An Coimisiún Pleanála

FSC Report

ABP-322732-25

Appeal v Refusal or Appeal v Condition(s)	Appeal v Condition (Condition 3)
Development Description	Construction of a Portal Framed Storage Warehouse Building Unit 8, incorporating ancillary two-storey office space at Anchor Park, Courtown, Little Island, Co. Cork
Building Control Authority Fire Safety Certificate application number:	FSC2407196CC (Submission No. 3024571)
Appellant	Mr Christopher Murnane
Appellant's Agent	Mr. Pat Carey, PMCG Consulting Engineers
Building Control Authority:	Cork County Council
Inspector	Colin Barden

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1.0 Introduction

1.1. The proposed development at Anchor Park, Courtown, Little Island, Co. Cork consists of the construction of a new portal frame storage building (Unit 8). The building is compartmented into two separate warehouses Unit 8A and Unit 8B each incorporating it's own ancillary two-storey office space. Warehouse Unit 8A has a floor area of 5136.08m^2 and Warehouse Unit 8B has a floor area of 4876.49m^2. The height of both warehouses is 15.3m (to external parapet), and circa. 13.8 from floor to average ceiling hight, with 12.5m of high-racked storage being proposed throughout both warehouses. Each warehouse is a two-bay portal frame structure.

1.2. A Fire Safety Certificate Application, with Building Control Authority (BCA) Ref. FSC2407196CC was submitted to BCA on 08/10/2024. The supporting documents submitted with this application included a report, by B-Fluid Ltd., dated 18/09/2024 on a 'CFD Analysis of the Smoke Ventilation System' in Warehouse Unit 8.

1.3. A Grant of Fire Safety Certificate was issued by the BCA on 06/05/2025 with 3 conditions.

1.4. An appeal against Condition 3, below, was lodged with An Coimisiún Pleanála (the Commission) on 04/06/2025.

> *"Condition 3:*
>
> *Facilities for ventilation of smoke and heat shall be in accordance with Section 5.4.3.3 of Technical Guidance Document B and in particular the National Fire Protection Association Fire Code 204M "Guide for Smoke and Heat Venting". The report and accompanying CFD analysis submitted on 08/10/2025* ***** *does not clearly demonstrate compliance with the above.*
>
> *Reason:*
>
> *To ensure compliance with Part B5 of the Second Schedule to the Building Regulations 1997 as amended."*

***** : Note typographical error in Condition 3 which I believe was intended to refer to the submission date of 08/10/2024.

2.0 **Information Considered**

2.1. The information considered in this appeal comprised the following:

- Copy of statutory and supporting documents submitted with the application on 08/10/2024, including:-
    - B-Fluid Ltd. Report dated 18/09/2024 regarding 'CFD Analysis of the Smoke Ventilation System' in Warehouse Unit 8.
- Revised Information Letter, by B-Fluid Ltd., submitted on 15/11/2024.
- Revised information submission, by PMCG Consulting Engineers, submitted on 02/12/2024.
- Revised Information Letter, by B-Fluid Ltd., submitted on 23/01/2025.
- Revised Information Letter, by B-Fluid Ltd., submitted on 25/02/2025.
- Revised information Letter, by PMCG Consulting Engineers, submitted on 25/02/2025.
- Copy of BCA 'Decision to Grant' dated 06/05/2025
- Appeal letter by the Agent, Pat Carey, PMCG Consulting Engineers dated 04/06/2025, including the following attachments:
    - Letter dated 04/06/2025 from B-Fluid Ltd. setting out the grounds for the appeal as it relates to the Computational Fluid Dynamics (CFD) modelling set out in the application, and
    - Report dated 18/09/2024 by B-Fluid Ltd. regarding 'CFD Analysis of the Smoke Ventilation System' in Warehouse Unit 8.
- Copy of BCA Response to Appeal dated 07/07/2025.

For clarity, references to the 'Appellant' in this report include submissions made on their behalf by their Agent(s) in this appeal process. The term 'Applicant' is used when referring to the Fire Safety Certificate Application process.

3.0 Relevant History/Cases

3.1. I am not aware of any relevant building control history relating to the appeal site, including any previous FSC, Revised FSC, Regularisation FSC or/and any dispensation or relaxation of the Building Regulations.

