) The shuttle that was involved was a Heavy Goods Vehicle shuttle, or an HGV, which transports lorries (cargo trucks). The carrier wagons on which these lorries are conveyed are covered with a solid roof, and the sides are open lattice.

The tunnel is 50.45 kilometers long (31.35 miles), and runs from Folkestone in the United Kingdom, to Coquelles, France and is operated by a private corporation, Eurotunnel. It is configured with two running tunnels which run in parallel (each tunnel is referred to as the north running tunnel and the south running tunnel) and measure 7.6 meters (25 feet) in diameter each. A service tunnel runs between the two running tunnels. It is connected to the running tunnels by 270 cross passages located every 375 meters (1,230 feet). The service tunnel measures 4.8 meters (16 feet) in diameter. The depth of the tunnel beneath the seabed varies from 45 meters to 75 meters (150 feet to 250 feet).

The fire was reported to have occurred in a carrier wagon at the rear of the train. According to personnel from the French Fire Brigade, the fire was observed as the train was entering the tunnel. This report was relayed to the Railway Control Center (RCC), and the decision was made to have the train continue towards the UK where the fire would be extinguished when it emerged, per pre-existing standard operating procedures. This information was relayed to the driver of the train.

There are emergency response teams stationed at each end of the tunnel that are referred to as the First Line of Response, or FLOR. The FLOR from the French side began responding immediately through the service tunnel. The United Kingdom team was notified initially, but a response was not requested. However, the UK FLOR elected to begin responding towards the midpoint of the tunnel via the service tunnel in the event that they were needed.

During the passage through the tunnel, the driver of the train received a warning light on his control panel that indicated that there was an abnormality in the train that may cause a derailment. Standard operating procedures require that the train be stopped until such a condition can be verified, and he was able to bring the front of the train to a controlled stop at marker 4131, approximately 19 kilometers (12 miles) into the tunnel from the terminal at Coquelles.

The Chef de Train (CdT), who is in overall charge of the train, then opened an exterior door on the club car to determine what was wrong, and smoke immediately entered the club car, which was occupied by 33 people. He then closed the door, but it was reported that the smoke was so heavy that people were required to lie on the floor in order to breathe.
According to UK fire officials, the CdT then proceeded to evacuate the passengers and crew from the club car and into the cross passage.

The French FLOR arrived on the scene and assumed command. A passenger train traveling in the opposite tunnel was stopped and the uninjured passengers were placed on it.

The UK FLOR arrived on the scene while the French FLOR was treating the injured victims. After a brief consultation between the officers of the French and UK FLORs, it was decided that the French would continue to treat the victims while the UK personnel sent a crew into the tunnel to evaluate the fire.

The door at the cross passage at marker 4131 was used to gain access to the tunnel. By this time the Supplementary Ventilation System (SVS), which can control the direction and volume of the airflow within the tunnel, had been activated and air was being directed from the front of the train towards the rear (UK side towards the French side). Personnel from the UK FLOR entered the running tunnel and verified that the club car and locomotive did not contain any additional trapped victims. They then proceeded towards the rear of the train to evaluate the conditions.

Meanwhile, the victims who were being treated in the service tunnel were transported by ambulance vehicles through the service tunnel to the French terminal.

Additional fire-fighting resources from the French side arrived, and a French command officer assumed command of the incident and declared it a bi-national emergency. (Per the pre-established bi-national plans for the Tunnel, any incident which occurred within a country’s territory would be commanded by that country’s personnel. This incident was well within the French boundary.)

Through an oversight, the UK second line of response (SLOR) was not notified of the fire until 10:02 p.m. At approximately 10:19 p.m., the UK SLOR was responding via the service tunnel. The SLOR for both countries is comprised of fire fighting resources that respond from stations located outside of the respective terminals. The command officer who served as the UK liaison with the French incident commander responded as part of the SLOR.

A consultation was held between the French and United Kingdom command officers, and it was decided that the French would attack the fire from cross passage 4163 and that the UK FLOR would attack the fire from cross passage 4201. This strategy would allow the French FLOR to attack the fire from “upstream” and the UK FLOR to attack the fire from the middle. It was felt that if the fire was attacked from only upstream, they would not be able to gain effective fire control within an acceptable period of time. This was based on the fact that few crews could actually be placed within the tunnel because of space limitations.

UK personnel were positioned at the cross passage door at 4201, which was then
manually opened. The air pressure in the service tunnel was being maintained at a higher level than the air pressure in the running tunnel, which resulted in a very high airflow through the open cross passage door into the running tunnel. This airflow was so strong that it was necessary for personnel to brace themselves as the door was opened and to ensure that they did not have any loose equipment, which would have been blown into the tunnel as the door was opened.

In addition to the airflow in the service tunnel, the ventilation system in the running tunnel had been increased and was blowing from the UK side to towards the French side (west to east). The airflow in the running tunnel, coupled with the airflow coming out of the cross passage, created a “bubble” that measured approximately 1 meter (3.2 feet) out of the cross passage into the running tunnel. Within this bubble it was possible to stand in relative comfort and safety. However, once personnel passed beyond this boundary, there was intense heat and smoke which required that all personnel wear full protective equipment.

Hose lines were connected into the service tunnel’s wall hydrant and advanced into the running tunnel. Initial fire-fighting efforts focused on extinguishing the fire directly in front of this cross passage door. Once this was achieved, personnel then turned to the east and began advancing hoselines towards the rear of the train. Attempts were made to advance lines down the walkway on the north side of the train, through the train itself, and on a smaller maintenance walkway on the south side of the train. Due to the extreme heat, crews were able to work for only about 8 minutes before having to retreat and be replaced by fresh crews.

It was extremely difficult to advance the lines. Large amounts of concrete were spalling off explosively from the tunnel lining due to its exposure to the fire. This resulted in very fine concrete rubble collecting on the access walkway, which had the consistency of large grains of sand and made the footing very difficult. In addition, this concrete rubble was hot, and a number of fire fighters reported that the soles of their feet were becoming hot while standing on this rubble. Furthermore, the fire fighters were being regularly bombarded on their helmets by the debris as it fell off of the tunnel lining.

The debris was also collecting on the roof of the HGV transporters, which ultimately collapsed in a “V” shape due to the weight of the material.

Two lines were being advanced from the UK position, while five or six lines were being advanced from the French position. It was reported that there was insufficient water pressure and volume to maintain an aggressive attack until Eurotunnel engineers reconfigured the water supply approximately 6 hours into the incident.

Fire control was reported at 5:00 a.m. on the following day, and the fire was reported to have been extinguished at 11:15 a.m.

A total of eight HGV transporters and their contents were completely destroyed, as
well as a loader and the rear locomotive. Significant damage occurred to the tunnel lining for approximately 200 meters (656 feet), with serious damage to an additional 200 meters (656 feet).

