**Report BCAC-99c**

# Fire Engineering Report

# 70 The Corso, Manly

in confidence to
**Nasus Pty Ltd**
**C/o:- Building Code of Australia Consultants**

March 2019

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## EXECUTIVE SUMMARY

This is a report of the analysis of the Fire Safety aspects of the non-compliance with Deemed-to-Satisfy Solutions of the National Construction Code of Australia (NCC) in the existing building at 70 The Corso, Manly, NSW, as it arrives after the proposed additions and alterations. The purpose of the analysis is to establish the compliance of the building with the Performance Requirements of the NCC. The numerical results have been obtained using methodology found in scientific publications and Fire Engineering computer software. The report is written in accordance with the International Fire Engineering Guidelines.

The analyzed non-compliances with Deemed-to-Satisfy Solutions are as following:

| No | Issue | Clause of the NCC | Performance Requirements |
|---|---|---|---|
| 1 | The maximum travel distance to a single exit in the first floor is approximately 34 m. The allowed maximum is 20 m. | D1.4(c)(i) | DP4 |
| 2 | The discharge door from the stairway serving the first floor to Rialto Lane swings inwards. | D2.20(b)(i) | DP2(b), DP4 |

The assessment in this report has been carried out in accordance with Clauses of the NCC A0.5(b)(ii) (appropriate verification method) and A0.5(d) (comparison with the Deemed-to-Satisfy Solutions). Performance Requirements have been identified using Clause A0.7 of the NCC. They have been satisfied by virtue of Clause A0.2(a) of the NCC. The report has been written in accordance with the International Fire Engineering Guidelines.

## RECOMMENDATIONS OF THE REPORT

1. Class 5 and Class 6 parts of the building shall be fire separated with an FRL of not less than 30/30/30. The offices of the first floor shall be smoke separated from the corridor of the first floor below and above the suspended ceiling.
2. The building shall have a smoke detection and alarm system in accordance with AS 1670.1 – 2015.
3. On smoke detection, the ventilation and air conditioning system in the area where detector is activated shall shut down automatically.
4. All the glazing between the offices and the corridor in the first floor shall comply with the requirements of AS 1288 – 2006 for tempered Grade A safety glass.
5. The doors between the offices of the first floor and the corridor shall be self-closing smoke doors in compliance with Section 3 of Specification C3.4, except that they are allowed to swing into the office.
6. The said smoke doors shall be equipped with magnetic holders with local controls, but released automatically on activation of the smoke detection and alarm system.
7. Two side windows of Office 3 shall be fixed and glazed in Grade A or B safety glass complying with AS 1288 – 2006 or glass bricks.
8. The discharge door from the stairway to Rialto Lane shall be equipped by an automatic holder that would keep the door open, if it is slammed against the wall. The door shall be available to be released being pulled from the holder by one hand applying a reasonable effort. A sign “PULL” shall be attached or painted from inside of the door above the handle in letters not less than 60 mm high at the contrasting background.

Subject to these recommendations, the non-compliances with the Deemed-to-Satisfy Solutions listed in the table above will not compromise the compliance of the building with the NCC.

March 2019

Dr. Victor Shestopal
Director,
Accredited Certifier in Mechanical and Fire Safety engineering
Registration No. BPB0374.

## 1. INTRODUCTION

This report examines the fire safety aspects of non-compliances with Deemed-to-Satisfy Solutions of the National Construction Code of Australia (NCC) in the existing building at 70 The Corso, Manly, NSW, as it arrives after the proposed alterations, and establishes performance solutions to satisfy Performance Requirements of the NCC.

Sources of information are listed in Appendix 1.

Revisions:

| Date | Number | Reason for revision |
|---|---|---|
| December 2018 | a | Initial document |
| January 2019 | b | Amendments following comments by the BCA Consultant |
| March 2019 | c | Final drawings. Merging of two retails in the ground floor |
| | | |

## 2. SCOPE OF PROJECT

There are aspects of the building that deviate from Deemed-to-Satisfy Solutions of the NCC. The fire engineering report should demonstrate that subject to proposed Performance Solutions, notwithstanding these non-compliances, Performance Requirements of the NCC will be satisfied, which according to Clause A0.4 of the NCC, will cover the deviations from Deemed-to-Satisfy Solutions.

The fire safety issue required to be addressed in the report is:

**Safe egress from the building during a fire.**

Other objectives of the NCC are assumed to be covered by Deemed-to-Satisfy Solutions.

Fire Modelling and Computing makes all reasonable efforts to incorporate practical and advanced fire protection concepts into its advice. It should be recognised however that fire protection is not an exact science, and no amount of advice can, therefore, guarantee freedom from either ignition or fire damage. The level of fire protection which is recognised satisfactory is that of the Building Code of Australia and compatible with the International Fire Engineering Guidelines (Ref. 1). The extent to which the advice is implemented and variations in its implementation may also affect the achieved level of fire safety.

