

Energy, Oxygen, and Air Requirements for Emergency Escape from a High-Rise Building

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From before the movie "Towering Inferno," people have been concerned about emergency escape from tall buildings. All these concerns became real in the World Trade Center tragedies. Escape using stairs can be hampered by 1) poisonous smoke and 2) other people. Protection against poisonous combustion products can be afforded by escape devices that supply enough air or oxygen to the escapees to allow them safe egress. How much air or oxygen is required? Tests were conducted to determine these values experimentally. Fifteen volunteer subjects were calibrated in the laboratory to determine individual relationships between heart rate and minute ventilation, and heart rate and oxygen consumption. They were then asked to move upstairs and downstairs either at their fastest speed or at heart rates corresponding to limits on minute volume of 35 L/min. Because travel times for the same distance were so much longer at the limited flow rate, total air and oxygen required was more (14.0 L and 5.0 L, respectively) than at their fastest speed (77.1 L and 2.6 L). The average times for upstairs movement were 7.90 sec/flight (fastest) and 26.9 sec/flight (flow limited). Average times for downstairs movement were 5.18 sec/flight (fastest) and 12.8 sec/flight (flow limited). Total physical work rate required was 739 Nm/sec for upstairs and -1091 Nm/sec for downstairs travel at the fast speed.