The UK team arrived on the scene at 9:30 p.m. A number of civilians were in the tunnel, and about seven or eight were lying down, receiving treatment from the French FLOR.

The UK officers attempted to learn what was occurring, but there were problems communicating due to the language differences. They were able to get the gist of what had occurred, however. The UK crews began assisting in administering first aid, along with the French crews.

Approximately 2 or 3 minutes later, a crew from the French FLOR made entry into the running tunnel to locate the fire. They were not able to make entry very far and pulled back into the cross passage tunnel, closing the cross passage door behind them.

One factor that added to the difficulty of sizing up the incident was that the crew of the train was among those patients who had suffered smoke inhalation, and apparently they were not able to provide information to the responders.

The senior UK and French FLOR officers discussed the incident, and it was decided that the French would continue to care for the patients until they were evacuated from the tunnel and the UK FLOR would begin evaluating the conditions in the south running tunnel.

At 9:35 p.m., a tourist shuttle in the north running tunnel was stopped directly opposite the incident scene. The cross passage to the north running tunnel was opened in order to move the ambulatory victims onto the shuttle. The non-ambulatory patients were not placed on the train because ambulances were responding into the service tunnel to transport these victims. These ambulances arrived shortly, and the injured patients were transported out of the service tunnel to the French side.

A freight train had entered the south running tunnel from the French side following the entry of the shuttle that was on fire. This train was stopped at CP 5685, and the sole occupant, the driver, self evacuated out of the cross passage door. It was felt that the movement of air caused by the HGV shuttle that was on fire, coupled with a similar piston of air moving with the freight train helped to force the smoke towards the front of the HGV, towards the club car.

The UK officer advised the control center that he was in charge of an entry team at this point in time. This is a pre-established procedure that was implemented to avoid any potential confusion regarding requests for ventilation control. It was very important for the personnel operating the EMS to know who to take orders from during the incident.

At 9:40 p.m., a team of fire fighters from the UK FLOR entered the tunnel at CP 4131 to perform reconnaissance. An entry control team was stationed at the cross passage door to maintain communication with the entry team. The entry team was using their portable radios, and the entry control team connected a portable radio
into a system in the tunnel that would allow their radios to communicate within the confines of the tunnel. The entry team took a charged hose line and a thermal imaging camera into the tunnel.

The natural direction of the airflow would have been from the UK side to the French side. However, there was still some air movement in the opposite direction due to the “piston effect” caused by the stopped train, the train that had followed the fire train into the tunnel, and the two trains that had preceded the fire train. This resulted in the air flow moving from the French side to the UK side as the fire fighters entered the running tunnel, resulting in heavy smoke conditions throughout the area. When the team first entered the tunnel, they reported that the entire train was covered with soot.

The entry team first moved to the west and verified that the cab of the locomotive was empty.

They then moved to the east and proceeded down toward the rear of the train to evaluate conditions. Smoke conditions were beginning to improve at this time. It was theorized that the SVS was operating at this time, with air flowing from the west to the east.

As the UK team walked towards the east, they reached a slight bend to the left in the tunnel near car #21. At this point they lost radio communications with the personnel located at the entry point at CP 4131. It was theorized that the fire had damaged a part of the radio system in the tunnel that caused this breakdown in communication.

Up to this point they did not observe any damage to the tunnel.

They continued for approximately 600 meters (2,000 feet) from CP 4131 towards the rear of the train. As they passed CP 4163 they began to observe noticeable damage to the tunnel fittings, including fallen pipework and brackets on the walkway, and cabling hanging down. The fire also became visible at this point. The severity of the damage to the tunnel increased as they continued walking towards the fire. They stopped after walking 300 meters (984 feet) past CP 4163. There was debris on the walkway at this point. Since the entry team had lost radio communications with the entry control team, they returned to the cross passage door to report their observations.

A French command officer was on the scene at this point and he assumed the position of incident commander. He also made the formal declaration that this was a bi-national incident.

At some point, the UK officer in charge contacted the RCC regarding the status of the UK SLOR. It was realized at this time that no notification had been made to the Kent Fire Brigade, and that the SLOR had not been activated. This notification
was made at 10:02 p.m., and fire fighters and command officers from KFB began responding. By 10:19 p.m., the UK SLOR with 10 fire fighters and two command officers was in the tunnel, responding.

A Kent Fire Brigade command officer arrived on the SLOR and began coordinating operations with the French IC, who spoke English. They both entered the running tunnel through CP 4163 to assess the situation, and the UK command officer reported that they could walk about 18 or 27 meters (20 or 30 yards) before it became too untenable. They returned to the service tunnel to develop a strategy to attack the fire.