According to reports from the Kent Fire Brigade, approximately 406 millimeters (16 inches) of concrete was destroyed in some areas, leaving only 51 millimeters (2 inches) of concrete remaining.

No injuries to fire fighters from either country were reported.

The fire resulted in passenger service interruption for 15 days. Freight trains started running through the undamaged tunnel again on November 21, 1996. Eurostar (passenger trains that operated between London and Paris) service was allowed to resume on December 4, 1996. Tourist shuttles (cars only) between Folkestone and Coquelles were allowed to begin service on a limited basis on December 10, 1996. Tourist shuttles carrying coaches started running again on January 6, 1997.
3.0 The Tunnel

The tunnel, which started service on May 19, 1994, is 50.45 kilometers (31.35 miles) long, 38 kilometers (24 miles) of which is under the sea. There is a system of three tunnels which make up the undersea crossing. Trains pass through the two outer tunnels, that are referred to as the north and south running tunnels. In between the two running tunnels is a service tunnel through which service and emergency vehicles can pass. There are 270 cross passages located every 375 meters (1,230 feet) between the running tunnels and the service tunnel.

The route of the tunnel is through a layer of rock called chalk marl. This route was selected because the marl, which is a mixture of chalk and clay, is easy to tunnel through and is impervious to water.

3.1 Running Tunnels

The two running tunnels each measure 7.6 meters (25 feet) in diameter. The course that the tunnels take underneath the seabed was determined by the strata of rock through which the tunnels were bored. The depth of the tunnel beneath the seabed varies from 45 meters to 75 meters (150 feet to 250 feet).

The lining of the tunnel is made of 850,000 individual pre-fabricated, reinforced concrete panels measuring 406 millimeters (16 inches) thick.

Within each running tunnel are the tracks on which the trains run. Power is delivered through an overhead wire catenary that provides power to the trains at 25,000 volts.

The running tunnels each measure 7.6 meters (25 feet) in diameter. On the left side of this picture the evacuation walkway is visible. Immediately above it is the piping for the tunnel hydrant system. At the left edge of the picture is the cross passage door leading into the running tunnel from the service tunnel.

(Photo provided by the Kent Fire Brigade. Used with permission.)
On one side is an access walkway which measures 800 millimeters (2.6 feet) wide, and on the other side is a maintenance walkway that measures 500 millimeters (20 inches). The tunnel is not illuminated during normal operations, but is equipped with overhead lighting that can be turned on if needed.

There are two crossovers located in the running tunnels. There is one that is 17 kilometers (11 miles) from the UK portal, which is 47 meters (154 feet) below the seabed. It measures 156 meters long (512 feet), 18 meters wide (59 feet), and 9.5 meters high (31 feet). Another one is 15.7 kilometers (9 miles) from the French portal. It is located 45 meters (150 feet) below the seabed.

The purpose of the crossovers is to allow rail traffic to be moved from one side of the tunnel to the other. This avoids taking an entire tunnel out of service during normal maintenance operations.

Large doors separate the two tunnels at these cross-over points. There are three positions for these doors: open; closed, but not sealed; closed and sealed. When they are closed and sealed, they are designed to provide 90 minutes of fire protection between the running tunnels.

### 3.2 Service Tunnel

The service tunnel is located between the two running tunnels, except at the two running tunnel cross-over points where it diverges and is routed around the cross-overs. The function of the service tunnel is to provide access for maintenance and emergency vehicles to both running tunnels, and to also provide a safe haven for any passengers that must be evacuated from a train.

*The service tunnel runs between the two running tunnels.*

*(Photo provided by the Kent Fire Brigade. Used with permission.)*
The service tunnel measures 4.8 meters (16 feet) in diameter and has a flat surface on the bottom on which vehicles can travel. Rubber tired, diesel-powered vehicles are used within the service tunnel.

The air pressure within the service tunnel is kept at a higher level than that of the running tunnels in order to stop any products of combustion from a fire from moving into the service tunnel through open cross passage doors. In order to maintain this higher air pressure, each end of the service tunnel is equipped with air locks that measure 55 meters (180 feet) long through which vehicles must pass. Vehicles must enter the airlock through one door, wait while the door is closed, then pass through the second door after it is opened.

Embedded within the floor of the service tunnel are guide wires. This system provides steering guidance for the specialized vehicles used by maintenance personnel and emergency responders. These vehicles are able to travel at higher speeds and pass other vehicles with closer tolerances than otherwise might be possible.

Overhead lighting is provided and can be controlled either remotely by the railway control center or locally within the tunnel.

The lining of the service tunnel is constructed of prefabricated, reinforced concrete panels similar to the running tunnels. They measure 320 millimeters (13 inches) in thickness.

3.3 Cross Passages

There are 270 cross passages between the service tunnel and the running tunnel every 375 meters (1,230 feet). Each cross passage is numbered based on its distance from a reference point in the Folkestone terminal, so the numbers increase going from the UK to France.

The doors leading from the service tunnel to the running tunnels have a fire rating of 120 minutes. The position of the doors is monitored in the RCC in each terminal, and they can be opened either remotely by the RCC, at the individual cross passage under power, or manually using a hand crank. All of the doors either swing inward towards the service tunnel or are sliding doors.

Seventy six of the cross passage doors have Air Distribution Units (ADU) located in them that are used in ventilating the running tunnels. They are equipped with one way valves to ensure that air only passes from the service tunnel to the running tunnel. In addition, there is a separate fire damper that is normally held open. Loss of power to the damper control, either by command or loss of electrical service, will cause the damper to close. It is possible to close up to two of the ADU dampers during maintenance operations without affecting the ventilation flow in the tunnel.
3.4 Fire Suppression and Detection

There are no automatic fire suppression systems in either the running or service tunnels themselves. Technical rooms in the service tunnel that contain electronic equipment are equipped with automatic Halon 1301 suppression systems. These systems can be activated either automatically upon the detection of smoke or fire within the room, or manually by the RCC or by a local manual pull station. Prior to discharge, the ventilation system in the rooms is shut down, and dampers on the ductwork are closed.

Providing detection to the two running tunnels are 66 clusters of smoke detectors, flame detectors, and carbon monoxide (CO) detectors which are referred to as stations de detection (SDs). These clusters are spaced approximately 2 kilometers (1.24 miles) apart. The smoke detectors are both ionization and optical, and the flame detectors are ultraviolet (UV) and infrared (IR). The smoke detectors and CO detectors are located within the service tunnels. Air sampling tubes draw air from the running tunnels.

The flame detectors are located within each of the three tunnels. Each SD has two flame detectors, and they are spaced approximately 10 meters to 12 meters (33 feet to 39 feet) apart from each other.

