JGA

Fire Engineering Consultants

Appeal Against Conditions attached to Fire Safety Certificate (FSC 1761/17)

Appeal Ref: 29B. FS0563

Project	**Construction of a National Paediatric Hospital, Block A, Herberton, Rialto, Dublin 8**
Local Authority	**Dublin City Council**
Date	**20 September 2017**

Contents

1.0 INTRODUCTION

This case concerns the appeal of three conditions attached to the Fire Safety Certificate for the National Paedriatric Hospital, James Street Dublin 8. A Fire Safety Certificate was granted by Dublin City Council for the Hospital on 2 May 2017 with four conditions attached. These were:

Condition 1
The atrium smoke control system to be verified as compliant with HTM05-03 Part M "Guidance on the Fire Safety of Atria in Healthcare Buildings" and ancillary design references and Part B (Fire Safety) of the Second Schedule to the Building Regulations prior to occupation and use of the building.

Reason:
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017.

Condition 2
A life safety sprinkler system complying with BS EN 12845 shall be installed throughout the building (other than hazard areas having an alternative suppression system).

Reason
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017 and to limit the size of a fire, control fire spread, provide additional time to evacuate, limit fire damage and be beneficial in terms of operational continuity.

Condition 3
All glazed elements incorporated in the atrium enclosure shall maintain the minimum period of fire resistance of 60 minutes (integrity and insulation) of the atrium enclosure.

Reason
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017

Condition 4
Except as modified by the above conditions, the additional information received on 01/12/2016, 07/012/2016, 14/12/2016 and 16/03/2017 from Michael Slattery Associates shall be incorporated in the development.

Reason
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017

The appellant is appealing conditions 1, 2 and 3.

2.0 INFORMATION REVIEWED

The following information was reviewed in the assessment of this case:

- Appeal submission by Michael Slattery Associates (MSA) received by the Board on the 1 June 2017.
- Fire Safety Certificate Compliance report and drawings submitted by MSA to Dublin City Council 17 May 2016
- Additional information submitted by submitted by MSA to Dublin City Council 1 December 2016 (letter and drawings)
- Additional information submitted by submitted by MSA to Dublin City Council 8 December 2016 (letter and drawings)
- Revised Fire Safety Certificate compliance report and drawings submitted by MSA to Dublin City Council 14 December 2016
- Smoke Control Report submitted by MSA to Dublin City Council 6 February 2017
- Additional information submitted by submitted by MSA to Dublin City Council 6 February 2017
- Additional information submitted by submitted by MSA to Dublin City Council 16 March 2017
- Fire Safety Certificate grant issued by Dublin City Council 2 May 2017.
- Fire officers report on Fire Safety Certificate appeal dated 27th June 2017
- Letter from Dublin Fire Department to the Board 31st July 2017 enclosing notes of meetings and details of Hospital fires
- Letter from MSA dated 2 August 2017
- Letter from MSA dated 23 August enclosing and NHS review of fire London hospital fires and their Management"

3.0 DISCUSSION

3.1 Condition 1

The atrium smoke control system to be verified as compliant with HTM05-03 Part M "Guidance on the Fire Safety of Atria in Healthcare Buildings" and ancillary design references and Part B (Fire Safety) of the Second Schedule to the Building Regulations prior to occupation and use of the building.

Reason:
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017.

3.1.1 BCA's Comments

The BCA states that the original application didn't adequately address the atrium smoke control design in accordance with HTM05-03 Part M and that despite additional information being submitted on three occasions, their "major" concerns were not addressed.

These concerns appear to be centred on the following:

1. The tenability criteria used by the appellant to justify tenable conditions on the balconies was derived from BS 7974-6 and did not adhere to the guidance in HTM05-03 Part M which requires a smoke clear layer to be maintained at least 3m above the balconies and a maximum smoke temperature of 200^{o}C.

2. Due to the low smoke temperatures calculated using normal zone modelling techniques, the smoke control report recommends CFD modelling to verify that stable smoke layer temperatures are maintained. The BCA is concerned that there is a heavy reliance on CFD modelling which could be invalidated due to potential changes to the building during construction.

3.1.2 Appellants Response

In their submission the appellant states the following with respect to condition 1

1. That the compliance report and subsequent submissions clearly demonstrated and verified by analysis that the atrium smoke control design is compliant with HTM05-03 Part M, and accordingly with Part B (Fire Safety) of the Second Schedule to the Building Regulations.