3.2. There was no reference in the history on file to any relevant Board decisions at other locations.

4.0 Appellant's Case

4.1. The appellant is appealing the attachment of Condition 3 to the grant of the fire safety certificate on the basis that it sets out requirements that are not necessary to demonstrate compliance with Part B of the Building Regulations. The following points are set out in support of the appeal:

4.2. In their initial appeal submission (04/06/2025) the Appellant highlighted the following.

- To achieve compliance with Part B of Building Regulations TGD-B 2006 (2020 reprint) was used. Section 5.4.3.3 of TGD-B sets out requirements for Large Undivided and Windowless Accommodation.
- TGD-B permits alternative approaches such as a fire engineering analysis. Fire Engineering can by either deterministic or comparative. A comparative analysis is unrealistic in this case and therefore a deterministic analysis has been undertaken.
- A CFD Modelling Analysis has been undertaken setting out this deterministic approach and the results demonstrate compliance with Regulation B5.
- Fire is a complex phenomenon and there are on going developments in the field of fire engineering to improve the understanding of fire behaviour and it's consequences, therefore the Appellant does not agree with Cork County Council's condition that suggest in order to achieve compliance with Section 5.4.3.3 of TGD-B that the NFPA 204M Guide has to be followed.
- The following addition safety measures are provided:
    - Low-risk storage

- L1 fire detection and alarm system in accordance with I.S. 3218
- Travel distances that do no exceed the limitations set out in TGD-B
- Automatic opening vents (no required in the regulations)
- Supplementary ventilation is availing since 10% of the roof area is covered with rooflights
- 38.8m^2 of low-level doors that can be opened manually to allow additional air inlet
- Building is compartmented
- External fire hydrants.

- The initial appeal submission was accompanied by a 'letter of support' from the CFD Modellers (dated 04/06/2025) which also notes the following:
  - The CFD Modellers disagree with the wording of Condition 3 that states *"The report and accompanying CFD analysis submitted on 08/10/2024 does not clearly demonstration compliance with the above."* (i.e. with Section 5.4.3.3. of TGD-B). The CFD Modellers contend that the ventilation provision for the unit does satisfy the functional requirements of Regulation B5.
  - The CFD analysis undertaken is sufficient to maintain tenability criteria to industry standards, such as CIBSE Guide E, BS 7974 etc.
  - The steady state max 50MW design fire chosen is conservative.
  - Each warehouse is considered as one smoke reservoir. There is no smoke curtain proposed however the shape of the roof in each warehouse has two pitches which naturally splits the roof into two sections.
  - Each roof pitch in each reservoir has 11 or 12 roof vents. There are no inlet air vents in walls proposed. However natural buoyancy effects mean that hot smoke will be exhausted from roof vents closest to the fire while other roof vents, more remote from the fire, will facilitate inlet air.

- The smoke ventilation will operate automatically, which is above the requirement of TGD-B which states that *“Facilities for the ventilation of heat and smoke for firefighting purposes are not generally required to operate automatically.”*.
- The smoke ventilation system will operate early as for this type of warehouse beam detection or similar will be adopted.

5.0 Building Control Authority Case

5.1. In their response to the Appeal submission the BCA raise the following points:

- The proposed design assumes an ultra-fast growing fire up to 120 seconds with a 50MW steady state fire for 20 minutes total duration of modelling carried out. It seems unrealistic that an uncontrolled fire in high-bay racking without automatic fire suppression would not reach flashover and would maintain a 10m clear layer and a hot layer temperature of 60ºC as proposed in the CFD Modelling Report.
- This application includes 12.5m high racking and was proposed as normal hazard storage and assessed under TGD-B 2006 (2020 reprint). However TGD-B 2024 now defines racking in excess of 7m high as high hazard.
- TGD-B 2020 reprint states that *“space below the roof generally requires division into smoke curtains”*. Smoke control design codes such as NFPA 204M, require smoke curtains/downstands to keep the smoke reservoir size within certain limits, if there are no limits the smoke will keep travelling and cooling and eventually drop down to below head height.
- The CFD analysis is based on Automatic Opening vents (AOVs) opening immediately however the Compliance Report stated that the smoke detection will be a double knock system (two devices required to operate for automatic activation) and therefore the vents will not open immediately.

- The attendance of the Fire Service to this location is likely to take at least 20minutes which has not been taken into account e.g. per BS7974-5.
- Cork County Building Control Authority requested that the applicant submit a third-party independent verification of the CFD Analysis. This was not received.
- The supplementary roof lights mentioned by the CFD Modellers in their submission to the Commission was not mentioned or analysed in submissions to the BCA.
- The low-level doors providing possible air-inlet ventilation mentioned by the CFD Modellers in their submission to the Commission was not mentioned or analysed in submissions to the BCA.
- The additions safety measures/points raised are standard requirements with the requirement of TGD-B and do not provide enhanced fire safety in this case.