Cross zoned, or double, detection is used for the smoke and flame detectors in order to reduce the potential for false alarms. Two detectors of different types (i.e., two flame detectors, UV and IR, or two smoke detectors, optical and ionization) have to be activated in order for a confirmed fire alarm. In the event that only one device goes into alarm, an unconfirmed fire alarm signal is transmitted.
In the event that a second device is activated, then a confirmed fire alarm signal is transmitted to the Fire Emergency Management Center (FEMC) and the Main Control Center (MCC).

Within the tunnels are a series of local fire detection units which monitor the fire suppression and detection systems.

The water supply at the Folkestone terminal provides fire fighting water for the terminal operations.
Connecting the SDs are 74 local fire detection units (LFDUs) that monitor the SDs and transmit any alarms received.

The water supply for the tunnel is from four locations:
• Castle Hill, which normally supplies the UK underland section;
• Shakespeare Cliff, which normally supplies the UK undersea section
• Sangatte, which normally supplies the French undersea section
• Beussingue, which normally supplies the French underland section

Each of these four locations has a water tank that holds 800 cubic meters (211,000 gallons) of water. When the water supply drops below 750 cubic meters (198,000 gallons), they are automatically refilled via connections to a municipal water supply.

Each location has a 15 m$^3$/hr (66 gpm) jockey pump that maintains a minimum pressure within the water main. Three of the stations, Shakespeare Cliff, Sangatte, and Beussingue, have 120 m$^3$/hr (528 gpm) low-pressure pumps that are brought on line when there is a demand on the system. In addition, each of the four stations has a 120 m$^3$/hr (528 gpm) high pressure pump, with the exception of the pumping station at Castle Hill that has two high-pressure pumps. The system is designed to supply water at a pressure of 30 bars (435 psi) which is reduced at the cross passages to 7 bars (102 psi). The total design capacity of the system is to supply four handlines, each flowing 30 m$^3$/hr (132 gpm), for a total of 120 m$^3$/hr (528 gpm).

Each of the pumping stations is primarily responsible for supplying water to a specific section of the water main. However, in the event that one of the pumping stations is out of service, it is possible that a section of the system can be supplied by two other pumping stations. High-pressure pumps are then brought on line to meet any demands.

Power is supplied to the pumping stations by the national power grids. In the event of a total loss of power, backup generators are located at Shakespeare Cliff and Sangatte. If this situation arises, then each pumping station will be responsible for providing water to one-half of the water main system.

As a last resort, it is possible to provide water to the main solely by gravity feed. The pressures, however, will be greatly reduced. This mode can only be selected manually.

At each cross passage, two branch lines measuring 125 millimeters (4.92 inches) are connected to the main. One branch line goes into the north running tunnel, and another branch line goes into the south running tunnel. Connected to each branch line are four hydrants—one in the cross passage by the door to the running tunnel, and three within the running tunnel. Within the tunnel, the hydrants are spaced 125 meters (410 feet) apart on the side of the running tunnel closest to the service tunnel.

There are sectional valves at each cross passage that can isolate the branch lines...
and also isolate the water main. At every third cross passage is a motorized sectional valve that can be controlled remotely from the RCC via the engineering management system (EMS).

Three additional motorized sectional valves, which are normally in a closed position, divide the water main system into four parts, each being fed by one pumping station. In the event that additional water is required, the valves can be opened remotely by the RCC.

At each cross passage is a branch line that provides a hydrant connection within the service tunnel as well as a place in which the foam generator can be installed if needed.

There are a series of motorized valves throughout the length of the water main that allow the control centers to isolate various sections as needed.
The water main is designed to operate at a nominal pressure of 40 bar (580 psi). This pressure is reduced at the cross passages to 7 bar (102 psi) by pressure-reducing valves on the cross passage branch lines.

The system is designed to flow a maximum flow of 120 cubic meters per hour (528 gpm). This is considered sufficient to supply four hose lines simultaneously. Based on the quantities of water available, each of the four sites is designed to supply sufficient volume for four to six hours of fire fighting operations.

The water system is also designed to allow for foam generation. In the piping system in the cross passages are connections for foam generators that are carried on the emergency response vehicles. A foam supply is carried on the FLOR and SLOR vehicles.

### 3.5 Ventilation

There are two locations at which the ventilation for the tunnels is controlled—one at Shakespeare Cliff in the United Kingdom and the other at Sangatte, France.

Within the running tunnels, there are two modes of operation for the ventilation system. The normal ventilation system (NVS) provides an airflow through the tunnel during normal operations. This is done by moving air through the service tunnel and then into the running tunnels through a series of openings called air distribution units, or ADUs.

However, if an incident occurs within the tunnel, the airflow can be increased and directed in specific directions using the SVS. The fans for the SVS are located at Sangatte in France and Shakespeare Cliff in the UK. There are six pre-determined settings on the SVS.

When a train passes through a tunnel, air is pushed by the train as it moves, creating what is referred to as a “piston effect.” To relieve the pressure created by this air movement, 200 pressure relief ducts (PRDs) allow the overpressure to be relieved between the two running tunnels. These PRDs are located every 250 meters (820 feet), measure 2 meters (7 feet) in diameter and connect the two running tunnels. They are equipped with dampers that have a fire rating of 90 minutes.

### 3.6 Power Supply

Normal operating electrical power is provided to the three tunnels through each terminal. Each country provides power for one half of the tunnel.

Power is delivered within the tunnel to the locomotives via an overhead wire called a catenary. The catenary is divided into sections measuring 1.2 kilometers (0.75 miles). Each section is provided with independent power supplies.

Within the service tunnel are 148 electrical rooms that distribute the power throughout the length of the three tunnels. Each of these rooms is protected by a Halon 1301 suppression system that can be activated automatically, remotely, or manually.
Ventilation System

NORTH RUNNING TUNNEL

SERVICE TUNNEL

AIRLOCK

SOUTH RUNNING TUNNEL

PRESSURE RELIEF DUCTS (PRDs)

FRESH AIR

NORMAL VENTILATION

EXHAUST AIR (OR FRESH AIR)

SUPPLEMENTARY VENTILATION

Graphic Provided by the Kent Fire Brigade used with Permission.
3.7 Drainage

There is a drainage system within the tunnel to carry off any liquids that may enter the tunnel as a result of normal run-off from the rolling stock, rainwater, accidental spillage from the rolling stock, leaks, or from fire-fighting operations.

Liquids enter the drainage system and are carried by gravity to one of five pumping stations that are located at the low points of the tunnel and at Shakespeare Cliff and Sangatte.

Water used in the tunnel for fire fighting is collected within the gravity drainage system and is diverted into the dangerous goods sumps. It is then evaluated and disposed of accordingly.
4.0 Terminals

There are two terminals for the tunnel. One is located at Folkestone in the United Kingdom, and the other is at Coquelles in France. They are similar in terms of functions (loading and off loading the shuttles, passenger handling, passport and immigration control, etc.). The emergency response organizations, facilities, and equipment are also identical at each terminal. The terminal at Coquelles contains the major maintenance and repair facilities for the rolling stock.