The concepts outlined in this report assume a complete and operational building, and do not address protection of the building during construction works. The major fire protection features to be incorporated in the design

with respect to occupant safety in the event of a fire are outlined in this report in principle. Property protection, business interruption, environmental protection and insurance requirements were not specifically considered, as they are not in the proposed scope of the analysis.

The report will not include an NCC assessment as far as Deemed-to-Satisfy Solutions are concerned and will concentrate on the specified Performance Solutions requiring Fire Engineering analysis.

The report is carried out in accordance with the "International Fire Engineering Guidelines" (Ref. 1).

## 3. PROJECT DESCRIPTION

### 3.1. Building characterisation

The building is a 2-storeys structure:
The ground floor will have two retail spaces, Class 6.
The upper storey will be used for offices Class 5.
The Class 6 and Class 5 parts of the building will be fire separated in accordance with the recommendations of this report. They will have separate entries. The upper storey is served by a single stairway and will not have a lift.

The required type of construction of the building is C.

### 3.2. Dominant occupant characteristics

Occupants of the retail part of the building can be divided in two groups: staff and customers. Staff members will be familiar with the building and the routes of egress. Customers will have a limited knowledge of the layout of the building. They may include children who are not necessarily under constant supervision. These occupants are always awake and alert, but their mobility can vary in accordance with their age and physical capabilities.

Occupants of the offices are adults. They will not include children and elderly persons. People with disabilities may be among the occupants, but only such that can work in a multi-storey building that has no lift. Hence their capabilities of walking downstairs will be close to normal.

### 3.3. Active fire protective measures

Active protective measures in this building will comprise:

- Portable fire extinguishers in accordance with Clause E1.6 of the NCC and AS 2444 – 2001.
- Fire detection and alarm system in accordance with AS 1670.1 – 2015 enhanced with recommendations of this report.
- Emergency lighting and "Exit" signs in accordance with Part E4 of the NCC.

## 4. FIRE SAFETY LEGISLATIVE REQUIREMENTS

The Performance Requirements are the only part of the NCC with which a building must comply. The Deemed-to-Satisfy Solutions are only one method of achieving the Performance Requirements. There is no obligation for a design to adopt either in part or in full the Deemed-to-Satisfy Solutions.

Clause A0.1 of the NCC states that:

> *Compliance with the NCC is achieved by satisfying the Performance Requirements.*

Clause A0.2 of the NCC specifies the methods whereby it may be demonstrated that a building solution achieves the Performance Requirements. They are:

*(a) Performance Solution; or*
*(b) Deemed-to-Satisfy Solution; or*
*(c) combination of (a) and (b).*

The report demonstrates that the relevant Performance Requirements of the NCC identified in accordance with Clause A0.7 will be satisfied, using the appropriate verification methods in accordance with A0.5(b)(ii) and comparison with the Deemed-to-Satisfy Solutions, and thereby the regulatory issues will be addressed.

## 5. NON-COMPLIANCES WITH DEEMED-TO-SATISFY SOLUTIONS

### Clause D1.4(c)(i):

*Class 5, 6, 7, 8 or 9 – No point on a floor must be more than **20 m** from an exit, or a point from which travel in different directions to 2 exits is available.*

The maximum travel distance to a single exit from the First floor will be approximately **34 m** (see Figure 1).

**Clause D2.20(b):**

*A swinging door in a required exit or forming part of a required exit must swing in the direction of egress unless—*

*(i) it serves a building or part with a floor area not more than 200 $m^2$, it is the only required exit from the building or part and it is fitted with a device for holding it in the open position; or*

*(ii) it serves a sanitary compartment or airlock (in which case it may swing in either direction)*

The Rialto Lane discharge door from the stairwell swings opposite direction of egress, contrary to this clause.

## 6. RECOMMENDATIONS AND PERFORMANCE SOLUTIONS

1. Class 5 and Class 6 parts of the building shall be fire separated with an FRL of not less than 30/30/30. The offices of the first floor shall be smoke separated from the corridor of the first floor below and above the suspended ceiling.
2. The building shall have a smoke detection and alarm system in accordance with AS 1670.1 – 2015.
3. On smoke detection, the ventilation and air conditioning in the area where detector is activated shall shut down automatically.
4. All the glazing between the offices and the corridor in the first floor shall comply with the requirements of AS 1288 – 2006 for tempered Grade A safety glass.
5. The doors between the offices of the first floor and the corridor shall be self-closing smoke doors in compliance with Section 3 of Specification C3.4, except that they are allowed to swing into the office.
6. The said smoke doors shall be equipped with magnetic holders with local controls, but released automatically on activation of the smoke detection and alarm system.
7. Two side windows of Office 3 shall be fixed and glazed in Grade A or B safety glass complying with AS 1288 – 2006 or glass bricks.
8. The discharge door from the stairway to Rialto Lane shall be equipped by an automatic holder that would keep the door open, if it is slammed against the wall. The door shall be available to be released being pulled from the holder by one hand applying a reasonable effort. A sign “PULL” shall be attached or painted from inside of the door above the handle in letters not less than 60 mm high at the contrasting background.