6.0 Assessment

6.1. ***De Novo* assessment/appeal v conditions**

Having regard to the nature of the appeal which is solely against a condition (Condition 3), and having considered the drawings, details and submissions on the file and having regard to the provisions of Article 40 of the Building Control Regulations 1997, as amended, I am satisfied that the determination by the Board of this application as if it had been made to it in the first instance would not be warranted. Accordingly, I consider that it would be appropriate to use the provisions of Article 40(2) of the Building Control Regulations, 1997, as amended.

6.2. **Content of Assessment**

6.2.1. This appeal centres about the adequacy of a smoke and heat ventilation system proposed to meet the requirements set out in Section 5.4.3.3 of TGD-B 2006 (2020 reprint), and in particular the use of a CFD model to demonstrate the adequacy of an automatic smoke and heat exhaust ventilation system without the presence of downstands/smoke curtains separating individual smoke reservoirs.

In the first instance it is important to recognise that Section 5.4.3.3 is prima facia guidance under Regulation B5 of Building Regulations. The wording of Regulation B5 (at the time of the application) was as follows *"A building shall be designed and constructed that there are adequate provisions for access for fire appliances and for such other facilities as may be reasonably be required to assist the fire service in the protection of life and property"*.

The primae facia guidance in Section 5.4.3.3 of TGD-B is reproduced in full below:-

5.4.3.3 Large undivided and windowless spaces - Large undivided floor areas can present difficult firefighting problems. The accumulation of heat and smoke in a fire may prevent access to these areas and limit the potential for rescue and effective firefighting from within the building. The provision of smoke and heat venting can greatly improve the effectiveness of such operations.

Fire extinguishment is normally accomplished by absorption of heat by water from hose streams or sprinklers. The reduction of heat build-up within the building by adequate venting facilities can reduce the amount of water required for cooling and extinguishment. However, ventilation is not a substitute for sprinklers or other extinguishing facilities. Its purpose is to release smoke and heat from the building and to improve accessibility for the fire services.

The principles described above are equally applicable to large windowless accommodation, where a fire has very limited ability to vent to the outside, and thereby giving rise to difficulties with firefighting operations.

Facilities for ventilation of smoke and heat for the purpose of assisting the fire service in the protection of life and property should be provided in single storey buildings or compartments exceeding 4,000 m^2 in area or 20,000 m^3 in cubic capacity (see Appendix C, Diagram 35) having the following uses:

- Shop (Purpose Group 4),
- Industrial (Purpose Group 6), or
- Storage (Purpose Group 7).

Ventilation facilities include roof mounted exhaust ventilators of suitable size and distribution and adequate inlet air provisions. The space below the roof generally requires division into smoke reservoirs of appropriate dimensions. Ventilation may also be provided or supplemented by the nature of the roof/building fabric, such as by the use of rooflights. It may also be possible to provide inlet air from adjacent smoke reservoirs or by means of external windows or doors. Facilities for the ventilation of heat and smoke for firefighting purposes are not generally required to operate automatically.

Guidance on the design of ventilation systems appropriate for these purposes are contained in Section 3, Chapter 9 of the Society of Fire Protection Engineers "Handbook of Fire Protection Engineering" (2nd Edition). Guidance is also contained in the National Fire Protection Association Fire Code 204M "Guide for Smoke and Heat Venting".

Note: Ventilation of heat and smoke may also be required for the purpose of protecting the means of escape (see Section B1) in large and complex buildings such as shopping centres (see also 3.5.3), large assembly and recreation buildings and buildings with an atrium (see 3.5.5).

Each storage warehouse exceeds the area (4000m^2) and volumetric limits (20,000m^3) in 5.4.3.3 of TGD-B and therefore requires smoke and heat venting for the purpose of assisting the fire service. It is noted that 5.4.3.3. describes this system as follows:-

- comprising of roof mounted exhaust ventilators,
- space below roof generally required to be divided into smoke reservoirs of appropriate dimensions
- ventilation may be provided/supplemented by nature of the building, e.g. rooflights
- inlet air may be from adjacent reservoirs or via external windows / doors.
- facilities for ventilation of smoke and heat are not generally required to operate automatically.

The proposed smoke and heat ventilation system in this case has the following features:-

- roof mounted exhaust ventilators,
- no subdivision into smoke reservoirs and no downstands/curtain, but has a two pitch roof design,
- there was no mention of supplementary ventilation (e.g. by roof lights) in the smoke ventilation system design submitted with the Fire Safety Certificate Application,
- no dedicated inlet air, but the CFD Analysis shows that, for the given fire size, inlet air is available via roof ventilators remote from the fire,
- automatic operation of roof ventilators.