The two terminals and the tunnels are collectively referred to as the “concession.” It is operated by a private corporation called Eurotunnel.

The primary difference between the two terminals is that of the layout of the track. In order to turn the trains around for a return trip, the terminal at Folkestone uses a “figure 8” configuration, while the terminal at Coquelles uses a conventional “race-track” layout.

In addition, the rolling stock maintenance facilities are located at Coquelles.

4.1 Control Centers

There are eight control centers for the concession, four at each terminal. They include:

- Terminal Control Center
- Railway Control Center
- Fire Emergency Management Center
- Major Incident Control Center

![The terminal control center at each terminal controls the above ground operations.](image-url)
4.1.1 Terminal Control Center

The Terminal Control Center (TCC) controls all of the above-ground operations in each terminal.

4.1.2 Railway Control Center

The railway portion of the tunnel system is normally controlled at the Railway Control Center (RCC) located in Folkestone. An identical control center exists in Coquelles and is fully capable of controlling operations as a backup.

4.1.3 Fire Emergency Management Center

Each terminal has a Fire Emergency Management Center (FEMC) that monitors:

- The fire detection and suppression system in the technical rooms, and;
- The fire detection and CO monitoring equipment in the running tunnels.

To accomplish this, each FEMC has a panel on which the full length of the tunnel is depicted. Indicators for each LFDU and SD are shown on this “mimic panel.”

In addition, there are three computer workstations with graphic displays that indicate the status of a number of sensors within the tunnel, in both English and French.

4.1.4 Incident Control Center

In the event of an emergency, the Incident Control Center (ICC) at each terminal can
be activated. These facilities, that are not normally staffed, are locations where all of the affected agencies can gather to coordinate management of the incident. There are stations established within the ICCs for agencies such as fire, police, ambulance, Eurotunnel, etc. The facilities are equipped with communications capabilities that allow them to communicate with personnel inside of the tunnel as well as outside resources.

4.2 Emergency Sidings

In each terminal there are sidings where trains can be routed if there is a problem. The siding at Folkestone is made up of two sections of concrete reinforced walls that are approximately 6 meters (20 feet) high and 75 meters (246 feet) long. There are markers on the track that let the locomotive driver know where to stop in order to position the proper car within the emergency areas.

Each siding section is equipped with a number of foam monitors at the top of each side. These monitors are connected to a foam generator that has a 5,000-liter (1,321-gallon) tank of FFFP foam.

Within each section it is possible to shut down the electricity to the catenary within 20 seconds by TCC. However, before the application of agent it is necessary to ground out the system, which takes approximately 15 minutes.

At Coquelles, the siding is comprised of earthen berms instead of reinforced concrete walls. The siding is the length of a complete train.
4.3 Security

Security for the terminals and the tunnel is provided by law enforcement agencies for each country, as well as contract security personnel. Within the UK, the agency is the Kent County Constabulary. Within France, it is Police de l’Air et des Frontières (PAF).

One of the security features at Folkestone is a building that can x-ray a full truck. Other security provisions include perimeter fencing and infrared closed-circuit television.

An additional security concern is that of stopping animals from entering the tunnel. Animals within a tunnel present a hazard to the operations, and it is necessary to stop animals from crossing the borders due to quarantine restrictions. There are additional measures taken to detect animals crossing the fence, such as motion and weight sensors.

Within each terminal, at one point the grounds come under the jurisdiction of the other country. Security forces from the opposite country are stationed within the terminals and patrol the grounds.
4.4 Tunnel Operations

The tunnel began freight operations on May 19, 1994, and began providing passenger service on October 12, 1994. From July 1995 to June 1996, the following amounts of traffic had moved through the tunnel:

- Small vehicles (cars, vans, campervans, motorcycles) 854,174
- Coaches (buses) 27,791
- Trucks 271,925
- Eurostar passengers 2,233,608
- Freight 1,178,193 tonnes (1,298,759 tons)

Travel time from terminal to terminal is approximately 35 minutes, of which 26 minutes is spent within the tunnel itself. At peak times, it is possible to have shuttles departing four times an hour. It is possible to have seven trains in each tunnel at any given time.

There are four types of trains that use the tunnel: Eurotunnel tourist shuttles, Eurotunnel HGVs, Eurostar passenger trains, and standard freight trains.

Each shuttle is equipped with a locomotive at the front and rear of the train.
Eurotunnel Tourist Shuttles

These shuttles travel from Folkestone to Coquelles and carry passengers in their private vehicles. A customer can drive up to the terminal, purchase a ticket, pass through immigrations and passport control, and then drive the vehicle directly onto a train. Once a train is loaded, the passengers can ride in their vehicles or move about the train.

HGVs

The HGVs are trains that carry lorries (cargo trucks) on board. The lorries are loaded and off-loaded at the terminals in Folkestone and Coquelles. Each carry wagon on the HGV is capable of holding one articulated truck (tractor/trailer) weighing up to 44 tonnes. The drivers ride in a club car at one end of the shuttle for the duration of the trip, not in the lorries.

Eurostar Passenger Trains

The Eurostar passenger trains that use the tunnel run between London and Paris. They are capable of speeds up to 300 kilometers per hour (185 mph), but are limited to 160 kilometers per hour (100 mph) in the United Kingdom. Passengers ride in conventional rail cars. Vehicles are not transported on Eurostar trains.

Standard Freight Trains

In addition to the other trains, standard freight trains also pass through the tunnel.
These freight trains are not loaded or unloaded at the two terminals, and use the

tunnel as a route between the two countries. There is only one driver on board these

trains.

There are a number of standard operating procedures that were developed over time

between the two countries relating to emergency operations involving a shuttle fire.
One important factor that has to be considered is the location of the fire in relation

to the club car on an HGV.

There are times, due to high winds, when it is not possible to run the shuttles around

the turn-arounds at the terminals to reverse the direction of the trains. When this

situation arises, it is then necessary to “run the trains backwards.” When this oc-

curs, on the HGV shuttles, the club car, that the drivers of the lorries ride in during

the trip, may be at the rear of the shuttle.

When this situation arises, the standard operation procedure for the shuttles change.
For example, if a fire should occur on a shuttle that is running with the club car at the

front of the shuttle, the first option is for the train to continue running through the

tunnel until it emerges out of the other side of the tunnel. If the shuttle is running

with the club car at the rear, then the procedure would be for the train to stop imme-

diately, and the passengers and crew would be evacuated into the service tunnel.
5.0 Rolling Stock

The two types of Eurotunnel trains (tourist and HGV) are staffed with a driver and the CdT. The driver is responsible for the operation of the train and occupies the main cab of the forward locomotive. On the tourist shuttles, the CdT occupies the main cabin of the rear locomotive. On the HGV shuttles, the CdT has a cabin in the club car.

