

# Highway Tunnel Fire Traffic Control Plan

Wang Liu<sup>1,\*</sup>

<sup>1</sup> School of Traffic and Transportation, Chongqing Jiaotong University, Chongqing 400074, China

\* Corresponding author: Wang Liu (Email: 1120365636@qq.com)

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**Abstract:** Tunnel fire accidents occur from time to time, due to its special structure, will cause huge losses, this paper by studying the division of tunnel fire, put forward the principles and specific measures of traffic control, and carry out zoning control of tunnel fire traffic, and prepare a plan for the traffic control of the affected area and the fire tunnel area.

**Keywords:** Tunnel fire, Traffic control, Segment division.

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## 1. Introduction

Once a tunnel fire occurs, the high temperature toxic gas in the tunnel will spread rapidly, seriously hindering the evacuation of personnel and vehicles in the tunnel, and at the same time, the high temperature will affect the mechanical and electrical facilities and tunnel structure in the tunnel, which will not only bring huge economic losses, but also lead to serious casualties. By controlling the traffic in the tunnel section where the fire occurs, it can effectively reduce the number of vehicles entering the tunnel after the fire and reduce the number of trapped people. As early as 1966, the Waight V H [1] of the United States used movable obstacles, variable signs, closed-circuit television monitoring and on-board radio to control traffic during peak hours in the tunnel in the Caldecott tunnel, and found that the traffic control system made it feasible for vehicles in the tunnel to run in reverse. Tsai-YunLiao et al. [2] developed the simulation allocation model DynaTAIWAN through numerical simulation experiments in the Xuefeng Mountain Tunnel to simulate traffic control strategies and reflect the driver's response to route guidance.

## 2. Traffic Control Technology

### 2.1. Traffic Control Principles

Under tunnel fire conditions, traffic control is implemented and the following principles are followed:

#### 2.1.1. Saving people is the main thing, and saving wealth is the supplement

The most basic principle of traffic control for highway tunnel fires is to minimize the harm to personnel in the tunnel, and a driving safety guarantee system should be established, and vehicle driving rules and regulations, vehicle dangerous goods management methods, monitoring and alarm systems should be formulated to prevent the occurrence of tunnel fires. When a fire breaks out in the tunnel, a traffic control plan is adopted in time to block subsequent vehicles from entering the burning tunnel and reduce trapped vehicles and personnel.

#### 2.1.2. Self-help combined with rescue

Establish high-standard personnel rescue and self-rescue facilities and methods, and coordinate the control of traffic control signals, variable speed limit signs and variable information signs in each section in the event of a fire incident.

The upstream personnel of the fire source parked the vehicle on the right side of the road in time, and reached the unburned tunnel through the nearest cross passage to implement self-rescue. At the same time, rescuers rushed to the scene of the fire as soon as possible and organized the safe and rapid evacuation of personnel.

#### 2.1.3. When it is safe, restore traffic as soon as possible

Under the condition of ensuring the safe evacuation of trapped people, firefighters are in place in time to extinguish the fire, clean the scene, test the tunnel structure, and restore traffic as soon as possible under the condition of ensuring safety.

### 2.2. Traffic control measures

In the event of a fire accident, the duty officer of the monitoring center immediately notifies and reports the fire information (location, type, severity, scope of impact, etc.), and the responsible personnel decide to start the corresponding traffic control and ventilation system plan. The watchman of the monitoring center notified the emergency rescue team to rush to the scene of the fire accident to organize traffic. Road maintenance personnel place reflective cones and warning signs at a safe distance to maintain road traffic order. As needed, through loudspeaker shouting or patrol personnel on-site command, ensure that the emergency lane is clear and not occupied by other social vehicles. Publish fire accident information before the toll booth and hub interchange, inform the driver in advance of the fire accident in the tunnel, and choose other routes to pass. And at least on the variable information board at the entrance of the tunnel to publish the accident information "tunnel fire, no driving", patrol personnel on-site command to ensure that the emergency lane is unblocked, to ensure that fire trucks, ambulances, police cars, maintenance vehicles rush to the scene of the fire in time. Follow the command of the traffic police at the scene, and the road maintenance personnel assist the traffic police to open the central separation belt for vehicle evacuation according to the situation. The monitoring center closely monitors the traffic flow dynamics and tunnel ventilation in the tunnel. Adjust traffic lights, variable information signs, variable speed limit signs, lane indicators and other facilities for traffic control and guidance according to the control plan, Table 1 describes the specific method.

