

## **Fire safety in buses**

Transmitted by the experts from Norway and Sweden

### **1 Background**

The number of bus fires is large and there is a potential for catastrophic consequences when fires occur in connection to crash accidents. With this background, the Norwegian Public Road Administration and the Swedish Road Administration have initiated a research project together with SP Swedish National Testing and Research Institute. The project started in spring 2005 and will finish in spring 2008.

The main objective of the project is to generate increased knowledge about fire cause and fires in buses. The knowledge can be used to decrease the number and consequences of bus fires; prevent start of fires and delay start of fires; inhibit fire spread and smoke development in fire incidents; and to provide more time for emergency evacuation in case of fire. The results will be used as basis for proposal of concrete measures and changes in regulations to increase the fire safety of bus travelling.

### **2 Evaluation of fire safety**

The project has confirmed that fire safety in buses is a significant problem. Statistical surveys of bus fires in Norway and Sweden show that as many as 1 % of the buses are involved in fire incidents each year, although fortunately only few fires develop to big fires (Informal document No GRSG 90-16). If a fire gets hold in the passenger compartment there is a major risk of disaster due to very rapid fire spread and smoke development. Several fires with multiple casualties have happened in recent years and the potential for more disasters is significant.

Survey and fire tests of interior material and seats in buses have been carried out (Informal document No GRSG 91-19 and GRSG 92-18). The products were tested both with the presently required flame spread test method specified in ISO 3795 and with several other test methods used in fire safety regulations in fields like passenger ships, buildings and trains. The evaluation of fire behaviour was made according to existing requirements that are based on modern fire safety principles. The results show that the flame spread test (ISO 3795) is not enough to represent common types of bus fire. The present fire safety requirements imply a low level of fire safety for bus passengers. Most of the interior materials used in buses today would not be allowed in trains, passenger ships, hotels or hospitals.

The main problems that were identified are flame spread, heat, smoke and toxic gases. The conclusion is that the fire safety level can be improved with materials that resist fire for a

longer period of time and that produce less smoke. This will result in more time for evacuation, easier evacuation and more time to extinguish the fire.

### **3 Proposals for improvement of ECE 118**

#### **3.1 Flame spread**

A proposal is to introduce a flame spread test as specified in ISO 5658 for evaluation of ignition and flame spread as an alternative to the present test based on ISO 3795.

The standard is ISO 5658, Reaction to fire tests -- Spread of flame -- Part 2: Lateral spread on building products in vertical configuration, International Organization for Standardisation. The initial fire source in ISO 5658-2 is stronger than in ISO 3795. ISO 5658-2 determines the lateral flame spread on vertically orientated specimens exposed to radiant heat from a methane-fuelled radiant panel at an angle to the specimen as shown in the figure below. A small gas burner flame acts as pilot ignition source. The maximum distance of flame spread corresponds to a critical heat flux value (CHF) which is used as classification criterion. The CHF requirement for ships and trains corresponds to maximum allowed flame spread distances of approximately 380 mm and 250 - 350 mm respectively.

Appropriate requirement levels have to be defined before this test can be introduced in the Regulation. Further work is therefore needed.



Figure: Photograph of the ISO 5658-2 panel test.

#### **3.2 Smoke production**

A proposal is to introduce a smoke production test as specified in ISO 5659 for evaluation of smoke production and toxic fumes in addition to the present tests in Regulation 118.

The standard is ISO 5659-2 Plastics -- Smoke generation -- Part 2: Determination of optical density by a single-chamber test, International Organization for Standardisation. Specimens of 75 by 75 mm are positioned horizontally within a 0.5 m<sup>3</sup> sealed chamber and exposed to controlled levels of radiant heating, see the figure below. A retainer frame covers the periphery

of the specimen. Two different levels of irradiance, 25 kW/m<sup>2</sup> and 50 kW/m<sup>2</sup>, are prescribed both for passenger ships and the proposed train requirements. The smoke evolved from the specimen is accumulated in the chamber and the attenuation of a light beam passing through the smoke is recorded continuously and the results are reported in terms of specific optical density. ISO 5659-2 is today the principal test for smoke generation assessment. Toxic and corrosive substances in the smoke are determined continuously by infrared spectroscopy gas analysis. A small gas sample is taken from the geometrical centre of the chamber and analysed around time of smoke maximum.

Appropriate requirement levels have to be defined before this test can be introduced in the Regulation. Further work is therefore needed.



Figure: Photograph of the ISO 5659-2 smoke generation test.

#### 4 Further work to be carried out

Further work has to be carried out in order to get a good basis for requirements regarding fire safety. Comparisons can be made with fire safety requirements for trains, ships and public buildings. For the moment, we need more knowledge on how to define appropriate requirement levels to be used in the ISO 5658-2 and ISO 5659-2 tests. Guidance on pass/fail levels can be found when comparing with corresponding requirement levels for trains, ships and buildings, but it is not self evident that we just can copy those levels.

In order to get more knowledge on how a fire can spread and develop in a vehicle a full-scale fire test of a coach will be carried out. The test will generate information and knowledge on the following issues:

- How and how quickly do smoke and fire spread from a fire in the engine compartment?
- How can a fire in a tyre/wheelhouse spread to the passenger compartment?
- How quickly does smoke and fire spread in the bus when the fire penetrates to the passenger compartment? What is the highest danger, seats/walls/ceiling?
- What is the time range for safe escape in case of a fire?
- What is the heat release rate for the complete bus at flashover?
- What is the total generated energy?

Tests of fire in the engine compartment will be carried out. The test will generate a knowledge basis for:

- Relevant test method to evaluate the fire barriers between engine and passenger compartment.
- Repeatable test method for evaluation of extinguishment systems in the engine compartment and detection of engine fires.

When the results from the above mentioned tests are available, we think that we are in a position to make concrete proposals for amendments in the regulations.