On the tourist shuttle there are an additional six crew members, that results in a total crew of seven people. On an HGV shuttle, there is one additional crew member, for a total of three.

5.1 Locomotives

At the time of this report there were 38 Eurotunnel shuttle locomotives, all of the same design. Each was 22 meters long, 3 meters wide, and 4.1 meters high (72 feet long, 10 feet wide, and 13 feet high).

They receive their power via an overhead catenary that delivers the electricity at 25,000 volts. There are two roof mounted pantographs through which the electricity is routed from the catenary to the locomotive. Both pantographs can be dropped using an emergency drop button in both the front and rear cab that will cut the power to the locomotive.
The power is transformed within the locomotive to deliver 1,500 volts to the shuttles, a 110 volt DC lighting circuit and a 220 volt AC domestic supply. Each locomotive is capable of providing 5.76 MW (7,600 horsepower) of power and is capable of pulling a load exceeding 2,000 tons.

The locomotives are capable of a maximum speed of 160 kilometers per hour (100 mph), but normally run at approximately 140 kilometers per hour (87 mph).

Each tourist shuttle is configured with two locomotives, one at the front and the other at the rear. Both locomotives are under power during transit and provide traction for the train. In the event that one locomotive should lose power, the other is capable of moving the train.

The front end of the locomotive is referred to as the Number 1 end. The rear of the locomotive is the Number 2 end. The right and left side of the locomotives are designated when looking forward towards the Number 1 end.

Within the locomotive there are four separate compartments labeled Zone 1, Zone 2, Zone 3, and Zone 4.

Zone 1 is the forward cab in which the locomotive driver sits during normal operations. Zone 2 is a vestibule compartment directly to the rear of Zone 1, between the main cab and the engine compartment. Zone 3 is the engine compartment that contains the transformers and other equipment that powers the train. Zone 4 is the rear cab, that is a secondary cab.

Each of the four zones is separated from the other by fire rated walls and doors. Each zone is equipped with Halon 1301 suppression systems that can be activated either automatically or manually. There are two bottles in each zone, a primary and secondary Halon supply.

Detection is provided within each zone by a combination of ionization and optical smoke detectors and flame detectors. There is a 30 second delay in which the driver can abort the discharge of Halon. Halon will not be discharged into Zone 1, the main cab, when the driver has a control key inserted in the panel.

The Halon can be manually discharged by the driver by pushing a manual release button followed by a separate “confirm” button. It is also possible to discharge Halon into the compartments using manual releases on the bottles. In addition, there are manual pull handles located on the outside of the locomotive.

There are a number of doors though which it is possible to enter the locomotive. Emergency response crews carry keys that enable them to enter the four compartments on the locomotive.

In addition to the electric locomotives, there are also five diesel-powered locomotives that are used for maintenance and can be used in emergencies in the event of a power loss to move any shuttles that are disabled within the tunnels.
5.2 Tourist Shuttles

There are nine tourist shuttles comprised of two rakes, that together make up a complete train. Each rake is made up of the following:

- A single locomotive
- A loader (either single deck or double deck)
- Twelve carriers
- Another loader (single deck or double deck)

This results in 30 vehicles (two locomotives, four loaders and 24 carriers) for a total length of 800 meters (2,620 feet).

Single Deck Loader

A single deck loader is used for loading large passenger vehicles, such as buses, onto the single deck shuttles. These vehicles are 26.43 meters (87.71 feet) long and 4.10 meters (13.5 feet) wide and weighs 15 tons. The sides and roof slide forward, allowing the vehicles to load into the single deck shuttle cars.

Double Deck Loader

The double deck loader is used to load cars onto both the upper and lower deck of the tourist shuttles. The double deck loader measures 27.25 meters (89.40 feet) long, is 4.10 meters (13.5 feet) wide, and also weighs 15 tons. The sides of the vehicle open to allow cars to enter the loader and load both levels of the shuttles.

Double Deck Shuttle

As the name implies, the double deck shuttles have two levels that carry passenger cars. Ten cars can be carried per wagon.
Fire Protection Features

There are a number of fire protection features in the four tourist wagon vehicles (single and double deck loaders and single and double deck shuttles).

Detection
There is a combination of ionization and optical smoke detectors located at the ceiling level of the vehicles. In addition, there are UV flame detectors located at two opposite corners of the ceilings. Gas detectors are located at the floor level in a drain that collects any fluids that may drain off of the vehicles and routes them to a sump. A flame arrestor is located on the sump to avoid flashback into the occupied space from the sump.

Suppression
There are two types of automatic suppression systems on board the loaders and shuttles. Total flooding Halon 1301 is used, as well as aqueous film forming foam (AFFF).

If a single smoke detector is activated, a warning signal is sent to the locomotive driver. Activation of a second smoke detector will result in an automatic evacuation alarm being sounded in the car affected and in the two adjacent cars. An audible alarm sounds and lighted signs on the wall direct people to adjacent cars. The ventilation system is shut down and the total flooding Halon system discharges.

If a gas detector senses flammable vapor within a certain range, the floor mounted AFFF system will discharge immediately.
There are three levels of alarm status possible:

Level 1  It is possible to manually reset the alarm system from within the train.
Level 2 & 3 The system cannot be reset from within the train and can only be done upon arrival at the terminal.

<table>
<thead>
<tr>
<th>Detector Status</th>
<th>Comment</th>
<th>Alarm Status</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any detector or gas alarm &lt;10% or a manual pull station activation</td>
<td>Possible anomaly</td>
<td>Level 1</td>
<td>Alarm to CdT. Video monitoring automatically switched to affected stations. If it is a gas alarm activation, the ventilation remains operational. If it is a smoke alarm activation, the ventilation system is shut down.</td>
</tr>
<tr>
<td>Any 2 detectors</td>
<td>Presence of fire or fuel leakage assumed</td>
<td>Level 2</td>
<td>Automatic evacuation of the wagon. If gas vapors are detected, AFFF is automatically released.</td>
</tr>
<tr>
<td>Opacity meter level 3 alarm</td>
<td>Immediate danger</td>
<td>Level 3</td>
<td>Automatic Halon discharge. Ventilation is automatically shut down.</td>
</tr>
</tbody>
</table>

The fire alarm/suppression system has three modes of operation:

Mode 1: When the train is at a platform, but is not in the process of being loaded or unloaded, the system can be placed in this mode. The system is powered, but the alarms, detectors and suppression systems are inhibited.

Mode 2: This mode is used for the loading and unloading operations. The ionization detectors are disabled and the Halon system is in manual mode. The vapor detector system and the AFFF system is fully operational.

Mode 3: The detection and suppression systems are placed in this mode during transit. All detectors are fully operational and all suppression systems are on automatic.

