# CFD Analysis using OpenFOAM in the Design of Air-Conditioning System for a Large, Modern International Airport

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Passenger Terminal Building (PTB) is a very important feature of modern, large international airport. Airport consists of public spaces for arrival, departure, baggage reclaim, retail, recreation, security & check-in, offices etc. Baggage reclaim hall, departure pier, retail and recreation areas are large volume spaces. It is important to ensure proper distribution of conditioned air for adequate human comfort in these areas. Distribution of conditioned air is designed using supply terminals such as binnacles and jet nozzles. Prediction of conditioned air flow and consequent temperature distribution within the occupied space is not straightforward while using this type of air-conditioning system as analytical techniques are not amenable. Hence, CFD analysis was carried out to evaluate effectiveness of air distribution system using OpenFOAM 2012. The workflow of OpenFOAM was customized, taking into account HVAC design parameters such as outdoor conditions, external heat gain (solar &non-solar) and internal heat loads (people, lighting, equipment) as input data. One of the challenges faced was to create geometry with building envelop and interior details for flow domain. A third-party CAD modeling software such as Blender was used to capture geometry features, specifically ducts and nozzles that could be exported to OpenFOAM. Creating zones for human occupants (seated and standing) proved to be quite challenging while using an alternate CFD software compared to OpenFOAM. Block mesh led to mesh count exceeding 50 million in order to resolve small geometrical features using snappyHexMesh in the airport area. Handling this mesh count with available CPU cores proved to be a challenge but resolved with block mesh and the controls provided by castellated mesh under snappyHexMeshDict. So, overall mesh count was reduced to about 5 to 12 million cells with mesh size ranging from 0.03 m to 2.8 m. Both tetrahedron and hexahedron mesh was used. snappyHexMesh with custom control was applied to snap mesh for specific parts like pillars and grille. Toposet was used to define and change cell zones for applying heat loads, without the need of meshing again. With reduced mesh count, Gauss upwind scheme was used for solution. Indoor design condition expected was 23±1 $^{0}$C with supply air temperature at 14 $^{0}$C. CFD results confirmed temperature distribution with maximum of 20 $^{0}$C within the occupied height of 2m from floor level. As a result, it is concluded that design of air-conditioning is adequate for thermal comfort. Also, CFD results show temperature stratification above occupied level, indicating efficient air-conditioning. In the construction industry, where time and cost are a major criterion, OpenFOAM is an effective CFD tool for evaluation of air conditioning design for thermal comfort in large public spaces such as airports.