The proposed smoke control design is supporting by a CFD Model and Analysis as set out in the CFD Modelling Analysis Report submitted with the Fire Safety Certificate Application. The central question therefore is the adequacy of the proposed design compared to the requirements of Regulation B5 and the primae facia guidance set-out in Section 5.4.3.3. of TGD-B 2006 (2020 reprint).

6.2.2. To examine and answer this question it will be necessary to consider the thematic issues emerging from the review of the appeal. Each of the following issues will be examined in turn below;

- Fire Engineering Approach
- Fire Growth Rate
- Heat Release Rate
- Design Fire Size
- Smoke Reservoir Size
- Compensating Features

6.2.3. Fire Engineering Approach

Section 0.1.4 of TGD-B 2006 (2020 reprint) states that *"The use of alternative design solutions, standards, systems or methods of fire protection to those outlined in this document are acceptable, provided the level of fire safety achieved is adequate to satisfy the requirements of the Building Regulations."*

The Appellant contends that the imposition of Condition 3 suggests that fire engineering solutions are not acceptable to demonstrate compliance, which is in their opinion contrary to the guidance provided in TGD-B.

Is it is noted that the Department of Housing Local Government and Heritage (DHLGH) published an *"Information Note on Alternative Approaches to Demonstrate Compliance with the Building Regulations"* in March 2024. This Information Note highlights that *"The use of alternative approaches to those outlined in a Technical Guidance Document may be acceptable, provided that the performance achieved is adequate to satisfy the requirements of the Building Regulations."* The Information Notes goes on to say that the responsibility for compliance rests with the owners of the building and that *"where alternative approaches are being considered, the local building control authority should be consulted at the earliest possible opportunity, to seek advice from the authority on the proposed development"*.

In relation to the use of Fire Safety Engineering the DHLGH Information Note states that the Fire Safety Engineering design process includes a qualitative assessment of the design, a quantified analysis and a comparison with defined safety criteria. It goes on to recommend that the relevant local building control authority should be consulted before critical decisions or assumptions are made about the fire safety design and to discuss relevant matters such as acceptance criteria, peer review, and reporting.

There was no evidence submitted of any earlier consultation with the BCA on this development for the purpose of undertaking a qualitative design review and setting out the acceptance criteria. I note that the Information Note mentions ‘peer review’ and that the BCA asked for such a peer review to be carried out of the CFD Analysis undertaken. However there was no evidence submitted of any peer review having been undertaken of the CFD Analysis submitted.

The DHLGH Information Notes states that a Fire Engineering solution can be undertaken using the following alternative approaches;

> (a) a probabilistic or risk-based approach; or
>
> (b) a deterministic approach, (which establishes the worst credible fire scenarios to be considered in detail, with the addition of appropriate safety factors); or
>
> (c) a comparison of the performance of a proposed alternative approach with that achieved using the guidance in the Technical Guidance Document.

In their submissions with the Fire Safety Certificate Application the Applicant states that a comparative analysis could not be undertaken due to the innovative design undertaken. However they also go on to say in their submission to the BCA dated 25/02/2025 that a second CFD Analysis would be undertaken, this time with a smoke curtain present, to demonstrate the difference between the two scenarios (with/without smoke curtains). This is no evidence that this second CFD Analysis was ever undertaken or submitted to the BCA. Following the guidance in the DHLGH Information Note I am of the opinion that it would have been entirely possible and reasonable to undertake a design compliant with 5.4.3.3. of TGD-B and use same in a comparative analysis to clearly demonstrate to the BCA the differences between the primae facia and engineered solutions. I therefore do not agreed with the Appellants opinion that the imposition of Condition 3 is somehow preventing the Appellants from pursuing a fire engineered alternative approach design. Indeed it is a fire engineered alternative approach that has been undertaken, submitted to the

BCA and decided upon by them. The BCA simply do not accept that the alternative approach submitted adequately demonstrates compliance with Regulation B5. This will be examined in the following sections.

6.2.4. Fire Growth Rate

Uncontrolled fires in buildings will generally grow until either constrained by the available fuel or limited by the amount of ventilation (air/oxygen). The only other way of preventing continued fire growth is the provision of suppression such as by automatic sprinklers or fire service intervention. Where fires are limited by fuel, ventilation or suppression they can reach a steady state during which time they produce a steady heat release before eventually decaying.