## 7. OBJECTIVES AND PERFORMANCE REQUIREMENTS

The objectives of the report are to demonstrate that the proposed Performance Solutions satisfy the following Performance Requirements, as required by Clause A0.7 of the NCC:

**DP4:**
*Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to—*
*(a) the travel distance; and*
*(b) the number, mobility and other characteristics of occupants; and*
*(c) the function or use of the building; and*
*(d) the height of the building; and*
*(e) whether the exit is from above or below ground level.*

**DP2(b):**
*So that people can move safely to and within a building, it must have any doors installed to avoid the risk of occupants—*
*(i) having their egress impeded; or*
*(ii) being trapped in the building.*

## 8. ASSESSMENT

### 8.1. Fire in the office

The issues to be answered are: whether in case of a fire –
- the glazed walls of the corridor will withstand a possible fire;
- the conditions in the corridor can become untenable before the occupants evacuate;
- whether the fire brigade personnel will have safe routes for fire fighting and search-and-rescue operations.

The corridor will be free of any combustibles, except may be floor lining in accordance with Specification C1.10 of the NCC. Hence the only plausible fire scenario is a fire in the office. The worst-case scenario is a fire in Office 3 nearest to the exit stair, because such a fire can block the route of travel from Offices 1 and 2 that are remote from the final exit. The analysis is carried out using Fire Dynamics Simulator FDS6 created by NIST USA. The modelled configuration is depicted in Figure 2. Three scenarios are considered:
(1) Smoke door from Office 3. Fire close to the door.
(2) Smoke door from Office 3. Fire close to the window. It is assessed to find out whether the situation with a fire close to the source of fresh air may result in a larger heat release rate and to be the worst case.
(3) Door of Office 3 is without smoke seals. This scenario is included to justify the recommendation of the report to construct the office doors as smoke doors.

It is recommended in Ref. 2 to approximate a fire in the office by a “Medium” standard fire. This advice is followed in the report. The offices in the building are small and have elongated shape. Because of this, the maximum heat release rate reached by the developing fire depends on the amount of oxygen available to the fire. To decrease the heat release rate, the side windows of Office 3 are recommended to be glazed so that they will not allow the fresh air

into the office during a fire. The only openable window is assumed to be initially closed. The worst-case scenario is that this window shatters. According to Ref. 3, ordinary window glass breaks when smoke temperature reaches approximately 350 – 400°C. As computed by FDS6, in a scenario of a fire close to the window this happens in approximately 5 minutes after ignition and in a scenario of a fire close to the office door in approximately 7 minutes. If initially the window is closed, the fire will be suffocated long before the window shattering. Hence it is assumed for computation purposes that there is initially a small opening, as shown in Figure 2. The computed heat release rate in all three scenarios is presented in Figure 3. It is evident that the maximum heat release rate is predicted to be 1.1 – 1.2 MW, long way below 5 MW recommended for the offices in Figure 2 of Specification E2.2b of the NCC. This enables usage of unprotected tempered glass.

In Scenario (2) the fire source is closer to glazing than in Scenario (1). Therefore, Scenario (2) is the worst case for glazing survival. The maximum temperature at a distance of 125 mm from the glazing is plotted using SmokeView facility in Figure 3. The maximum intensity of heat radiation is plotted in Figure 4 These extreme figures are:

maximum temperature 375°C;
maximum heat flux 10 kW/m².

The temperature is approximately the maximum which ordinary window glass can withstand, but the glazing will be tempered safety glass. The data for the intensity of heat radiation that tempered glass can withstand can be found, for instance, in Ref. 4. In the tests carried out in that work tempered glass was not damaged at all when the heat flux was 11.3 kW/m². When 23 – 26 kW/m² was applied, tempered glass fractured in 7 min 45 s. As it is evident from Figure 3, in the subject building the peak of heat production will last for less than 2 minutes.

**Inference:**

**Tempered glass complying with the requirements of AS 1288 – 2006 to Grade A safety glass can be used for separation between the offices and the corridor and for glazing of the side windows of Office 3 without additional means of fire protection.**

The recommendation of the report to use wired glass for glazing of the side windows of Office 3 is based on the advice of Ref. 4:

"*At a level of impressed radiant heat that could cause self-induced ignition of textile furnishings (**37 kW m$^{-2}$**) only the wired glass. Though finely cracked, could be expected to remain as a shield for the combustible contents of a building".*

The office door can be kept open until the smoke detector is activated. A smoke detector is assumed to activate not later than at the obscuration of 8 %/m, as required by Clause 4.10.2.1(a) of AS 1668.1 – 1998. The computed obscuration is plotted for Scenarios (1) and (2) in Figure 6. The computed activation time is

less than **40 seconds**. Given that some time is required for the door to rotate into the closed position, it is conservatively assumed in computations that the door will remain open for **90 seconds** after ignition.

