Fire and Evacuation analysis of 1000+ seat Blended Wing Body aircraft configurations: Computer Simulations and Large-Scale Evacuation Experiment

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INTRODUCTION

Very Large Transport Aircraft (VLTA) pose considerable challenges to designers, operators and certification authorities. Capable of carrying more than 800 passengers, the A380 may be considered a VLTA however; it is nevertheless a conventional aircraft configuration and so falls within the realms of past operations and certification experience. The aviation industry's drive for increased efficiency is leading to the consideration of less conventional designs and even greater passenger capacity, such as the Blended Wing Body (BWB or Flying Wing) passenger aircraft.

BWB designs being considered by the EC Framework 6 project NACRE (New Aircraft Concepts REsearch) are capable of carrying in excess of 1000 passengers on a single deck with 20 exits and eight longitudinal aisles. Furthermore, BWB layouts will mean that cabin crew at exits will not be able to assess the situation at opposite exit locations making redirection of passengers difficult. Indeed, the restricted and complex visual access and complex spatial connectivity offered by these aircraft configurations make wayfinding by passengers and redirection by cabin crew difficult and challenging. The industry standard evacuation certification regulations [1,2] require the aircraft manufacturer to demonstrate that the maximum complement of passengers and crew can be evacuated from the aircraft within 90 seconds through half the normally available exits. The BWB concept represents a significant departure from conventional aircraft design and as a result there are many challenging questions that need to be addressed. How long would it take to evacuate a BWB aircraft with around 1000 passengers and crew? How long would it take an external post-crash fire to develop non-survivable conditions within the cabin of a BWB aircraft? Is it possible for all the passengers to safely evacuate from a BWB cabin subjected to a post-crash fire? These questions are explored in this paper through computer simulation and experimental analysis.

BWB CONFIGURATION

As part of project NACRE many BWB configurations are being considered. In this paper we consider configuration FW1-1-1. The FW1-1-1 configuration is the base case from which all other NACRE BWB variants are generated. It is derived from the best design to emerge from the earlier EC Framework 5 funded project VELA [3]. The FW!-1-1 configuration consists of 1020 passengers in a single class configuration, 25 cabin crew and 20 floor level Type-A exits (see Figure 1).

FIRE AND EVACUATION SIMULATIONS

As part of project NACRE, a specially modified version [3] of the airEXODUS aircraft evacuation model [4] was used to explore evacuation issues associated with BWB aircraft. In addition, a series of large scale egress trials were conducted using a specially constructed BWB mock-up to verify key airEXODUS predictions. To simulate the fire, the SMARTFIRE [5]

Computational Fluid Dynamics (CFD) software was used. Finally, the results from the fire simulation and the evacuation simulation were linked to investigate the evacuation in the presence of the developing fire. The results from these evacuation and fire simulations along with the results from the experiment will be presented.

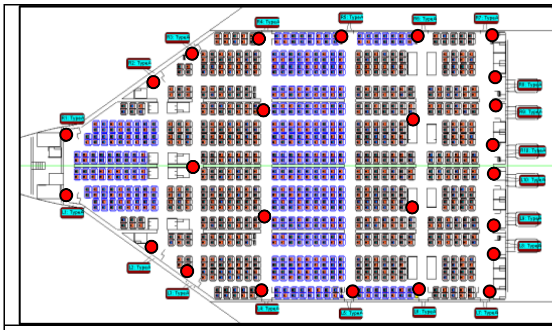

Figure 1: Cabin layout for FW1-1-1 showing location of cabin crew (circles) and exits

Figure 2: View from within the BWB mock-up during Trial 1 Session 1

LARGE SCALE EVACUATION TRIALS

Conducting full-scale trials involving over 1000 people was prohibitively expensive and impractical and so it was decided to undertake large-scale trials using a portion of the BWB cabin. Furthermore, given the complex passenger behaviour associated with the rear part of the cabin and the concerns over the modelling of this passenger behaviour, the trials focused on this part of the cabin. The key issue of interest was identifying whether participants would redirect and bypass a usable exit while trying to evacuate. To accurately represent this behaviour within the mock-up it was estimated that 380 people would need to be utilised in the mock-up of this area. A series of four trials were conducted over two days with two groups of participants, 375 participants on the first day and 358 participants on the second day. Data from the trials was collected using some 12 internal fixed mounted video cameras and five external fixed mounted cameras. In addition, a special roving head mounted camera was used in each trial. On completing each trial, participants were also required to fill in a questionnaire. The trials will be described along with the comparison of the model predictions with experimental results.

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