The scenario considered in the design submitted is a growing fire up to a peak / steady state of 50MW fire size for the duration of the modelling period (20 minutes). The CFD report mentioned both ultra-fast t^2 and t^3 fire growth curves and proposes to use a t^3 growth period. The calculation give in the modelling appears to use an incorrect ultra-fast t2 fire growth rate, of $Q=0.18*t^2$, whereas CIBSE Guide E gives the UF t2 fire growth as $Q=0.1876*t^2$ and a different formula/ growth coefficient for t^3 fires as $Q=0.045*t^3$. However, I note that CIBSE Guide E limits the validity of this latter formula to fires in the racking flue of up to 10MW for a 10m high rack.

There are no results given in the CFD report for how long it takes to reach a steady state of 50MW, however I would expect that to take less than 2 minutes for a t^3 growth rate and circa 8.5 minutes for an Ultra Fast t^2 fire growth rate.

There is no rational given for limiting the fire growth rate at these times, i.e. there is no demonstration of the fire growth being limited by fuel, oxygen or suppression. This is, in my opinion, a fundamental flaw in the inputs to the CFD model given the absence of a reason for further fire growth, such as the presence of automatic sprinklers.

6.2.5. Heat Release Rate

In estimating the heat release rate per unit area (HRRPUA, kW/m2) the CFD Analysis makes reference to guidance in VTT Working Paper 139 – *“Design Fire for Fire Safety Engineering”*. Section 5 of VTT Working Paper 139 contains guidance on design fires for different occupancies however Section 5.3 states that FDS (Fire Dynamics Simulator, a CFD Fire Modelling Software) can be used to generate an estimate of Heath Release Rate (HRR).

> 5. Design fires for different occupancies
>
> **5.3 Warehouses**
>
> **5.3.1 Burning of stored goods**
>
> Direct assessment of the heat release rate of the combustibles in warehouses on the basis of experimental data involves some difficulties:
>
> - The fires can be very large, of the order of tens of megawatts, and the amount of experimental data with so high HRR values is limited (but fortunately not entirely non-existent).
> - The combustibles are not very well defined because
>   - the stored items vary
>   - the lay-out and storing height vary.
>
> To overcome these problems, the methodology described in detail in section 6, enabled by the FDS fire simulation program, can be used to get *an estimate the heat release rate*. The results show that – given the inherent uncertainties involved in our knowledge of the stored goods and their configuration – the accuracy of the HRR predictions obtained by using the methodology is sufficient for FSE usage.

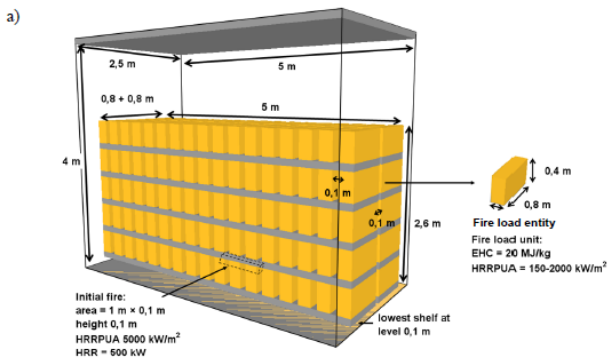
Unfortunately, the CFS Analysis does not demonstrate the use of Section 6 of the VTT guide. Instead the report reproduces the guidance from Section 5.4 and Figure 28 of VTT Report on “Shops and other commercial occupancies”. The example racking given in this section of VTT Report and reproduced in the CFD Analysis report (and in the figure below) has the following dimensional criteria:

- Racking Height = 2.6m
- Racking Length = 5m
- Racking Width = two 0.8m racks back to back giving a total width of 1.6m
- Ceiling Height = 4m

- Separation Distance: NA – only one rack modelled.

5. Design fires for different occupancies

a)



b)

Fuel envelope volume V_{FE}	22.1 m^3
Fuel envelope area A_{FE}	51.84 m^3
Floor area	8.5 m^2
No. packages	136
Fuel volume V_F	8.704 m^3
Single package exposed area:	
upper level	0.96 m^2
others	0.8 m^2
Fuel exposed area A_F	111.52 m^2
Filling ratio = V_F / V_{FE} =	39 %
Burning area ratio = A_F / A_{FE} =	215 %
Fuel density ρ_F	500 kg/m^3
Fuel mass M_F	4352 kg
Fuel heat of comb. ΔH_F	20 MJ/kg
Fire load $Q_F = \Delta H_F \times M_F$	87040 MJ
Aisles around	1 m
=> total floor area A_f	25.9 m^2
=> fire load density q"	3361 MJ/m^2

Figure 28. Model for the shop shelve fire load entity: a) schematic presentation and b) some calculated characteristics.

