Building and Construction Authority

An MND Statutory Board
In Collaboration with

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Dear Sir / Madam

JOINT BCA/ACES/IES CIRCULAR 2022

GUIDELINES ON CFD SIMULATION AND REPORT FOR ADOPTION OF JET FANS AS ALTERNATIVE SOLUTION IN-LIEU OF DUCTWORK FOR MECHANICAL VENTILATION IN CARPARKS

Objective

This circular is to inform the industry of a set of guidelines on Computational Fluid Dynamics (CFD) simulation and the report to be submitted to the Commissioner of Building Control (CBC) for approval for the adoption of jet fans as an Alternative Solution in-lieu of ductwork for mechanical ventilation (MV) in carparks.

Background

2. Jet fans are commonly used in carparks for MV systems of vehicular exhaust. Currently, projects using jet fans in the MV system design will require the submission of Alternative Solution to the CBC for the adoption of jet fans as an alternative to conventional ductwork of MV systems for carpark as specified in Singapore Standard SS553: Code of Practice for Air-conditioning and Mechanical Ventilation in Buildings. To establish the effectiveness of the jet fans in dissipating the vehicular exhaust, an appointed Professional Engineer in the branch of Mechanical Engineering (PE(Mech)) will conduct CFD simulations for the project. The results obtained from the CFD simulations would be used

to justify the PE(Mech)'s assessment on the sufficiency of the jet fan design in the application for approval of Alternative Solution (AS) from the CBC in-lieu of MV ductwork in the carpark.

3. Today, there is differing industry practice in carrying out CFD simulation (e.g. values to be adopted for critical parameters). BCA has thus collaborated with Association of Consulting Engineers Singapore (ACES) and Institution of Engineers Singapore (IES) and in consultation with CFD and jet fans specialists, a set of guidelines to standardise the key aspects of the CFD simulation and necessary content was developed.

Guidelines

4. The guidelines on the CFD simulation and CFD report for the adoption of jet fans as an AS in-lieu of ductwork for MV in carparks are detailed in **Annex A**. Notwithstanding, as design and expected operations of a development vary, the PE(Mech), being a specialist in the alternative solution, should assess the suitability of the adoption of the guidelines for the CFD simulation to guide their design of the jet fan system for the development. The PE(Mech)should provide details of the design and expected operating conditions of the development and indicate any scenarios which may require more stringent assumptions in the CFD simulations in the report. Should there be any deviation from the recommended parameters in the guidelines, it should be supported with sufficient justification.

5. In addition, PEs(Mech) are reminded of their duty under section 9(3) of the Building Control Act 1989 to take all reasonable steps and exercise due diligence to ensure that the alternative solution satisfies the objectives and performance requirements that are prescribed in the building regulations in respect of ventilation, before issuing the certification of supervision for the jet fans system.

Effective Date

6. It is recommended that the guidelines in Annex A be adopted with immediate effect in respect of the CFD simulation and the report submitted to the CBC on the adoption of jet fans as an AS in-lieu of ductwork for MV in carparks.

For clarification

7. We would appreciate it if you could convey the contents of this Circular to the relevant members of your respective organisations. If you or your members have any queries concerning this Circular, please submit your enquiry through BCA's Online Feedback Form at https://www.bca.gov.sg/feedbackform/.

Thank you.

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ANNEX A

Guidelines for CFD Simulation and Report

Part 1: CFD Simulation		**Part 2: Report**
Criteria	**Guideline**	
Software	Follow BCA's GM Guideline on CFD Simulation under Green Mark 2021	1. For each of the criteria, the report shall clearly state the provision and assumption. For example, a. Write up of the software and simulation methodology indicating provision and compliance with each of the guideline b. Building plans showing location and size of natural ventilation openings c. Information of MV and jet fans system including air-change rate (ACH), flowrate, model, quantity and plans showing location of system. The PE for ACMV shall confirm that MV system (fresh air and exhaust fans) is provided as per SS553. d. Calculation of exhaust emission from vehicles and any references made in the calculation 2. The report shall clearly demonstrate and explain how the CFD results demonstrates the below. Where applicable to demonstrate the below, there shall be CFD results at different timeframes (e.g. every 400s) furnished in the report. a. steady state condition achieved b. performance of the system in meeting the acceptance criteria 3. Where there is deviation from the suggested default conditions, for example if the QP/Specialist assessed that occupancy of lower values may be adopted, supporting information and data for such development shall be provided in the report. 4. Similarly, should there be a need to adopt higher values due to different operating conditions, the assumed value shall be stated.
Simulation Methodology and Boundary Conditions	• RANS or LES is acceptable (minimally k-e turbulence model for RANS) • Standard wall function • Ambient CO concentration level = 0ppm • No wind • MV system in continuous operation	
Discretization Schemes and Convergence Criteria	Follow BCA's GM Guideline on CFD Simulation on Discretization Schemes and Convergence Criteria	
Grid size and mesh	Follow BCA's GM Guideline on CFD Simulation on Grid size and Mesh	
Building Model and MV system	Accurate model of: 1) building layout and openings In line with SCDF, any down-stand beams and other obstructions that are of depths of more than 1/10 of the car park floor to ceiling height shall be considered. 2) MV system in continuous operation 3) Maximum expected number of vehicles parked in the carpark	

Cars in operation and exhaust rate	As a default, assume 25% of vehicles (evenly distributed) are cruising at 10km/hr in the carpark, continuously emitting exhaust as below. Should there be areas where built-up of cars may be expected, CFD simulation shall be based on the expected operating scenario. <u>Exhaust Emission of Carbon Monoxide (CO)</u> • Petrol-driven vehicles – **Euro VI** (1.0g/km) • Diesel-driven vehicles – **Euro IV** (3.5 tonnes or below: 0.74g/km, greater than 3.5 tonnes: 1.5g/kWh) • Motorcycles – **Euro III** (2.0g/km) Note: • For the modelling of the exhaust from the vehicles, detailed modelling of the exhaust pipe is not required. Emission from a grid is acceptable. • For ease of assumption, unless the use of the carpark is distinctly different, you may assume vehicles in carpark of office/commercial buildings/shopping centers are petrol-driven vehicles such as passenger cars.	
Acceptance criteria	No hotspot of CO more than 25ppm should be observed on the CFD result at height of 0.5m and 1.7m at steady state	

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