The end of each wagon has doors that move into place once the shuttle is loaded and prepared to move. This barrier is comprised of a roll-down metal shutter and two sets of pass doors on each side. Each assembly has a fire rating of 30 minutes.

The pass doors are kept shut by pneumatic seals on the doors that are inflated once the doors assembly is swung into place. Passengers wishing to move between shuttles must press a button to deflate the seals, open the door, and pass through. The seals will then automatically re-inflate. It takes approximately 2 seconds for the seals to deflate.
The heating, ventilation, and air conditioning (HVAC) system has three modes of operation:

Normal operation, in transit: When in this mode, the system draws air in from the tunnels and circulates it throughout the individual wagon.

Normal operation, loading/unloading: The system exhausts the interior air in order to remove the exhaust fumes.

Fire: The system recirculates air within the individual wagon. Fire dampers close, isolating the system from the exterior. In the event that the fire is located within a double-deck wagon, smoke will be circulated throughout both levels of the wagon.
5.3 HGV Shuttles

For carrying freight, there are 8 freight shuttles that are referred to as Heavy Goods Vehicles shuttles, or HGVs.

There are three types of wagons that makeup an HGV shuttle: a lattice-sided carrier wagon, a loader wagon, and a club car. There are normally 28 carrier wagons, two loader wagons, a club car, and two locomotives on an HGV shuttle. It is possible to operate an HGV train with only one rake (locomotive, club car, loader car, and 14 carrier wagons and another loader.

The HGV shuttles transport cargo trucks on open-sided wagons. The drivers of the trucks ride in a club car that is located immediately behind the front locomotive, not in their vehicles. An HGV shuttle is staffed by a locomotive driver, a Chef de Train (CdT), and a steward.

Normally, the club car will be located directly behind the locomotive that is at the front of the train. However, during periods of high winds at either terminal, the trains will not be turned around because of the danger of derailment as the trains are navigating the curved track sections. When this occurs, the trains will not be turned around and will run back with the club car located at the rear of the train.

Club Car

Access for passengers to the club car is through four doors, two on each side of the car. There are also doors located at the front and rear of the wagon for use by the train crew. The CdT has a compartment at the rear of the club car where it adjoins the loader. All of these doors have pneumatic seals, similar to the tourist wagons, that must be deflated before they can be opened. A club car has seating for 52 passengers.

Loader

The HGV loader wagon has bridge plates on each side that are lowered at the terminal to allow for the lorries to be driven on and off of the shuttle. At one end of the loader wagon is a cabin that contains the controls for operating the bridge plates. The smoke detection system is also located on the top of this cabin.

There is an automatic coupler between the club car and the loader wagon that can be operated from within either the club car or the locomotive. It is necessary for several conditions to exist before the automatic system will allow the cars to be decoupled. The train must come to a complete stop, the brakes must be fully applied, and the power to the carrier wagons and loaders must be shut down. Then the automatic decoupler can be activated. The decoupling operation, once the train is stopped and power is isolated, takes about 3 minutes. It is possible to manually decouple the cars, but it is necessary to leave the club car to access the coupler and use a spanner wrench.
Carrier Wagons

The carrier wagons on which the lorries are transported measure 20 meters (66 feet) long, 5.6 meters (18 feet) high, and 4.1 meters (13 feet) wide. The shuttle had to be capable of transporting trucks, or lorries, weighing 44 tonnes (49 tons). Therefore, in order to minimize the weight, an open, latticework siding was used on the carrier wagons. Each carrier wagon is capable of carrying one articulated lorry (tractor/trailer) or several smaller vehicles.

Fire Protection Features

Each of the loader wagons is equipped with air sampling smoke detection systems on the bridge structure on one end of the loader. If smoke is detected, an alarm is transmitted to the locomotive driver and to the CdT, who is located in the club car.

Because of the configuration of the loaders, it is only possible to isolate the location of a fire to one rake or another using the smoke detection system. The individual carry wagons do not have detection systems on them, nor are there automatic suppression systems on the loaders or transport wagons themselves.

There are no fire barriers between each of the carrier wagons. There are no video cameras that monitor the HGVs for the locomotive driver.

The carrier wagons each have two sumps on them, one for normal runoff and one for hazardous materials, such as petrol or diesel. When the shuttles are taken through their normal maintenance procedures, that occurs every 9 days, the sumps are automatically emptied as they travel through the maintenance yard at the terminal in Coquelles.
On each loader is a bridge which has two air sampling systems. The sampling tubes can be seen in this photo going up and over the top of the bridge.
6.0 Fire Brigade

6.1 Structure

Fire protection and emergency services are provided by the fire services of each country. In the United Kingdom, this is the Kent Fire Brigade, and in France it is the Service Départemental D’Incendie et de Secours. In the UK there are 8 fire fighters on duty, and in France there are 11 fire fighters. The different staffing levels occur because the French fire brigade is responsible for providing fire protection to the grounds of the terminal, while the UK fire brigade provides protection for only the tunnel.

First Line of Response

The emergency response center at the terminal is staffed by full-time personnel. Eight responders are on duty in the UK and 11 in Coquelles. This combined force of 19 responders comprises the FLOR and is responsible for responding to all incidents that occur within the tunnel. Since they are stationed within the boundaries of the tunnel, they have the ability to respond to any incident, irrespective of the country in which it occurs.

In order to easily identify the members of the FLORs during an incident, they are all equipped with red helmets. This was an important asset during the fire in the tunnel since the incoming units from outside the terminals were dependent upon the expertise and knowledge of the fire fighters assigned to the tunnel.

Second Line of Response

The Second Line of Response, or SLOR, is comprised of personnel that respond from brigade stations located outside of the boundaries of the tunnel. The SLORs are made up of members of the existing fire brigades who have received additional training in emergency operations within the tunnel.

The Kent Fire Brigade has developed standard levels of response to an incident within the tunnel. If a request is made for a SLOR response, six predetermined fire appliances, each staffed by four members, are dispatched to a staging location within the perimeter of the Folkestone terminal. If it is necessary for them to respond into the tunnel, then they will respond to the emergency response center at the terminal, board the specialized SLOR emergency response vehicles, and travel through the service tunnel to the incident scene.

If additional resources are needed, another six fire appliances will be dispatched to the staging area from stations within the County of Kent. If these units are needed, the members can be transported to the incident scene via the service tunnel, or they and their appliances can be loaded onto an HGV train in the unaffected tunnel and transported to the vicinity of the incident.
Additional command officers from both countries also respond as part of the SLOR.

Emergency medical vehicles are located at each terminal and are staffed by personnel from the SLOR, depending upon the need for their response.

Along with the FLOR and SLOR, a communications vehicle stationed at the Folkestone terminal fire station responds to incidents within the tunnel. This vehicle is staffed by two members of the Kent County Constabulary. This vehicle is equipped with a variety of telecommunications equipment and is capable of increasing the communications capability within all three tunnels by connecting directly into pre-wired systems within the service tunnel.

