

Evacuation tests of passenger from buses and coaches in case of fire

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Abstract

Annually in Sweden, about 50 buses are involved in fire incidents; the most serious so far causing 15 fatalities. Typically, the bus compartment may be smoke filled within 50-90 seconds, making a fast evacuation of the passengers necessary.

Evacuation trials were carried out with 52 passengers in three different bus models. The city bus with two free exits had the shortest evacuation times. Fast evacuations were also found from the coach and the double-decker when two doors were in use. Evacuation times were prolonged when one door was blocked, when smoke reduced the visibility and when persons with disabilities were among the evacuees. Evacuation times exceeded 50 seconds in some cases. An additional evacuation door placed on the driver's side would decrease evacuation times.



Figure 1. Photos of the buses used in the evacuation tests. From left to right: City bus, Coach, Double decker. Photography: Pontus Albertsson and Torbjörn Falkner

Table 1. Description of buses used in the evacuation tests

Type	City bus ("Stadsbuss")	Coach ("Linjebuss")	Double decker ("Dubbel-däckare")
Model	Volvo B10M60	Volvo	Scania KL124EB
Seats	54	56	55
Doors	2	2	2
Door width front [mm]	600	750	800
Door width mid [mm]	800	700	850
Step heights front [mm]	250 (outer), 220, 240	280 (outer), 230, 200, 220	220
Step heights front [mm]	250 (outer), 230, 240	370 (outer), 250, 280, 230	220

Table 2. Age and sex of persons who participated in the evacuation tests

Age	Female	Male	Sum
17-18	25	7	32
31-40	-	1	1
51-60	2	1	3
61-70	5	2	7
70+	5	4	9
Sum	37	15	52

Table 3. Test matrix and results

Test No.	Bus type	Evacuation route	Test conditions	Number of tests	Evacuation time [s]
1	City bus	Front/mid	Baseline test	3	30
2	City bus	Front/mid	Stroller and walker	3	48
3	Coach	Front/mid	Baseline test	3	35
4	Coach	Front	Mid door blocked	3	53
5	Coach	Front	Disabilities	1	42
6	Coach	Front/mid	Disabilities	3	70
7	Coach	Front/mid	Smoke filled bus	1	51
8	Double decker	Front/mid	Belts on	3	33
9	Double decker	Front/mid	Belts not on	3	33
10	Double decker	Mid	Front door blocked	2	41
11	Double decker	Front/mid	Stroller, wheel chair, walker	1	58
12	Double decker	Front/mid	Smoke filled bus	1	55

It should be kept in mind that the evacuation times can be expected to be longer in a real scenario since the test persons knew what was going to happen, and since they probably developed their evacuation skills during the tests. In a real scenario additional time will also be required for opening the doors.

Wider doors were found to have a positive effect since the test persons lined up in two queues, instead of one queue for narrower doors.

Only evacuation through doors was investigated. Other escape routes were planned for future tests.