2. That the condition requiring the as built system to be verified prior to occupation is unnecessary due to the fact that this will be done under the BC(A)R certification process. They state that the Assigned Certifier and builder will be providing a completion certificate supported by the Fire Consultant and other design team members.

3. That the design was developed first by conventional zone modelling techniques to establish the degree of venting required and that this was then validated using Computational Fluid Dynamics.

4. That concerns raised by the BCA during workshops regarding the use of the atrium base were addressed by revisions to the architects drawings to clearly indicate the areas of the atrium where a limited fire load would be permissible and where this was not possible sprinkler protection would be provided.

5. That an ASET/RSET analysis was undertaken for the open balconies in the Biome. This analysis was based on the guidance in BS 7974 the fire engineering code of practice which is recognised and fully endorsed by HTM 05-05 Part J, which is also referenced in HTM 05-02 and HTM 05-03 Part M. They contend that this analysis demonstrated that the ASET times exceed the RSET values by a considerable margin.

6. That MSA would be undertaking further CFD modelling to address the impact of any future changes to the atrium design on the smoke venting system and that this will be submitted for approval in a revised Fire Safety Certificate Application.

3.1.3 Consideration

The guidance in HTM 05-03 Part M recommends a smoke venting system in an atrium where balconies or bridges are provided. This system should ensure that:

- Smoke is maintained at least 3m above the balcony or bridge level; and
- The temperature of the smoke does not exceed 200^{o}C for at least the period of time required to evacuate any occupants of the balcony or bridge.

However, in some fire scenarios, including many for fully code compliant building designs, a clear layer may not be maintained throughout the evacuation period. This is primarily due to the height of rise within the atrium that smoke would have to rise particularly for a fire on the lower levels.

When a fire occurs in an open space, such as beneath a high roof in an atrium, it will produce hot gases due to combustion. As these gases rise they will entrain large quantities of cool air. This entrainment, or mixing, is induced by the upward movement of the hot gases, which are replaced by cold air drawn into the fire column from below.

As the smoke plume rises, it increases in volume as more air is entrained into it, and forms the shape of an inverted cone as shown in Figure 1.

In addition to an increase in volume, the air entrained will cool the smoke the further it rises.

In a atrium, smoke will continue to rise until it forms a layer in the roof structure. The amount of smoke produced is directly related to both the size of the fire and the height through which it rises in order to reach the layer.

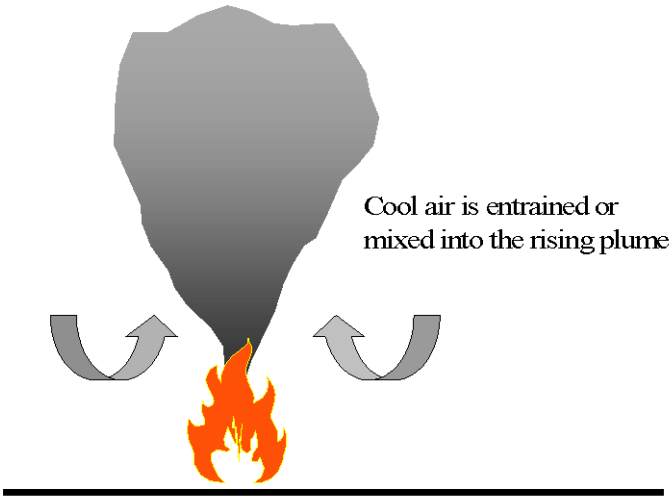

Figure 1 Entrainment into a Conical Plume

In a very tall atrium such as the Children's Hospital, the amount of air entrained into the rising smoke plume will be large and mean that a smoke clear layer would only be possible to maintain for the bridges on the lower levels. As smoke will build down to a

level at which a clear layer can be maintained, balconies on the upper levels will be within the smoke layer. Therefore, conditions within the smoke layer need to be considered.

The design for the smoke venting system allows smoke to build down to 1m above the door openings at level 2. Therefore, to protect the accommodation at levels 3 and above, protected lobbies are provided to doors accessing the atrium. This approach is compliant with the guidance in HTM 05-03 Part M in my opinion. Lobbies are also provided at levels 01 and 02 which is above the requirements of the guidance.