In Scenarios (1) and (2) computed results for the conditions in the corridor are almost the same. As it could be expected, the worst conditions are immediately after the door to the office is closed. The computed results for temperature and visibility are depicted in Figures 7 and 8. It is evident that with the smoke door installed the conditions in the corridor remain tenable indefinitely long.

Scenario (3) differs from Scenario (1) only by the assumption of clearances around the office door. For a non-standard glazed door plausible dimensions are: door width 1 m, door height 2.25 m, clearance at the bottom 25 mm, clearances at the sides and at the top 5 mm. This situation is approximated by three holes 125 mm x 150 mm between the office and the corridor, as depicted in Figure 2. The major computed results are demonstrated in Figures 8 – 10. They show that the temperature in the corridor may allow the occupants to pass the corridor in up to approximately 7.5 minutes after ignition (smoke at the head height will have temperature below 60°C). However, at this time the visibility in the corridor will be slightly above 1 m. It means the corridor will be impassable. The visibility at the head height is predicted to become 3 m, which is approximately a psychological limit, in approximately **4 minutes** after ignition. This is insufficient for safe evacuation. This result is a basis for the requirement of the report to use smoke doors for the offices.

### 8.2. Door swinging inwards

As it is evident from Figure 1 and computed results, in the worst possible situation neither smoke nor heat radiation will endanger the evacuees at the bottom of the stairway. Hence the evacuees reaching the door will be already at safety, and a minor delay in opening the door associated with a necessity of pulling the door will not endanger the evacuees.

Besides, the NCC does not require the door to swing outside, if the floor area of the part of the building served by the exit is not more than 200 m². The first floor is 236 m². However, offices are only 161 m². With a shorter corridor the same occupancy would not be required to have an exit door swinging outside. Hence the fire safety associated with the swinging discharge door is equivalent to that of a similar building complying with the Deemed-to-Satisfy solutions.

**Inference:**
**It is concluded, on the basis of Clauses A0.5(c) and A0.5(d) of the NCC, that subject to recommendations of this report, the relevant Performance Requirements of the NCC will be satisfied.**

# CONCLUSIONS

The report shows that subject to recommendations formulated in the Executive Summary, the relevant Performance Requirements of the NCC will be satisfied:

**DP 4:**
Exits will be provided from the building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to –

(a) the travel distance;
This issue has been subject to a detailed analysis in the report.

(b) the number, mobility and other characteristics of occupants;
The number of occupants is assumed in accordance with the size of compartments.

(c) the function and use of the building;
The performance solutions are related to a Classes 5 and 6 parts of the building.

(d) the height of the building;
The building is 2-storey.

(e) whether the exit is from above or below the ground level.
The analysis has been carried out for the exit from above the ground level and level exit.

**DP2(b)**
So that people can move safely to and within a building, it will have doors installed to avoid the risk of occupants—

(i) having their egress impeded; or

(ii) being trapped in the building.