While no measurements for the proposed racking system design were contained in the documents reviewed an examination of the drawings received suggests that the proposed racking system in these warehouses has the following dimensional criteria:

- Racking Height = 12.5m
- Racking Length = 55m
- Racking Width = two 1.2m racks back to back giving a total width of 2.4m
- Ceiling Height = 13.8m
- Separation Distance: 1.8m (across aisles to other racks),

To adopt the guidance in Section 5.4 and Figure 28 of VTT for racking in use in "retail shop shelves" to model high-bay racking of the above dimensions in an unsprinklered storage warehouse is, in my opinion, fundamentally flawed.

The CFD Analysis report does mention Section 6 of the VTT Report but provides no evidence that the racking systems proposed has been modelled as fuel packages in FDS to determine the appropriate HRRPUA. Instead the CFD Analysis Report simply states that a HRRPUA of 1030kW/m^2 has been determined as being appropriate in this case.

Table 2 of *"Guidance for the Design of Smoke Ventilation Systems for Single Storey Industrial Buildings, including those with Mezzanine Floors, and High Racked Storage Warehouses"* by the Smoke Ventilation Association (SVA) Issue 3 – 1994 gives heat release rates per metre height of storage from 30kW/m^2/m to 2900kW/m^2/m. The impact of the height (i.e. kW/m^2 versus kW/m^2/m height) does not appear to have been taken into account.

I will consider the relevance of the figure of 1030kw/m^2 further in the section on design fire size below however I also note that there was no sensitivity analysis carried out on this chosen heat release rate. Lower heat release rates may have resulted in worse smoke conditions due to the lower buoyancy of smoke.

6.2.6. Design Fire Size

There is no clear explanation for the 50MW steady state design fire chosen in the CFD Modelling report. However I do note that VTT Working Paper 139 – *"Design Fire for Fire Safety Engineering"* is referenced in the CFD Modelling Report regarding design fires and that the this VTT Working Paper refers to (95% fractile) 50MW steady state fire in relation to heavy good vehicles.

I also note that the burner size, number of burner chosen and HRRPUA entered into the CFD modelling produce a 50MW fire size i.e. 48.6 m^2 total burner area (12no. x 4.05 m^2 burners) multiplied by 1030 kW/m^2 results in 50.058 MW.

In the absence of any clear demonstration to the contrary I can only surmise that the 1030kW/m^2 figure was chosen with the desired burner sizes to produce the desired steady state fire size of 50MW.

I mentioned above that fire safety may be determined by fuel load, ventilation or suppression such as automatic sprinklers or fire service intervention. I want to now examine each of these in turn in relation to this case.

In relation to fuel load the SVA Guide states that for unsprinklered warehouse there is likely to be total (fire load) involvement and that flashover is likely to occur. Although not necessarily applicable to high-bay warehouses the SVA guide also refers to a $100m^2$ (10m x 10m) fire area as an arbitrary maximum beyond which the venting will produce no further tangible benefits, other then to assist fire fighting operations. If we calculate the fire size at $100m^2 \times 1030kw/m^2 = 103000kW$ = 103MW, which is double the design fire chosen.

The next possibility is that the fire size is limited by ventilation (or rather lack of oxygen). The CFD Analysis report does not claim that the 50MW fire size was limited by ventilation. There were no oxygen concertation levels presented in the analysis and no evident of oxygen starvation (which would indicate a ventilation controlled fire). The CFD analysis does show that 3 (out of 11/12vents) per warehouse acts as inlet vents. Each vent has an aerodynamic free area of $2.82m^2$ resulting in a total free area of inlet ventilation of $8.52m^2$ at circa 15m roof height. The classic ventilation limited fire size equation gives a heat release rate as Q˙max [kW]=1500Av(H^0.5) => 1500*8.52*(15^0.5) = 49497kW ≈ 50MW. This is not to suggest that this is evidence of the fire size being ventilation controlled, however it does suggest that it is entirely plausible that the CFD model simply ran iteratively until the ventilation reached a steady state for the fire size given (i.e. the vents stabilised in a manner to match the fire size given).

There is no sprinkler system proposed and the Appellant does not calculate the Effective Fire Service Intervention Time (as per PD 7974-5:2014+A1:2019). The BCA note, in their response to this appeal, that the fire service travel time to this site is likely to be in excess of 20 minutes, without yet considering alerting time, mobilisation time and setup time. Taking the 20 minute travel time alone and calculating the fire size using an Ultra Fast t^2 fire growth curve would result in $Q=0.1876*(1200)^2 = 270144kW$ = 270MW. Whereas a t^3 curve would reach into GigaWatt (GW) HRR levels.