### 6.2 Emergency Response Operations

Specific standard operating procedures were developed regarding the response of both the FLORs and SLORs to incidents within the tunnel and on the terminals. The French FLOR will respond to incidents in both the tunnel and within the Coquelles terminal. At the time of this report, emergency services within the Folkestone terminal were being provided by Kent Fire Brigade units located outside of the terminal. However, the UK FLOR will be taking delivery of a specialized response vehicle within the next three months that will enable them to respond to incidents within the Folkestone terminal.

Since the midpoint of the tunnel represents the boundary between the two nations, it was necessary to address the issue of jurisdiction during an emergency. If an incident occurs within each country’s border, that country would be the authority having jurisdiction over the management of the incident. Each country’s FLOR units could respond to any incident within the tunnel, however, regardless of its location.

The SLOR units could not respond beyond the midpoint of the tunnel into the other country’s jurisdiction unless specifically requested by the incident commander. For this to occur, the incident commander would have to formally declare a “bi-national incident,” that would then provide the authority for the additional resources from the other country to respond into an incident.

The declaration of a bi-national incident is a very important function. A number of pre-determined responses have been identified that will occur upon the declaration of a bi-nat incident. However, prior to the declaration of a bi-nat incident, it is fully within the jurisdiction of the nation in whose jurisdiction the incident occurs to handle it only with the resources of that country and both FLORs.

An automatic fire alarm in the tunnel will result in a full FLOR response. However, if there is a confirmed incident within the tunnel, the SLOR is supposed to be activated. The first level of a SLOR response is referred to as a Level 1 response, and results in six appliances and command officers from off terminal responding to the incident. A Level 2 response will result in an additional six appliances re-
There are several STTS's located at each terminal for the FLOR and SLOR units to use.

sponding to the staging point within the terminal grounds. In order to provide 12 SLOR units, it is necessary for the Kent Fire Brigade to have 50 apparatus movements within the county to fill stations and move apparatus to the tunnel site.

To improve communications, the UK fire fighters were receiving training in the French language. There was no standard language for operations specified, such as with international air operations where English is used.

The two terminals were in different time zones. To reduce confusion, the entire concession runs on the time at the Coquelles terminal, which is 1 hour ahead of the time zone in the UK. (The times used in this report, however, are all UK times since the source of much of the information in the report was based on Kent Fire Brigade records.)

The FLOR leader of the first FLOR to arrive on the scene is the officer in charge of the incident until the arrival of a senior officer from the nation in whose jurisdiction the incident occurs. Upon arrival on the incident scene, the FLOR leader identifies himself to the RCC as the officer in command of the incident. The RCC will then only take orders for operation of any of the systems in the tunnel from the officer in command.

There was a pre-determined process for alerting the various agencies and organizations involved in emergency response to the tunnel. According to information provided to NFPA, incidents within the tunnel are to be reported by the RCC to the FEMCs, who will then deploy the nearest FLOR units. The RCC will also inform the TCC, who will in turn alert the terminal controller. Depending upon the magnitude of the incident, the ICC may be activated.
The TCC is responsible for alerting the outside emergency response organizations (EROS) of an incident within the tunnel or at the terminal.

When an incident occurs within the tunnel, a forward control point (FCP) is established as close as practical to the incident. The role of the FCP is to provide a point to coordinate the activities and communications within the tunnel.

The first FLOR arriving on the scene of an incident within the tunnel will be responsible for sizing up the situation, providing a report to the stationnaire in the appropriate FEMC, and establishing a FCP. The senior firefighter on the team will be the initial Eurotunnel incident officer, and will be responsible for coordinating operations.

Due to the potential for a variety of incidents within the tunnel, it was necessary to identify the types of incidents and which agencies from each nation would be responsible for responding to them. The following list was developed to identify these responsibilities:

<table>
<thead>
<tr>
<th>Statutory Responsibilities</th>
<th>United Kingdom</th>
<th>French Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Services</td>
<td>Determined by</td>
<td>Prefecture du Pas</td>
</tr>
<tr>
<td>Coordination</td>
<td>Statutory Duty</td>
<td>de Calais (Direction)</td>
</tr>
<tr>
<td>Fire</td>
<td>KFB</td>
<td>SDIS</td>
</tr>
<tr>
<td>Rescue</td>
<td>KFB</td>
<td>SDIS</td>
</tr>
<tr>
<td>Fire Investigations</td>
<td>KFB</td>
<td>PAF</td>
</tr>
<tr>
<td>Hazardous Substances</td>
<td>KFB</td>
<td>Douanes and PAF</td>
</tr>
<tr>
<td>Casualty Recovery</td>
<td>Kent Ambulance Service</td>
<td>SAMU/SMUR and PAF</td>
</tr>
<tr>
<td>Criminal Investigation</td>
<td>Kent Police</td>
<td>PAF and the Procureur de la Republique</td>
</tr>
<tr>
<td>(including terrorist threat or action)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inquiries into Fatalities</td>
<td>Kent Police on behalf of</td>
<td>PAF and the Procureur de la Republique</td>
</tr>
<tr>
<td></td>
<td>HM Coroner</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kent Police</td>
<td>PAF</td>
</tr>
<tr>
<td>Vehicle and Equipment</td>
<td>Kent Police</td>
<td>Prefecture de Pas</td>
</tr>
<tr>
<td>Marshalling</td>
<td></td>
<td>De Calais</td>
</tr>
<tr>
<td>Bi-National Emergency</td>
<td>Kent Police</td>
<td>PAF</td>
</tr>
<tr>
<td>(Alerting Authority)</td>
<td></td>
<td>SDIS,</td>
</tr>
<tr>
<td>Bi-National Emergency</td>
<td>Kent Police, Kent Fire Brigade, Kent Ambulance Service</td>
<td>SAMU/SMUR</td>
</tr>
<tr>
<td>(Emergency Response Organizations)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the event of a fire on an HGV shuttle, there were three pre-defined options that could be taken. The first was for the shuttle to continue through the tunnel and emerge on the other side. The shuttle would then be routed to an emergency siding where the fire would then be extinguished.

The second option was to bring the train to a controlled stop within the tunnel, decouple the front locomotive and club car from the remainder of the train, and then continue on, leaving the portion of the train that was on fire in the tunnel. The fi-
nal option was to bring the train to a controlled stop within the tunnel and to evacuate the passengers and crew out of the running tunnel into the service tunnel.

In the event that an HGV shuttle is “running backwards” with the club car at the rear of the shuttle, the first option would then be to bring the train to a controlled stop within the tunnel and evacuate the passengers and crew. Continuing through the tunnel to emerge on the other side would not be an option that would be exercised because the fire would burn back towards the occupants.