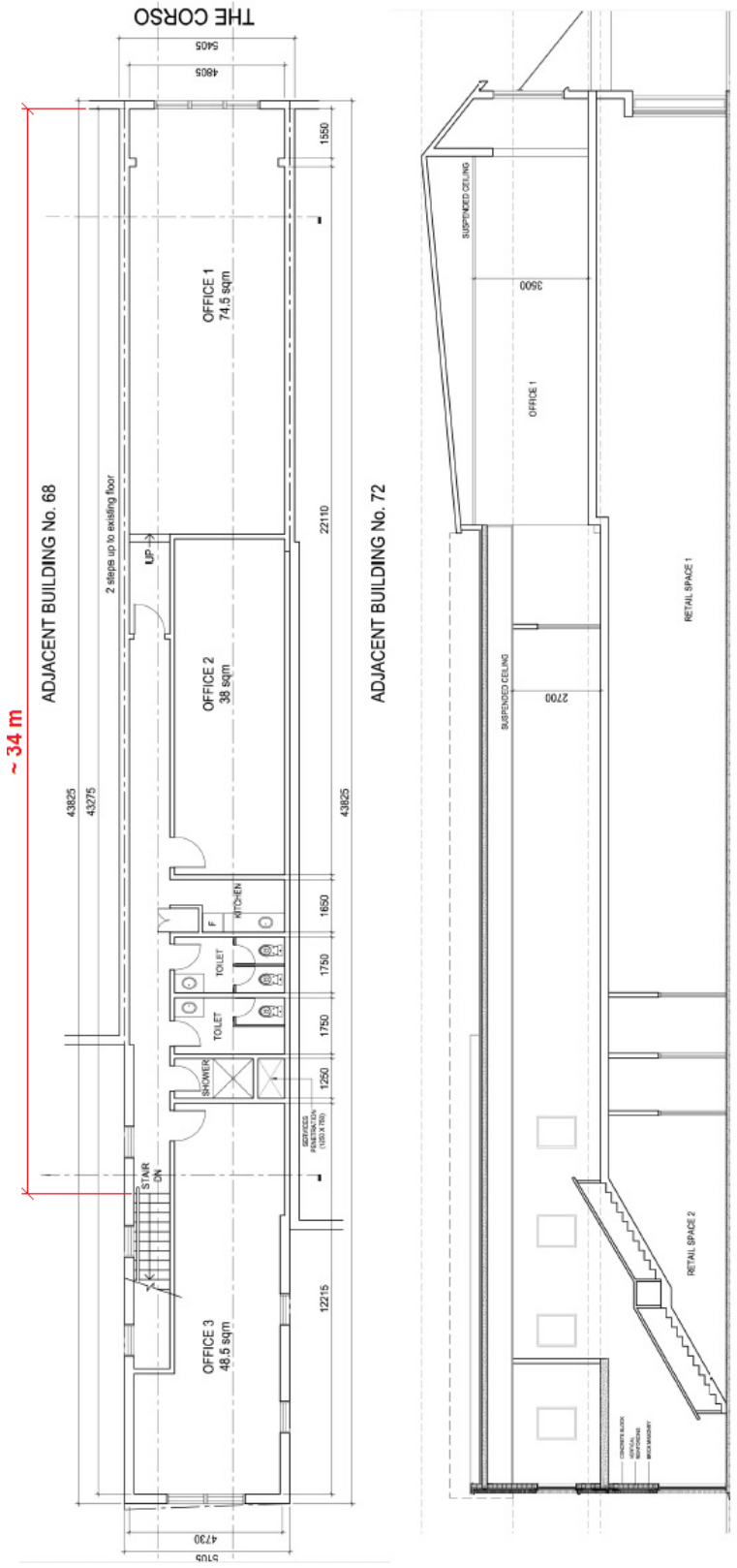


Figure 1. Configuration of the proposed first floor showing the non-compliance of the maximum travel distance to the exit with the Deemed-to-Satisfy solutions of the NCC.