It was decided that the French Fire Brigade would attack the fire from CP 4163, west of the fire, and move downwind towards the fire. A joint UK/French operation would work from CP 4201 to attack the fire from the middle.

A team made up of two UK and French FLOR members in full protective equipment was positioned with hoselines at the door at CP 4201. The door was manually opened. According to the personnel on the scene, the fire was reported to be burning white hot, as in a furnace, due to the ventilation that was providing air to the fire. They also stated that the fire was blowing horizontally, again due to the ventilation. Cables had fallen down from the ceiling, as well as pipework, that made entry into the tunnel difficult.

According to the UK command officer, when he stood in the door, conditions did not seem too bad. This was due to the fact that a “bubble” measuring about 1 meter (3.2 feet) was being created at the entrance into the running tunnel from the cross passage by the force of the ventilation. Conditions within this bubble were tenable and personnel could stand in there without having to wear protective equipment. However, when the crews who made entry to fight the fire came back “looking like lobsters”, he knew that towards the fire it was extremely hot.

The first plan was to suppress the fire directly in front of the cross passage door and then begin working towards the east in the direction of the rear of the train. Within one hour the fire in front of the door was knocked down, and they began moving towards the rear of the train. Crews were only able to work for about 8 to 10 minutes before they would have to be rotated.

There was an evacuation walkway 800 millimeters (31.5 inches) wide on the north side of the running tunnel. However, it was difficult to traverse this walkway due to the buildup of concrete debris on it. On the far side of the train was another, narrower maintenance walkway, that was also difficult to walk on.

Due to the amount of debris on the walkways, it was possible to only use one hose-line on the right and left sides of the shuttles. Another line was also used inside of the shuttle itself, but it was very difficult to advance this line due to the lorries.
Incident Scene at 11:45 p.m., UK time

North Running Tunnel
CP 4130 → CP 4162 → French FLOR point of entry → CP 4200

Service Tunnel
CP 4131 → CP 4163 → UK FLOR point of entry → CP 4201

South Running Tunnel

Direction of Travel
Area of Fire Involvement

Legend:
- Front Locomotive
- Club Car
- Undamaged Loaders
- Undamaged Carrier Wagons
- Damaged Carrier Wagons
- Damaged Loader
- Damaged Rear Locomotive

National Fire Protection Association
Fire Investigations Team
Channel Tunnel Fire
It was reported by a number of people that there were problems with the water supply. The UK fire fighters felt that they did not have sufficient water to attack the fire. At approximately 3:00 a.m., engineers from Eurotunnel reconfigured the water distribution system to improve the water being provided to both fire-fighting operations.

A potential reason for the water supply problems could be related to the number of hoselines that were being operated simultaneously. In speaking with fire personnel from both the French and United Kingdom brigades, it was determined that there were, at times, up to eight hoselines being operated simultaneously out of the two cross passage doors. According to official information regarding the water supply system, it was designed to accommodate only four hoselines operating simultaneously flowing 120 m³/hr (528 gpm), combined.

In addition to the number of hoselines operating, it was reported that a broken water line was found within the tunnel beyond the end of the rear locomotive. According to fire personnel, the water was coming out of this pipe under high pressure and hitting the opposite wall of the tunnel.

A significant hazard to the fire fighters operating in the tunnel was the concrete debris that was spalling off of the tunnel lining. The heat from the fire was expanding the moisture in the concrete, causing it to spall explosively. Fire fighters were being hit by the concrete debris while they were fighting the fire, and they were being advised as they entered to not look up in order to avoid injury.

This falling debris collected on the roofs of the HGVs, and they ultimately collapsed in a “V” shape. The debris also collected on the walkways within the tunnel. As it piled up, it created a sloping surface that was extremely difficult to walk on. In addition, personnel were reporting that the soles of their feet were getting burned from standing on the hot debris.

Operations in the cross passage door became very congested, and the decision was made to have the UK crews operate at CP 4201 and the French forces operate at CP 4163.

Additional fire brigade crews were brought to the scene by HGV shuttles operating in the north running tunnel. Apparatus and personnel were loaded onto the HGVs and transported to the incident. The personnel off-loaded their equipment and then relieved crews operating in the tunnel.

A rest area was established for the fire fighters. Bottles of water were provided for fluid replenishment.

At approximately 5:00 a.m. it was reported that most of the fire had been extinguished. A stop message (fire out) was given at 11:15 a.m. It was estimated by the UK that they used over 200 breathing apparatus cylinders during the operations.
After the fire was suppressed, it was determined that the fire had occurred on a lorry located in the rear rake of the train. Eight lorries were destroyed by the fire, as well as eight carry wagons and one loader. The rear locomotive was also damaged by the fire.