With respect to the balconies, as stated above, maintaining a smoke clear layer would not be practical and the appellant has sought to provide sufficient smoke venting to sufficiently delay the rate of smoke logging and to ensure that the visibility through the smoke is greater than 10m and the temperature within the smoke layer does not exceed 60^{o}C. The tenability criteria comply with the guidance contained in PD 7974-6: Application of Fire Safety Engineering Principles to the Design of Buildings. In addition to this, the appellant has carried out an ASET (available safe egress time) v RSET (required safety egress time) analysis for occupants on the balconies at levels 4, 5 and 6 of the Biome. The analysis for each scenario showed that the ASET was greater than the RSET by significant margins. In my opinion the analysis would comply with the guidance in BS 7974:2001.

The BCA expressed a concern about the over reliance on CFD. However, the design was initially carried out using zone models and was validated by the use of CFD. This is a standard approach in large atrium buildings and shopping malls. It should be noted that 15-20 years ago, the use of CFD modelling was not as practical as it is now due to increased computing power, and the majority of smoke venting designs were done using zone modelling techniques. I don't therefore, believe this to be a valid concern.

The BCA also express a concern that changes to the atrium design could adversely affect the performance of the smoke venting system. Unless the fire strategy design changed dramatically, e.g. removal of glazing etc then the performance of the smoke venting is unlikely to be affected. The key factor in this building is the sheer volume of the atrium space and its height. Any fire on the atrium base will grow slowly and the large amount of air entrainment due to the height of rise will result in relatively cool smoke which is not a significant risk to occupants.

In my opinion therefore, the condition should be removed and replaced with another condition requiring the CFD modelling for the atrium smoke venting system to be revised as necessary if a revised Fire Safety Certificate is required due to changes in the atrium design.

3.2 Condition 2

Condition 2

A life safety sprinkler system complying with BS EN 12845 shall be installed throughout the building (other than hazard areas having an alternative suppression system).

Reason

To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017 and to limit the size of a fire, control fire spread, provide additional time to evacuate, limit fire damage and be beneficial in terms of operational continuity.

3.2.1 BCA's Comments

The BCA state that they have considered the design and deem it appropriate to install life safety sprinklers throughout the building and cite the following benefits as being:

- Limit the size of the fire
- Control fire spread
- Provide additional time to escape
- Limit fire damage
- Be beneficial in terms of operational continuity

The BCA also state that the building at 29.9m has been deliberately engineered to avoid sprinklers as the top floor is just 100mm below the 30m threshold in Building Regulations guidance.

The BCA also infer that fires in hospitals are common place and by the nature of the occupancy are more problematic than other building types. They express the view that the guidance in Ireland is outdated and that the forthcoming review of the Technical Guidance Document B will include a provision for sprinklers in hospitals. The BCA are also concerned that the fire strategy for hospitals generally is solely reliant on passive measures. They state that no passive measure provides total reliability.

They also contend that outside Ireland and the UK that sprinklers in large hospitals are more common and state that Building Regulations in 75% of European countries would require sprinklers, but do not state which. They also highlight an example of Southmead Hospital in Bristol which is sprinklered and less than 30m in height.

The BCA also feel that the risk is higher in the Paediatric hospital due to the occupant profile being highly dependent sick vulnerable children.

Other points raised by the BCA include:

1. Transient fire loads at the base of the atrium could increase the fire loading in non sprinklered areas e.g. cleaners trolleys, stock for commercial units. They feel that sprinklers throughout, which presumably means the atrium would reduce the reliance on management to control the fire load.
2. Sprinklers throughout the Grenfell tower in London may have significantly altered the outcome of that tragedy.
3. Dublin Fire Brigade have a new policy requiring sprinklers to be provided throughout nursing homes. They contend that the proposed hospital is much larger and much taller than nursing homes and should therefore, also be sprinklered.
4. They provided an addendum of fire statistics for hospital fires both in the US and UK. Some of these statistics seemed to support the argument that fire

deaths were reduced in sprinklered hospitals when compared to unsprinklered hospitals.

5. They provided records of matters discussed at meetings with MSA indicating their insistence on sprinklers throughout was discussed at two of these meetings.

