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Detection of fires in the toilet compartment and driver sleeping compartment of buses and coaches—Installation considerations based on full scale tests

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ABSTRACT

Effective fire detection systems properly installed in bus and coach toilet compartments and driver sleeping compartments may save human lives and property loss. Rapid detection allows for early evacuation and extinguishment of a small fire, while late or no detection may allow the fire to spread. The purpose of the work presented in this paper is to provide recommendations on how to install fire detection systems in toilet compartments and driver sleeping compartments. The recommendations also cover what type of detection system is most suited. As a basis for the recommendations, full scale fire tests were performed with different detection systems. The fire tests were conducted in realistic mockups of a toilet compartment and a sleeping compartment. Different heat and smoke detection systems were analyzed at different positions for different fire scenarios to provide information on how to best install detection systems in these compartments. Five different scenarios were run and the most interesting finding was that two realistic fire scenarios in the toilet compartment did not activate fire detectors in the ceiling at realistic air flow rates. It is very rare that fire detectors are placed anywhere else than on the ceiling in toilet compartments on buses and the fire would then be very large upon detection.

1. Introduction

Fires in buses and coaches are very common and on average several buses[1] worldwide are involved in a fire incident each day. For instance, in the US approximately 160 bus fires were reported each year between 2004 and 2008 [1]. In Australia there are about 70 bus fires per year resulting in insurance claims [2] and in Sweden, Norway, and Finland about one percent of all buses in service, will suffer from a fire incident each year [3,4].

If passengers have reduced mobility the evacuation time may be severely extended. For instance, 20 elderly people died in a bus fire in Hannover 2008 [5]. The fire was caused by a short circuit in an electrical cable near the toilet and spread via the toilet compartment to the passenger compartment. With an effective fire detection system this tragedy might have been prevented. However, not all fire incidents lead to fatalities, but the property loss and the cost due to rescue operation, traffic jam, and clean up can be extensive. The environmental effects of both the fire itself and extinguishing agents may also be

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[1] In this paper the term "bus" refers to buses as well as coaches.

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severe [6]. All these effects might be mitigated with an effective fire detection system that enables early evacuation and suppression of the fire.

Based on reported fire incidents in buses and coaches the fires most frequently originate in the engine compartment or in the wheel well [1,4]. Several studies of fire protection in the engine compartment have recently been performed [7–9], and ongoing fire detection projects for these spaces are running e.g., at SP Technical Research Institute of Sweden. However, this paper focus on fire detection in the toilet compartment and driver sleeping compartment and no extensive study on fire detection in these compartments has, to our knowledge, been reported. In media, recent bus fires have been reported where the fire started in the toilet compartment [10,11] and in the catastrophic bus fire in Hannover 2008 the fire also started in the interior of the bus [5]. The study reported in this paper was partly triggered by the new UNECE requirement, regarding fire detection in the toilet compartment and driver sleeping compartment of buses, that came into effect in July 2014 [12]. The new requirement states that an excess temperature or smoke shall be detected in these compartments.

Reported in this paper is an investigation of what types of detection systems are most suitable in the toilet compartment and driver sleeping compartment of buses and how to best install the systems in these types of compartments. The main questions answered by this paper are how different types of detection systems placed at different positions respond to different fires and how the ventilation conditions may influence the response time.

2. Method description

Fire detector systems were tested at different positions in realistic test mockups of the toilet compartment and the driver sleeping compartment of buses. Different fire sources were positioned at different locations inside the mockups and tests were performed under different ventilation conditions.

2.1. Mockups

Statistics on height, width, and depth for toilet compartments and driver sleeping compartments were collected for 26 different buses and mean values were used for the design of the mockups [13]. The mockups are shown in Figs. 1 and 2. The toilet compartments of buses have in general quite similar dimensions and the largest differences were found between toilet compartments positioned in the rear of the bus and toilet compartments in double-deckers compared with toilet compartments positioned in the staircase, which is the most common location. The dimensions of the driver sleeping compartments were found to vary more than for toilet compartments, but also for these the mean values of the survey were used. The depth was in most cases the width of the bus. The sleeping compartment mockup has decreased ceiling height in the middle section which is due to the gangway in the passenger compartment. This decrease is not existent in all buses and it could also vary in size, but it was included in the mockup because it delays smoke distribution which severely affects detectors not placed in the direct vicinity of the fire.

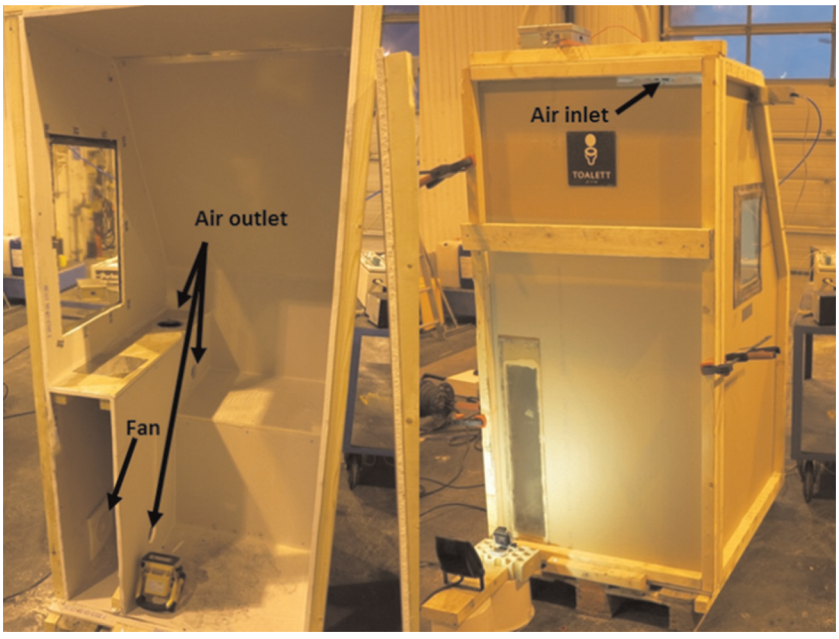

Fig. 1. Mockup of the toilet compartment in buses, seen from the front without door (left image) and with door (right image).