The investigation was being conducted by the French authorities. As of the date of this report, no determination had been made as to the cause of the fire.

### 7.3 Casualties/Damage

Eight passengers and crew members on the HGV shuttle were hospitalized for smoke inhalation. None of the injuries, however, were serious and all were eventually released. There were no reported injuries to any of the emergency response personnel from either nation.

According to fire officials, there was substantial damage over 500 meters between markers 4172 to 4220. There was severe damage over 280 meters between markers 4180 to 4209. The concrete liner had concrete spalled away and the reinforcing bars were exposed. All of the tunnel’s systems had been destroyed.

In between markers 4180 to 4201, it was reported that the spalling extended beyond the reinforcing bars. The most severe damage was observed between markers 4186 to 4191, where the concrete was exposed to the elevated temperatures for an extended period of time.
The tunnel itself received significant damage in the vicinity of the fire. Due to the heat of the fire, the concrete liner was dislodged, and in some areas it was reported that 406 millimeters to 457 millimeters (16 inches to 18 inches) of the concrete liner had spalled away. In some areas it was also reported that only 25 millimeters to 50 millimeters (1 inch to 2 inches) of liner was remaining between the tunnel and the bedrock. All of the utilities and track in the immediate area of the fire were destroyed.
Smoke spread east throughout the south tunnel, as well as into the north tunnel. It was determined that smoke spread into the other running tunnel through the cross over doors, that were in the closed position but not sealed, which provided an avenue for smoke spread.

The EMS that is designed to provide the various control centers with information on a number of the engineering systems in the tunnel, failed at some point during the fire. They were unable to monitor the status of the cross passage doors and determine how many were opened and closed. It is important that this be known because this information impacts on how the SVS is configured. The ventilation system is designed to accommodate three cross passage doors being open simultaneously. The cabling for the EMS system was located in the running tunnel in order to reduce the fuel load in the service tunnel, that was considered a safe haven. It was theorized that the fire burned through the cabling in the running tunnel.

One of the wall hydrants within the running tunnel apparently failed at some point and water was discharging into the running tunnel under high pressure. This added to the water supply problems that the fire-fighting crews were already experiencing.

There was fiberglass insulation used in the tunnel, and the fibers wound up in the air, causing skin irritation for the emergency responders, according to fire officials.
7.4 Lessons Learned

While speaking with command officers from both the United Kingdom and French fire services and the crews that responded from the Kent Fire Brigade, they were asked what were some of the “lessons learned” that could be passed on from this incident.

Ventilation

The most critical lesson learned that emerged out of this incident was the importance of ventilation. A plan for controlling the ventilation must be established and implemented quickly if the spread of the fire and smoke is to be limited.

In this incident, the SVS was activated promptly, which helped significantly in providing protection for the fire fighters operating within the tunnels. The force of the ventilation was so strong that personnel had to ensure that all equipment was secured before approaching the opening of the cross passage door to avoid having it drawn off by the force of the airflow.

The air bubble that was created by the force of the ventilation coming out of the cross passage door indicates the strength and volume of air moving through this opening. The bubble allowed personnel a small working area in which to access the fire scene. However, once they passed beyond the bubble, the heat was extremely intense, due to the “blowtorch” effect created by the ventilation fanning the fire.

Communications

Very early in the incident, the existing communications system was overwhelmed. Until the communications STTS was set up in the service tunnel, everyone at the concession was using a common radio system. There were only five channels available within the tunnel, and these channels were used by everyone at the site. There were no channels dedicated solely for fire department operations until the communications STTS was operational. This created a problem for the responders attempting to coordinate activities.

In addition, there were reports of communications difficulties between the two ICCs at each terminal. Cellular telephones provided backup.

Within the tunnel itself a system had been installed that would allow a portable radio to be plugged into a socket at a cross passage door. This radio would now be connected to an antenna system that would allow the now-hardwired portable radio to communicate with portable radios within the tunnel. However, this system apparently did not work for some reason when the first UK crews entered the tunnel for reconnaissance, and they lost communications once they passed beyond a certain point from the cross passage door.
There was a breakdown in the procedure for notifying the off-terminal responders from the Kent Fire Brigade, that delayed the response of additional resources to back up the FLORs. At the time of this report, the cause of the delay was unknown.

**Water Supply**

The original design of the tunnel water supply system was for it to supply four operating hoselines simultaneously. However, at some points there were eight lines operating from two cross passage doors. Eventually, engineers reconfigured the water supply to allow for each cross passage door to be supplied independently, which apparently helped to alleviate the problem.