In summary it appears that the CFD's focus is on demonstrating smoke ventilation given a 50 MW fire. It does not prove that 50 MW is the worst-credible fire size for this unsprinklered warehouse.

This again, in my opinion, is a fundamental flaw in the inputs to the CFD Analysis carried out.

I would therefore agree with the BCA on this point, the assumption that a 'worst-case' fire in an unsprinklered high-rack storage warehouse will grow for 120s and then remain at 50MW steady state is unrealistic.

6.2.7. Smoke Reservoir Size

Smoke reservoir sizes are normally in the range of 2000m^2 to 3000m^2. This is to ensure that the smoke layer remains relatively hot and buoyant and that smoke does not cool excessively and descend below the clear layer base, potentially reducing visibility etc. Section 10.2.2.2 of CIBSE Guide E (see extract below) notes that this is an arbitrary limit and that larger reservoirs may be acceptable provided heat loss to the surrounding structure has been considered. Smoke reservoirs in this case are proposed to be 4876m^2 and 5136m^2 which means that there is a risk of excessive cooling in the smoke layer. However there is no evidence provided that heat loss to the structure, has been taken in to account.

10.2.2.2 Area of reservoir

Historically, an area of 2000 to 3000 m^2 has been adopted as the maximum reservoir size to prevent excessive cooling and downward mixing of smoke (Morgan et al., 1999). However, this is an arbitrary limit and larger reservoirs may be acceptable, provided appropriate consideration has been given to heat loss to the surrounding structure. This may necessitate a more complex numerical fire engineering analysis or the use of computational fluid dynamics modelling.

The BCA point out that excessive cooling of the smoke layer at the large reservoir sizes may result in smoke descending below head height. I would agree with the BCA on this point.

6.2.8. Additional / Compensating Safety Features

The Appellant claims that the proposed design is accompanied by additional safety features and lists them in the appeal letter. I have considered and commented on each item listed by the Appellant in the following table:

Proposed Additional Safety Features	**Comments**
Low-risk storage.	The Compliance Report accompanying this Fire Safety Certificate Application categorises the storage warehouse as "normal hazard". The CFD analysis suggest that "high hazard" (e.g. ultra-fast fire growth etc.) has been considered. Given that TGD-B 2024 now definitively categorises high-rack storage over 7m as high hazard, the 12.5m high rack storage proposed in this case can definitely not be classified as "low-risk." Therefore no additional/compensating features.
L1 fire detection and alarm system in accordance with I.S. 3218.	A Category L2/L3 fire detection and alarm system was proposed in the Compliance Report accompanying the Fire Safety Certificate Application, not Category L1. The appellant mentions beam detection resulting in early vent activation in the appeal submission, however the Compliance Report submitted with the Fire Safety Certificate Application also specifically refers to a double-knock system for the warehouse vents meaning that two devices/beams have to activate before the vents are sent a signal to open. Therefore no additional/compensating features.
Travel distances that do not exceed the limitations set out in TGD-B.	Compliance with the travel distances in the primae facia guidance (TGD-B) is a basic level of compliance and cannot be considered to be additional / compensatory. Therefore no additional/compensating features.

Automatic opening vents (no required in the regulations).	It is acknowledged that this is in excess of primae facia guidance (which refers to manual operation), but has already been considered in the CFD modelling, so not additional/compensatory to the CFD Analysis already carried out.
Supplementary ventilation is available since 10% of the roof area is covered with rooflights.	Supplementary ventilation over 10% of the roof area was not included in the Fire Safety Certificate Application submitted, nor in the CFD analysis carried out. This was only mentioned by the Appellant in the appeal submission. Therefore no additional/compensating features.
38.8m^2 of low-level doors that can be opened manually to allow additional air inlet.	The provision of inlet ventilation via 38.8m^2 of low-level doors was not included in the Fire Safety Certificate Application submitted, nor in the CFD analysis carried out. This was only mentioned by the Appellant in the appeal submission. Therefore no additional/compensating features.
Building is compartmented	Compliance with the compartment limits in the primae facia guidance (TGD-B) is a basic level of compliance and cannot be considered to be additional / compensatory. Therefore no additional/compensating features.
External fire hydrants	Compliance with the provision of external fire mains and hydrants in the primae facia guidance (TGD-B) is a basic level of compliance and cannot be considered to be additional / compensatory. Therefore no additional/compensating features.

In summary there are no additional / compensatory safety features included in the Fire Safety Certificate Application, that are above the requirements of primae facia guidance (TGD-B), that have not ready be considered in the CFD Analysis Report.