3.2.2 Appellants Response

In making their initial appeal and responding to subsequent BCA submissions, the appellant made the following arguments:

1. The height of the building to the top storey is less than 30m by a significant margin and quote a range of 25.25m to 26.15m. On this basis sprinkler protection was considered unnecessary.

2. Level 7 is at a height of 28.9-29.9m and is mostly open air roof plant space. They contend therefore, that level 6 is the top most storey in determining building height to comply with HTM 05-02 and diagram 38 of TGD B which excludes roof top plant areas.

3. Sprinkler protection is provided throughout the basement levels, levels 04, 05 and 06 and in defined risk areas within the base of the atrium at ground and lower ground level.

4. An assessment was carried out to determine the necessity and benefits of extending the sprinkler system throughout the building making reference to the Building Standards Division in Scotland who carried out a cost benefit analysis on this issue and concluded there was no justifiable requirement for extensive sprinkler coverage.

5. They quote other studies in the UK which showed that full sprinkler coverage in hospitals was not justifiable based on
    a. Statistical data on fire incidents and outcomes in hospital buildings.
    b. Staffing levels provided on a 24/7 basis where staff are well trained in fire safety management.
    c. High level of fire detection coverage and compartmentation.

6. Welsh guidance states, in reference to HTM 05-02 that “there is no statutory requirement for sprinklers to be provided in hospitals with the exception of high rise buildings (top floor in excess of 30m above ground) and in certain commercial enterprises within hospitals.

7. That during the course of discussions with the BCA significant enhancements were provided including additional fire fighting cores and a wet riser system above the recommendations of TGD B. They claim that these enhancements were provided on the understanding that the extent of sprinkler coverage proposed was acceptable to the BCA.

8. That a concern of the BCA that the hospital could be extended above 30m in height in the future was addressed by the National Paediatric Hospital Development Board furnished a letter confirming that this would not occur.

9. The appellant contends that the BCA has misinterpreted HTM 05-02 on the requirements for sprinklers in buildings with a storey less than 30m above

ground and on the method for determining the height of a top storey in TGD B.

10. They dispute the BCA assertion that sprinklers are provided in hospitals in 75% of European countries and that there is an entirely different approach to that in HTM05-02. They contend that the practice in the UK is that sprinklers are generally not required in hospitals not exceeding 30m in height.

11. They dispute the statistics provided by the BCA in relation to fires in Irish Hospitals and provided statistics for 2011 to 2015 which showed no fires in hospitals were attended by Dublin Fire Brigade in this period.

12. The appellant disputes the BCA assertion that the guidance in HTM 05-02 was inadequate for the special needs of a Paediatric hospital and quotes Appendix H of the HTM which states the guidance is appropriate for buildings providing acute healthcare services to children.

13. They also dispute the BCA claim that the paediatric hospital is similar to a nursing home in that the mobility of occupants is completely different as is the staff to patient ratios. They also state that there is no requirement to provide sprinklers in nursing homes to comply with Irish Building Regulations.

14. They state that sprinklers at roof level in the atrium would have little benefit in controlling a fire on the atrium base due to the height being 17m.

15. They state that the document provided by the BCA in relation to hospital fires and sprinklers is misleading. In response to this they provide two reports summarising reviews of 5 hospital fires in London by the NHS and London Fire Brigade respectively. They state that the conclusions of both reports make no recommendations on the provision of sprinklers in hospitals.

3.2.3 Consideration

The relevant guidance for the Children's Hospital is

1. Technical Guidance Document B 2006; and
2. HTM 05-02 Guidance in support of functional provisions (Fire Safety in the design of healthcare premises) 2015 Edition.

3.2.3.1 Height of top storey

TGD B defines the height of the tope storey of a building as being

"Height of top storey measured from upper floor surface of top floor to ground level on lowest side of building".

Diagram 38 also confirms that roof top plant is excluded from this height. From the drawings the height to the top storey has been taken as approximately 25.35m to 26.3m above the adjacent ground level. For the purposes of assessing the appropriate fire strategy for the building, it is therefore, less than 30m in height.

3.2.3.2 Fire Code Guidance on Requirements for Sprinklers

TGD B classifies hospitals as Purpose 2 Residential Institutional. From table A2 sprinklers are not required for this purpose group regardless of building height.