This fire demonstrated the need for large quantities of water for an extended period of time. Master streams were not utilized in this incident; however, if needed, the system may not have been able to supply them, based on the problems that were occurring while using the existing handlins.

**Personnel**

This incident required an extensive number of personnel because crews were only able to operate in the fire area for about eight minutes. Provisions were made to rotate crews and bring in additional personnel on shuttles through the north running tunnel. This apparently worked well, and there were no reported injuries from either country’s emergency response organizations.

**Preplanning**

Extensive preplanning was involved in the design of the tunnel. The fire services from both nations were involved, and through this process they became familiar with each other’s operations and personnel. The one aspect that was emphasized by personnel from both countries was the value of personally knowing their counterparts. This aided immensely during the fire-fighting operations.

**7.5 The Aftermath**

As a result of the fire, the tunnel was completely shut down for several days. Rail freight started moving through the undamaged tunnel on November 21, 1996. Eurostar trains began running on December 4, 1996, and Le Shuttle tourist shuttles carrying cars resumed service on December 10, 1996. Shuttles carrying coaches were allowed to start running on January 6, 1997.

As an alternative, the ferry services between the United Kingdom and France were used, which resulted in significant delays and traffic jams because of the volume. On one day following the fire, a record 5,484 lorries were carried on the ferry service. However, on several days, rough weather in the English Channel resulted in the ferry service being shut down completely, which exacerbated the problem.
On Monday, December 30, 1996, at 6:17 p.m., another incident in the tunnel occurred. Both engines on a Eurostar train lost power completely, which resulted in the train being disabled approximately 12 miles into the tunnel for 2-1/2 hours. There were reported to be 469 passengers on board the train. According to initial reports, the train was disabled by melting snow and ice that caused several of the motors that drove the train to shut down.

8.0 Conclusion

This fire was an extremely challenging fire that tested many of the systems and procedures that had been installed within the tunnel. The fact that the fire was extinguished without any loss of life or serious injury to either the passengers, crew, or fire fighters is certainly a credit to the emergency response organizations from both the United Kingdom and France. Much will be learned from this incident as the details become known that can help emergency responders around the world who are faced with similar challenges.

Acronyms/Glossary

Bi-Nat  Bi-National. Due to the fact that the tunnel crosses between two nations, all of the procedures had to be developed jointly between the United Kingdom and France.

CdT  Chef de Train. The person who is in charge of the shuttle.

Concession  The term used to define the site that encompasses the grounds of both terminals and the tunnel.

EMS  Engineering Management System. The system that provides communications and control over the various systems in the three tunnels.

ERO  Emergency Response Organization. The various municipal and governmental agencies and organizations that would respond to emergencies in the tunnel.

FCP  Forward Control Point. A location within the tunnel from which the incident is managed by the ERO.

FEMC  Fire Emergency Management Center. A control center which is located at each terminal’s fire station and provides monitoring and communication with the units in the tunnels.

FLOR  First Line of Response. The units assigned to each of the emergency response stations within the terminals. There are 8 fire fighters on duty in the UK and 11 fire fighters on duty in France.

HGV  Heavy Goods Vehicles. Cargo trucks, or lorries.

IC  Incident Commander. The person in overall command of the incident.

ICC  Incident Control Center. There are two ICC’s, one at each terminal, that are activated during major emergencies. The ICCs are staffed by the various organizations involved in managing an incident.
A pre-determined response of 6 Kent Fire Brigade off-terminal units 

A pre-determined response of an additional 6 Kent Fire Brigade off-terminal units 

Normal Ventilation System. The normal ventilation system that is in operation in the three tunnels during normal rail operations. 

Officer in Charge. The senior officer in charge of an incident or unit. 

Railway Control Center. There are two RCCs, one at each terminal, that are responsible for underground rail operations. Although each RCC is identical, the Folkestone RCC is the primary one. 

Running Tunnel 1, also known as the South Running Tunnel 

Running Tunnel 2, also known as the North Running Tunnel 

Second Line of Response. Additional off-terminal resources that are deployed as needed. 

French FEMCs communications officer 

Service Tunnel. 

Service Tunnel Transport System. The specialized vehicles designed for transporting personnel and equipment in the service tunnel. 

Supplementary Ventilation System. A secondary ventilation system which can be brought on-line during emergencies to control the volume and direction of the airflow in the running tunnels. 

Terminal Control Center. There are two TCCs, one at each terminal, that is responsible for the above-ground terminal operations.