### 6.3 Equipment

**Personal Protective Equipment**

Each of the Kent Fire Brigade fire fighters wears full protective equipment, that includes coat, pants, boots, gloves, hood, helmet, and breathing apparatus. The Kent Fire Brigade has a very structured personnel accountability system that records the time a fire fighter starts using breathing apparatus, the pressure, expected duration, and expected exit time. The type of protective equipment worn by the French Fire Brigade was not determined.

**Vehicles**

Each fire brigade is equipped with identical specialized vehicles called service tunnel transportation system (STTS) vehicles. These vehicles, that are diesel powered and run on rubber tires, measure 10.2 meters (33.5 feet) long and 1.5 meters (5 feet) wide. They have a cruising speed of 50 kilometers per hour (30 mph).
One of the vehicles stationed at the Folkestone terminal is a communications vehicle that is staffed by law enforcement personnel from Kent County. This vehicle is designed to provide additional communications support within the tunnel and from the tunnel to the terminals. Upon arrival in the service tunnel in the vicinity of the incident, the vehicle plugs into existing hardwired systems.

Within the storage compartments are the various pieces of equipment and hose that the crews may need while operating at an emergency within the tunnel.

When the communications STTS is deployed it can dramatically increase the communications capacity within the tunnel for the emergency responders.
There are ambulance STTS units at each terminal that are not normally staffed, but can respond if necessary.
7.0 The Fire

7.1 Chronological Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>UK Time</th>
<th>Elapsed Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/18/96</td>
<td>8:45 p.m.</td>
<td>00:00</td>
<td>Report of an HGV shuttle on fire entering the tunnel at Coquelles</td>
</tr>
<tr>
<td>11/18/96</td>
<td>8:47 p.m.</td>
<td>00:02</td>
<td>FLORs from both UK and French side mobilized</td>
</tr>
<tr>
<td>11/18/96</td>
<td>9:15 p.m.</td>
<td>00:30</td>
<td>French FLOR arrives on the scene</td>
</tr>
<tr>
<td>11/18/96</td>
<td>9:30 p.m.</td>
<td>00:45</td>
<td>UK FLOR arrives on the scene. French FLOR is administering O2 to victims in the service tunnel.</td>
</tr>
<tr>
<td>11/18/96</td>
<td>9:35 p.m.</td>
<td>00:50</td>
<td>Passenger shuttle stopped in the north tunnel to evacuate uninjured passengers that had been rescued from the HGV shuttle.</td>
</tr>
<tr>
<td>11/18/96</td>
<td>9:40 p.m.</td>
<td>00:55</td>
<td>UK FLOR entered the tunnel for reconnaissance</td>
</tr>
<tr>
<td>11/18/96</td>
<td>10:02 p.m.</td>
<td>01:17</td>
<td>Kent fire brigade contacted.</td>
</tr>
<tr>
<td>11/18/96</td>
<td>10:19 p.m.</td>
<td>01:34</td>
<td>UK SLOR in the tunnel with 12 people on board (10 fire fighters and two officers)</td>
</tr>
<tr>
<td>11/19/96</td>
<td>3:00 a.m.</td>
<td>06:15</td>
<td>Water supply reconfigured by concession engineers</td>
</tr>
<tr>
<td>11/19/96</td>
<td>5:00 a.m.</td>
<td>08:15</td>
<td>Most of the fire was damped down</td>
</tr>
<tr>
<td>11/19/96</td>
<td>11:15 a.m.</td>
<td>14:30</td>
<td>Stop message (fire out)</td>
</tr>
</tbody>
</table>

7.2 Narrative

An HGV shuttle entered the tunnel from the terminal in France with 31 passengers and three crew members on board. The train was configured with two locomotives, a club car, four loaders, and 29 carry wagons (the normal configuration would be 28 carry wagons).

At 8:45 p.m., the UK FEMC received a report from the French FEMC that there was a train entering the tunnel on fire. It was reported that someone had seen the train on fire, and the report had been made to the TCC in Coquelles, who in turn notified the RCC. By this time, the train was into the tunnel.

The standard operating procedures called for a train to attempt to make it through the tunnel and emerge on the opposite side. The train would then be routed to an
emergency siding where the fire would be fought, so an immediate response into the tunnel was not initiated by the UK FLOR in anticipation of having to deal with the fire when the shuttle emerged in Folkestone.

When the FEMC in Folkestone notified the emergency responders of the incident, one of the UK officers went into the FEMC to check the status. The carbon monoxide (CO) readings in the tunnel were at twice the dangerous levels. The decision was made at 8:47 p.m. that the UK FLOR would respond to at least the midpoint of the tunnel. All 8 UK fire personnel responded on the two FLOR units.

According to Eurotunnel officials, the driver of the shuttle was informed of the fire by radio, and the plan was for him to continue driving through to the UK side. However, he then received a warning light on his control panel indicating that there was a potential derailment fault condition on the shuttle. Whenever such a warning occurs, the train must be brought to an immediate stop, which was done. Although the normal airflow in the tunnel would have been from the front of the train to the rear, when the train was stopped the smoke was brought up towards the front by the movement of air that is caused by the wake of the train.

When the driver was asked by the control center what his location was, he was reported to have said that he could not see the marker on the wall because of the smoke that now surrounded the train. There are sensors on the tracks that show the location of a train on monitors in the two RCCs. However, the monitors only indicate sections of track where a shuttle may be located, so the exact location cannot be precisely determined from the RCC. [It was subsequently determined that the shuttle had stopped approximately 19 kilometers (12 miles) into the tunnel].

The locomotive driver was notified by radio that there was a fire on board the HGV shuttle. He was directed to continue through, but a derailment fault warning on his control panel required that he stop the shuttle immediately.
When the shuttle stopped it was reported that the fire became more intense and burned through the overhead power catenary. When this occurred, the locomotive lost power and was not able to continue forward.

At some point the CdT opened a door on the club car, and smoke entered the car. According to media interviews, the occupants reported that the smoke was so thick that they were forced to lie on the floor.

The French FLOR began responding to the incident as soon as they were notified. However, since the original plan was for the shuttle to continue through to the other side, they did not enter the service tunnel immediately. However, they did eventually begin to follow the shuttle, through the service tunnel, essentially traveling “behind” it. This was done to avoid overrunning the shuttle if it did stop.

According to fire officials, the CdT had evacuated the passengers out of the club car and into the safety of the service tunnel.

The French FLOR arrived on the scene at 9:15 p.m. and began treating the passengers who were injured by inhaling smoke from the tunnel.

After responding for approximately 10 minutes, the UK FLOR received a report that the shuttle had stopped, an evacuation was being done and that the driver was locked in the cab of the locomotive. Since the UK officers were not sure whether the club car was at the front or rear of the train, they began working out possible scenarios that they might encounter upon their arrival.

When all of the STTS units responded, it became congested within the tunnel according to rescuers.