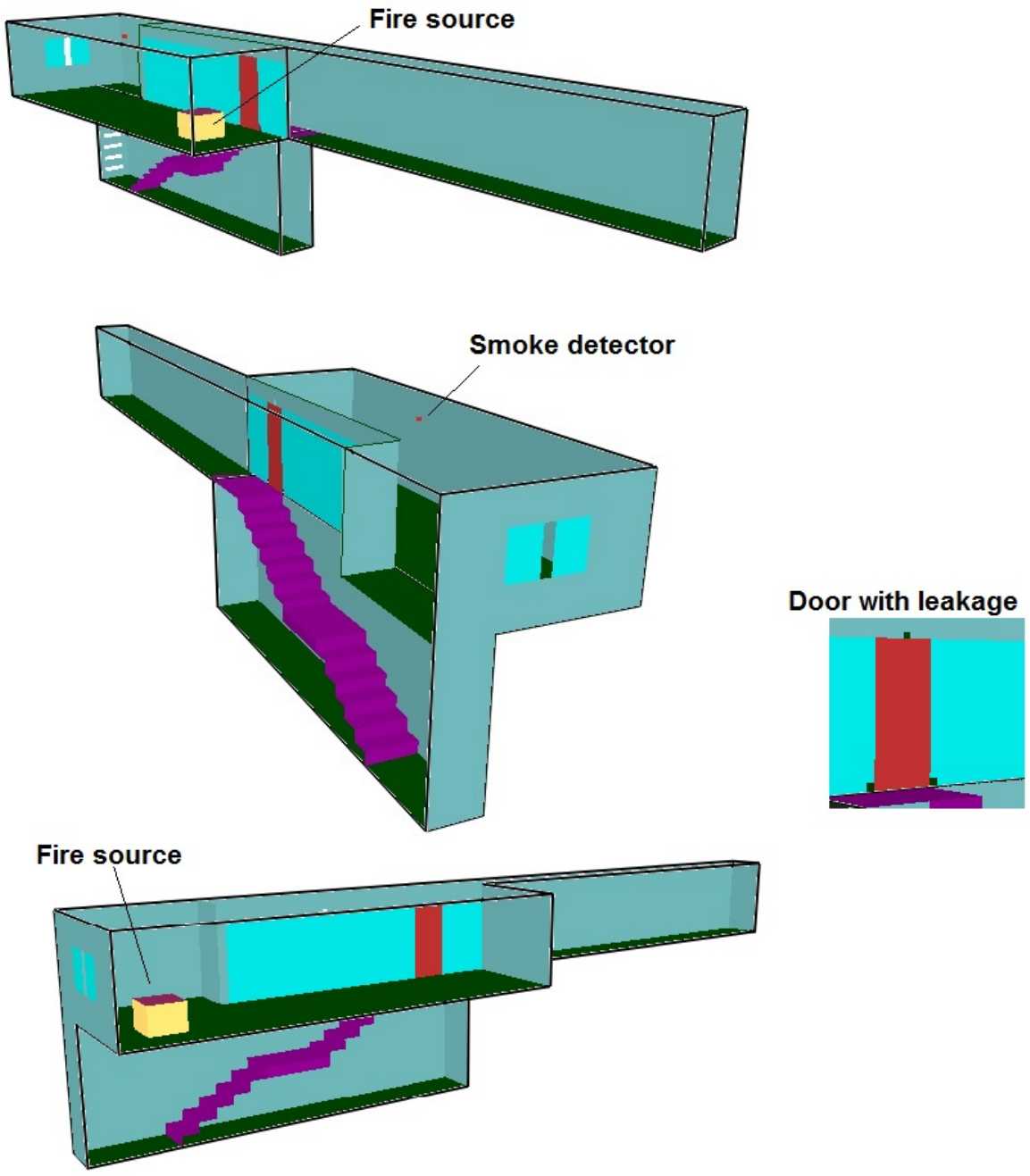


Figure 2. Configurations for FDS6 fire modelling:
(1) Smoke door. Fire close to the door.
(2) Smoke door. Fire close to the window.
(3) Door without smoke seals.
Ventilation from louvered ground floor door.

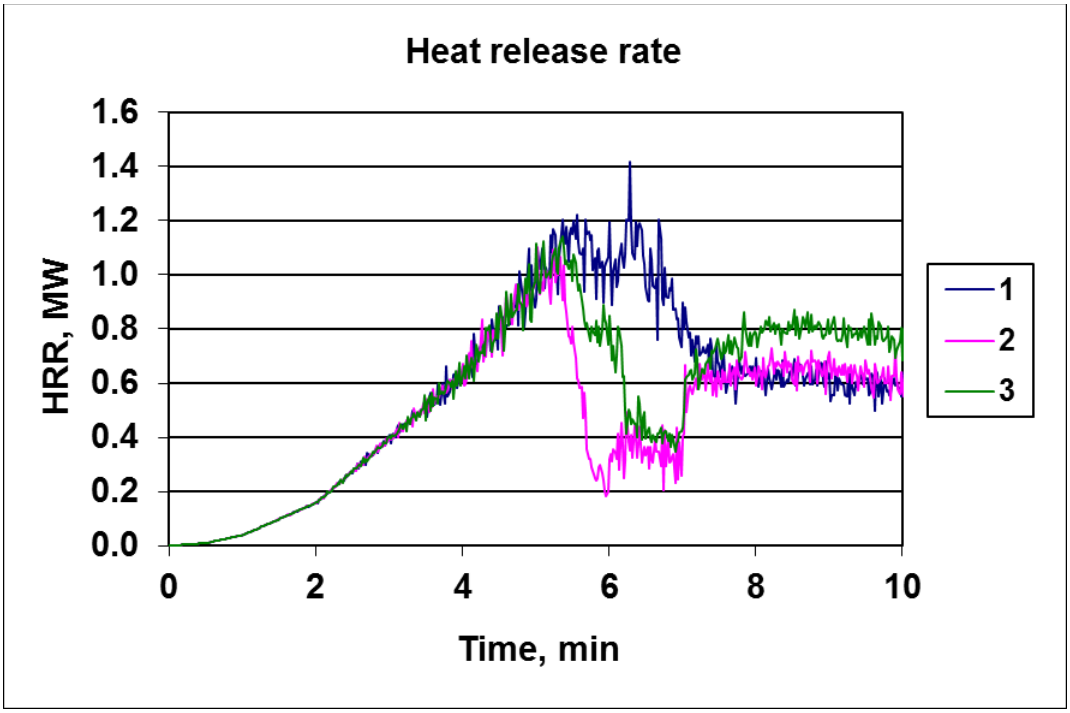


Figure 3. Computed heat release rate in all three scenarios discussed in Section 9 of the report.