However, the guidance in HTM 05-02 is more current and considered more appropriate. Table 5 of the Firecode states that unsprinklered hospitals with storeys at a height greater than 30m are not permitted. Section 5.68 further goes on to state:

"*With the exception of buildings over 30m in height, the guidance in this document **does not require the installation of sprinklers** in patient care areas of healthcare buildings. However, the design team is expected to consider the advantages that might be gained by installing life safety sprinklers throughout the building or to specific areas. Where specific hazards are identified in the building, it may be more appropriate to consider the application of an alternative fire suppression system, such as high pressure water mist technologies*".

From the above therefore, the following can be concluded:-

1. The height of the highest storey in the Paediatric Hospital is less than 30m.

2. The relevant guidance for the hospital only recommends sprinklers in buildings greater than 30m in height.

3. Sprinklers are not required in the Children's hospital to comply with current fire code guidance.

The BCA have cited the approach in other EU states which they say would require sprinklers. However, I do not believe that to be a valid argument. The approach to fire safety has always varied from country to country in many areas. For example in many countries stair capacity is sized on one or two floors however, in Ireland and the UK it considers all floors evacuating simultaneously. The Building Regulations guidance in Ireland adopts the same approach to fire safety in hospitals to that of the UK, which involves extensive compartmentation of the building to limit the size of any fire and the area which fire fighters have to carry out search and rescue.

In 2015, Irish fire brigades attended a total of 7,111 fires in buildings in Ireland. Of these just 59 were in hospitals with 74 in schools and 42 in offices. In England in 2016/17 there was a total of 15,815 fires in non residential buildings with 656 of these in Hospitals/medical care buildings. It is clear therefore, that hospitals represent a relatively low fire risk compared to other building types and that the approach to fire safety in Ireland and the UK is effective.

The BCA would appear to be concerned about the scale of the Paediatric Hospital in a fire fighting context. However there are a number of features provided that should ensure fire fighting conditions are no worse than any other building:

1. The extensive compartmentation provided throughout the building will limit the size of a fire and the extent to which it can spread. It will also limit the number of people affected and the area to which fire fighters may have to carry out search and rescue.

2. The design team carried out an assessment as to the need for sprinklers and have provided them in higher risk areas. The sprinklers will control the size of the fire and limit the potential for spread.

3. Additional fire fighting cores have been provided over and above the minimum requirements of code guidance.

4. Wet risers have been provided even though the building is only 26m high. This is significantly above the minimum requirements of Building Regulations guidance and will ensure fire fighters have readily available water supply on each floor.

Based on the above therefore, I can only conclude that the building does not require a sprinkler installation throughout to comply with Building Regulations guidance. I also believe that the fire safety risk to be low compared to other buildings and that there is nothing unusual about the Children's Hospital other than its size that would increase this risk. The size of the building is negated by the degree of compartmentation and other fire safety measures provided. On this basis therefore, the BCA should be instructed to remove the condition.

3.3 Condition 3

Condition 3

All glazed elements incorporated in the atrium enclosure shall maintain the minimum period of fire resistance of 60 minutes (integrity and insulation) of the atrium enclosure.

Reason

To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017

3.3.1 BCA's Comments

The condition relates to the requirement for the fire rated glazing to the atrium to have insulation properties in addition to integrity. The reasons stated by the BCA are as follows:

1. Section 4.51 of HTM 05-03 Part M states that glazing to an atrium must maintain the minimum period of fire resistance (integrity and insulation) of the atrium enclosure.

2. They acknowledge that section 4.52 permits the insulation requirement for the glazing to be omitted in certain circumstances but that the criteria was not met in the design submitted. These are

    a. It was not adequately demonstrated that the smoke temperature within the atrium does not exceed 140^{o}C. It was 136^{o}C but the BCA consider a difference of 4^{o}C to be insufficient given the number variants in the modelling.

    b. There are balconies and bridges in the atrium. They point out that section 4.52 only permits the insulation requirement to be omitted where the smoke temperature is less than 140^{o}C and there are no balconies or bridges on the atrium side of the enclosure.

3. The analysis did not consider the impact of a fire in the winter gardens which in two areas is separated from the adjacent accommodation by integrity only glazing.

4. The analysis is based on a design fire size of 2,500kW which is heavily reliant on management. Any increase in the fire loading could invalidate the atrium design.