**Table 1.** Tunnel monitoring traffic control facility control meter

Device type	Control content
Traffic lights	Red light; Yellow light; Green light; Left
Variable information flags	The current display content
Variable speed limit sign	Speed limit 0-80km/h
Lane indicator	Front↓, Reverse ×; × front, × reverse; Positive ×, reverse ↓
Cross-crossing lane indicator	Positive ←-; Positive ×
Cable	In the event of a fire in the tunnel, please park the vehicle on the right side of the road and evacuate the people in the vehicle through the crosshole

### 3. Traffic Control Section Division

#### 3.1. Highway section division

In the event of a fire in the tunnel, the highway where the tunnel is located can be zoned and controlled, and corresponding traffic control measures can be taken to effectively manage the traffic operation status, which can be divided into three sections[3].

##### 3.1.1. Fire tunnel area

The left and right lines of the fire tunnel from the entrance to the exit, combined with the tunnel traffic monitoring system, formulate corresponding traffic control measures and evacuation measures, and strictly implement them.

##### 3.1.2. Affected area

In the section near the fire tunnel, the tunnel fire affected area in this paper is outside the fire tunnel, and the length of

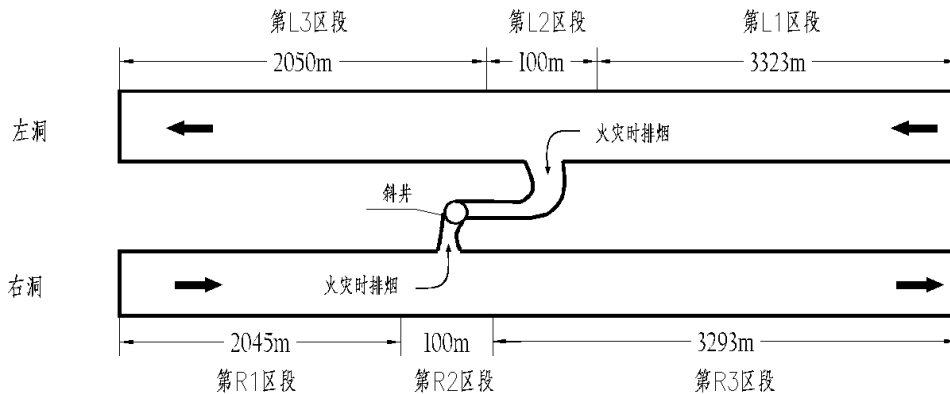
the affected area is determined according to Formula 2.5, and corresponding traffic control measures are implemented to provide assistance for personnel evacuation and rescue.

##### 3.1.3. No impact area

This area is not affected by tunnel fires, and no traffic control measures are required, but the information of the tunnel fire in front should be released in time to remind drivers to pay attention to driving safety.

### 3.2. Fire tunnel area

The fire tunnel area, as the main area of traffic control and the area of ventilation control, should continue to be subdivided. According to the actual situation of the Jiulingshan Highway Tunnel, it is divided into six sections according to the smoke prevention requirements in the event of a fire in the tunnel, as shown in Figure 1.



**Figure 1.** Schematic diagram of smoke exhaust zone of Jiulingshan Tunnel

### 4. Traffic Control Plan

#### 4.1. Influence area control plan

When the fire in the Jiulingshan Tunnel is confirmed, the traffic control plan is implemented in the affected area.