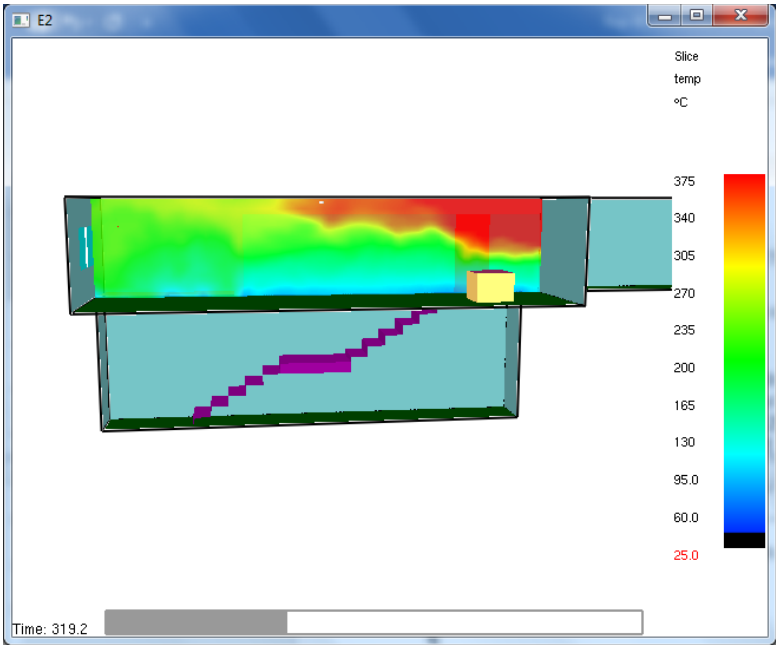


Figure 4. Maximum temperature at a distance of 125 mm from the glass wall separating Office 3 from the corridor.

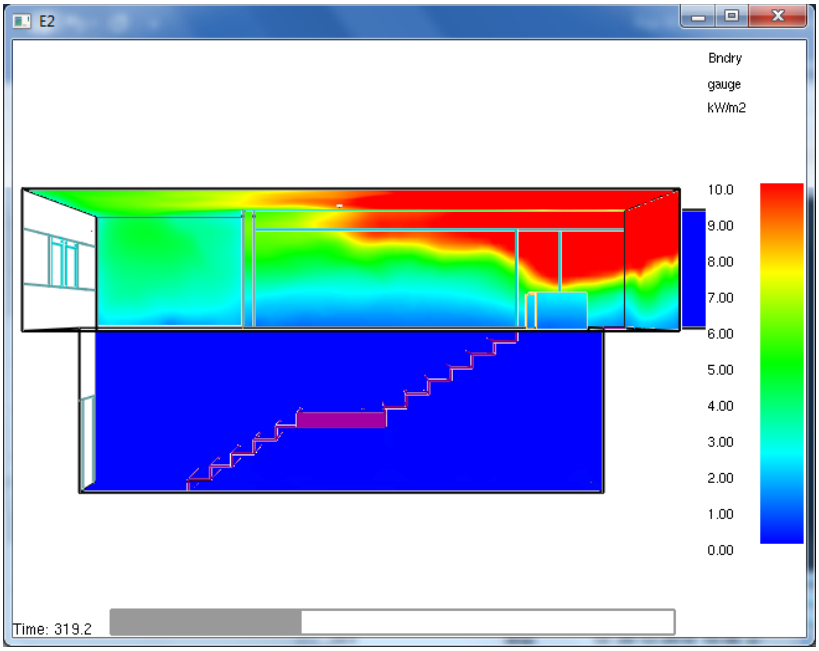


Figure 5. Maximum intensity of heat radiation impressed during a fire onto the glass wall separating Office 3 from the corridor.