6.2.17. Conclusion of Assessment

Having reviewed the statutory and supporting documents submitted with the Fire Safety Certificate Application I conclude that a fire engineered alternative approach to compliance with Section 5.4.3.3 of TGD-B 2006 (2020 reprint) was followed, however there are number of fundamental flaws in the inputs/assumptions used for the CFD Analysis carried out, and no additional/compensatory features, with the result that the Appellant, in my opinion, has not demonstrated compliance with Regulation B5 of Part B of the Second Schedule of the Building Regulations nor the *primae facia* guidance in Section 5.4.3.3 of TGD-B 2006 (2020 reprint). I also note that TGD-2024 no longer refers to NFPA 204M (which is an American Code) instead referring to the European CEN TR 12101-5, and that there are other industry standards that could be used, such as BS 7346-4:2003 and BS 7346-5:2005. I therefore conclude that Condition 3 should be retained, but amended to allow other design codes to be used. There should also, in my opinion, be a requirement for a smoke control design developed to comply with this condition to be submitted to and agreed with the Building Control Authority.

Also, given the above assessment the only viable way the CFD Modelling carried out would have validity is if automatic sprinklers are provided i.e. the assumed fire size is not limited by fuel, not ventilation controlled and not limited by fire service intervention. I acknowledge that 5.4.3.3 of TGD-B does not in itself require sprinklers however it is the case that the smoke control system design carried out to 5.4.3.3. can require sprinklers to function (e.g. refer to the SVA Guidelines mentioned in the assessment above) and I am of the opinion that that applies in this case. In my opinion the Appellant should also be given the option of continuing with the smoke control design presented in the CFD analysis report as long as this design is supplemented by the provision of automatic sprinklers in the warehouse to control the fire size.

7.0 **Recommendation**

7.1. Having regard to the above assessment my recommendation in this case is that the appeal be refused and the BCA be directed that Condition 3 be amended as set out below for the reasons and considerations set out below.

8.0 **Reasons and Considerations**

8.1. Having regard to the statutory and support documents submitted with the Fire Safety Certificate Application, the documents submitted by the Appellant as part of this appeal, the nature and size of Storage Warehouse 8A and 8B with floor areas of 5136m^2 and 4876m^2 respectively, to the guidance provided in Section 5.4.3.3 (Large Undivided and Windowless Accommodation) of Technical Guidance Documents-B 2006 (2020 reprint) which recommends the provision of a system for smoke and heat ventilation for such a building when the floor area exceeds 4000m^2 or volumetric areas exceeds 20,000m^3 and to the report and recommendations of the reporting inspector, the Commission considered that Condition 3 as originally attached by the Building Control Authority to the Grant of Fire Safety Certificate was necessary to satisfy the requirements of Regulation B5 of Part B (Fire) of the Second Schedule of the Building Regulations. The Commission concluded in respect of this condition that it had not been demonstrated by the Appellant in the Fire Safety Certificate Application and appeal documentation that the CFD Modelling would be complaint with Section 5.4.3.3 of TGD-B 2006 (2020 reprint). The Commission was therefore satisfied to attach Condition 3 with amendments as recommended by the reporting inspector.

9.0 Conditions

9.1. Should the Commission decide to refuse this appeal the following amended wording of Condition 3 is recommended.

CONDITION 3:

The smoke control system design shall comply with one of the following two options:-

a) The smoke control system design shall be in accordance with 5.4.3.3 of Technical Guidance Document – B 2006 (2020 reprint). This design shall be developed in accordance with the guidance specified in Section 5.4.3.3 of TGD-B 2006 (2020 reprint) or as otherwise agreed with the Building Control Authority.

   A report on the smoke control system design shall be produced by a competent person and shall be submitted to the Building Control Authority for approval,

   OR

b) The smoke control system design shall be as set out in the CFD Analysis Report submitted with the Fire Safety Certificate Application on 08/10/2024 AND an automatic sprinkler system in accordance with I.S. EN 16925:2018&LC:2018&AC:2020 shall be installed throughout each warehouse.

REASON FOR CONDITION 3:

To comply with the requirements of Regulation B5 of Part B of the Second Schedule of the Building Regulations 1997, as amended.

10.0 Sign off

I confirm that this report represents my professional assessment, judgement and opinion on the matter assigned to me and that no person has influenced or sought to influence, directly or indirectly, the exercise of my professional judgement in an improper or inappropriate way.

Colin Barden

BEng (Hons) (Fire Eng.), MSc (Fire Eng.), CEng MIEI

28/08/2025