5. Any Christmas tree in the atrium could extend beyond a single level resulting in greater flame heights and heat transfer causing ignition of combustibles on the non fire side of the glazing.

3.3.2 Appellants Response

In their appeal submission the appellant states that the requirements of HTM 05-03 Part M in relation to the atrium glazing has been met. This is namely the recommendation that where the rise in smoke temperature within the atrium can be demonstrated not to exceed 140^{o}C the requirement for the glazing to have insulation properties can be ignored. They state that

1. The CFD modelling shows that in the worst case scenario the smoke/flame plume temperature was 136°C with the mean temperature being in the range of 28-60°C.

2. In all locations where there are open balconies or bridges on the atrium side of the glazed atrium enclosure, the enclosure within 1.8m of the balcony has been specified as 60 minutes fire resisting integrity and insulation.

3. They state that the BCA's interpretation that a margin of 4°C below the criteria specified in HTM 05-03 is too low is incorrect. The key issue is the difference between 140°C and the point at where auto ignition would occur and they state paper would ignite at temperature of 233°C.

4. They also state that the BCA's interpretation that the presence of open balconies means that the atrium glazing should be integrity and insulation throughout is also incorrect.

5. They state that they addressed the BCA's concern regarding Christmas trees in that any trees in the base of the atrium would be artificial with fire retardant properties and refer to BS PD 7974-1 which recommends peak heat release rates of 400°C for artificial trees ranging from 2m to 2.5m.

6. Their final submission in relation to this condition was regarding the winter gardens where they contend that the trees and shrubs are well defined with minimal fire loading located well away from the glazing. As a result of this they contend there is no potential for flame contact with the glazing or smoke temperature exceeding 140°C.

3.3.3 Consideration

The technical issues with this condition are similar to those discussed above in relation to condition 1 and the smoke venting system. The large volume of the atrium and the height of rise means that smoke from a fire will entrain large amounts of air and will therefore, be inherently cool.

The temperature quoted of 136°C from the CFD analysis is in the locality of the fire plume and is localised. The mean temperature in the atrium did not exceed 60°C. The appellant is correct in his assertion that the key consideration is the temperature at which auto ignition would occur and this is significantly higher than 140°C. The limit of 140°C does not mean that auto ignition would occur at this point.

It should also be noted that the temperatures at which glazing is tested to BS 476 are significantly higher than what would occur in the atrium. The BS 476 fire test is based on the standard fire curve derived from the following:

$T = 345\log_{10}(8t+1) + 20$

Where T = temperature °C
And t = time minutes

After 60 minutes the temperature in this fire test would be 945°C which is a post flashover fire condition. To pass the insulation criteria the temperature on the unexposed side should not exceed a mean temperature of 140°C.

The CFD analysis showed that the worst case smoke temperature in the smoke plume was 136^{o}C. On this basis alone the temperature on the accommodation side of the glazing could not exceed 140^{o}C.

In relation to the balconies or bridges, the guidance does state that the glazing does not need to be insulated if there are none within the atrium. The BCA did not interpret the guidance incorrectly. However, I believe that the design addresses this by providing insulated glazing within 1.8m of each bridgelink.

The BCA expressed a specific concern about Christmas trees in the base of the atrium. It is reasonable therefore, to attached a condition restricting these to artificial trees with fire retardant properties and a maximum height of 2.5m.

The BCA should be directed to remove the requirement for insulated glazing and reword the condition to restrict the use of Christmas trees.

4.0 RECOMMENDATIONS

The Building Control Authority should be directed to remove condition 2 and attach the following conditions:

Condition 1
In the event of design changes to the atrium, a revised Fire Safety Certificate application will be required and will include a reassessment of the atrium smoke venting CFD modelling.

Reason
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017

Condition 2
Christmas trees on the base of the atrium are limited to artificial type with fire retardant properties and a maximum height of 2.5m.

Reason
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017

Condition 3
Except as modified by the above conditions, the additional information received on 01/12/2016, 07/012/2016, 14/12/2016 and 16/03/2017 from Michael Slattery Associates shall be incorporated in the development.

Reason
To ensure compliance with Part B of the Second Schedule to the Building Regulations, 1997 to 2017

Signed.....
Martin Davidson
B.Eng MSc (Fire Eng) CEng MIEI

Date: 20th September 2017