1. All variable information signs in the area display "Tunnel fire ahead, slow down, pay attention to safety";

2. Traffic control will be implemented at the exit from Tianbao to Daixi in the Yifeng service area, and vehicles entering the service area are prohibited from driving out, and they will be released after the traffic of the Jiulingshan Tunnel is restored;

3. Tianbao toll station released the fire information of the Jiulingshan Tunnel, and at the same time implemented some

traffic control and closed the entrance ramp to the direction of the interchange with creek;

4. The Daixi toll station released the fire information of the Jiulingshan Tunnel, and at the same time implemented some traffic control and closed the entrance ramp to the direction of Tianbao Interchange;

5. Strictly manage the emergency lane, prohibit the occupation of social vehicles, and ensure the smooth passage of rescue vehicles.

#### 4.2. Fire tunnel area control plan

Figure 2 shows the traffic control plan for the initial stage of tunnel fire and evacuation phase, using the fire in the R2 area as an example[4].

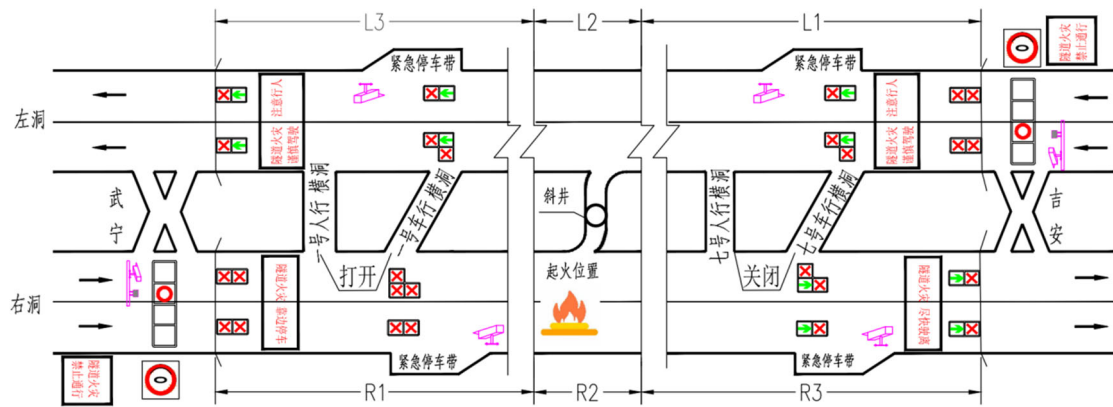


Figure 2. Schematic diagram of the R2 area fire traffic control plan

In the early stage of fire development and evacuation phase, the main thing is to safely evacuate trapped personnel and prevent subsequent vehicles from entering the tunnel, and allow vehicles in the uncaught tunnel to drive out when it is as safe as possible.

1. When a fire is confirmed in the tunnel area, the fire plan is executed. The variable information board on the approach section outside the left and right holes displays "Tunnel fire, no traffic", traffic lights are displayed in red, variable speed limit signs display "0", and the tunnel broadcasts "There is a fire in the tunnel, please stop the vehicle on the right side of the road, and the people in the car will evacuate through the cross hole".

#### 2. Burning tunnel

In the upstream area of the fire source, the front and back sides of the lane control sign display red "X", prohibiting vehicles from continuing to drive, and the variable information board in the cave displays "tunnel fire, pull over", and open the pedestrian cross hole and the vehicle crossing hole; In the downstream area of the fire source, the lane control sign shows green "↓" on the front and red "X" on the back, vehicles continue to pass, and the variable information board in the cave displays "tunnel fire, drive away as soon as possible", and close the cross passage.

#### 3. Tunnels that are not on fire

The front and back sides of the lane control signs at the entrance of the tunnel display red "X", prohibiting vehicles from entering, the rest of the lane control signs display green

"↓" on the front and red "X" on the back, vehicles continue to pass, and the variable information board in the cave displays "tunnel fire, pay attention to pedestrians, be cautious and slow down".

## 5. Conclusion

This article first clarifies the importance of traffic control in the event of a fire in a tunnel. Then, the principles of traffic control are summarized, specific traffic control measures are proposed, and fire sections are divided for the Jiulingshan Tunnel, and corresponding traffic control plans are prepared for different sections after the fire. It provides specific ideas for traffic control in tunnel fire emergencies.

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