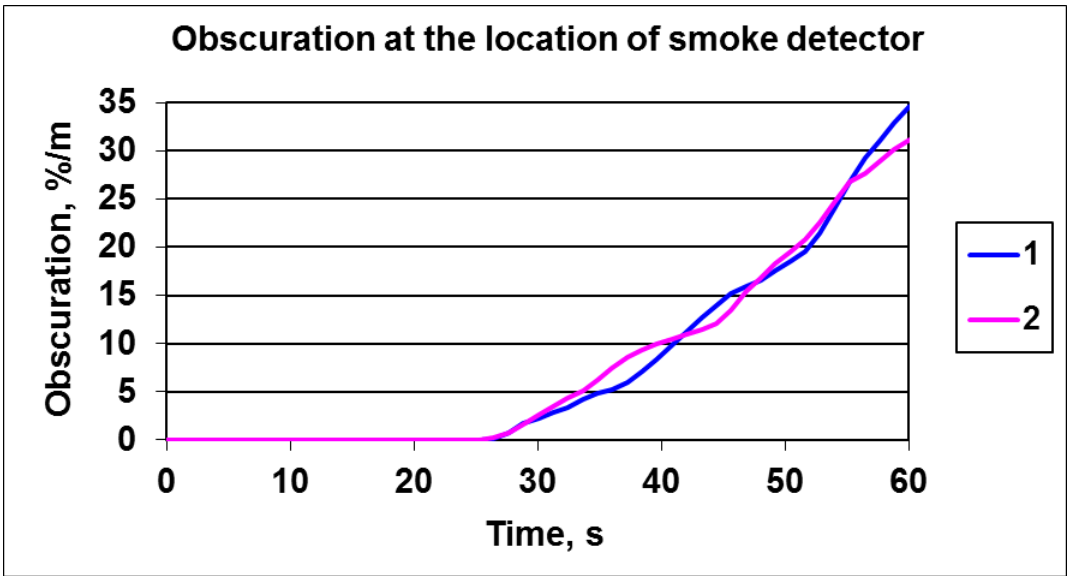


Figure 6. Computed obscuration at the location of the smoke detector. It is assumed that the detector is activated at 8%/m obscuration, i.e. in less than 40 seconds after ignition.

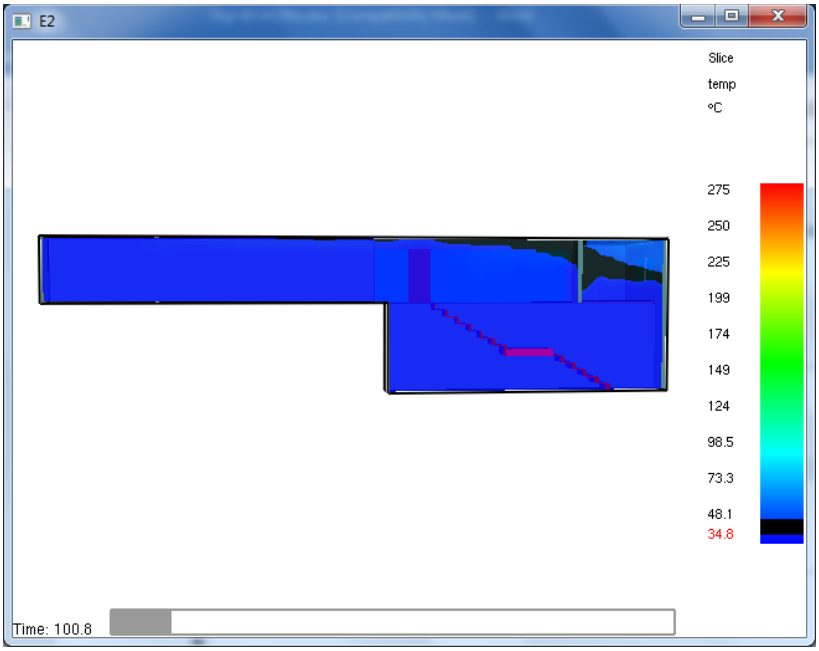


Figure 7. Maximum computed temperature in the corridor in Scenario (2) after the door to the office is closed.

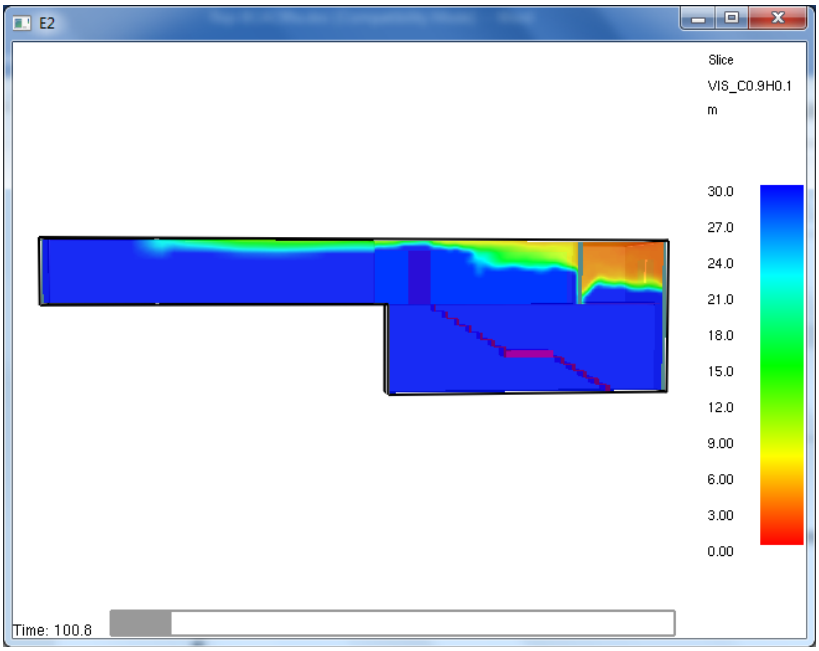


Figure 8. Computed visibility in the corridor in Scenario (2) immediately after the door to the office is closed.

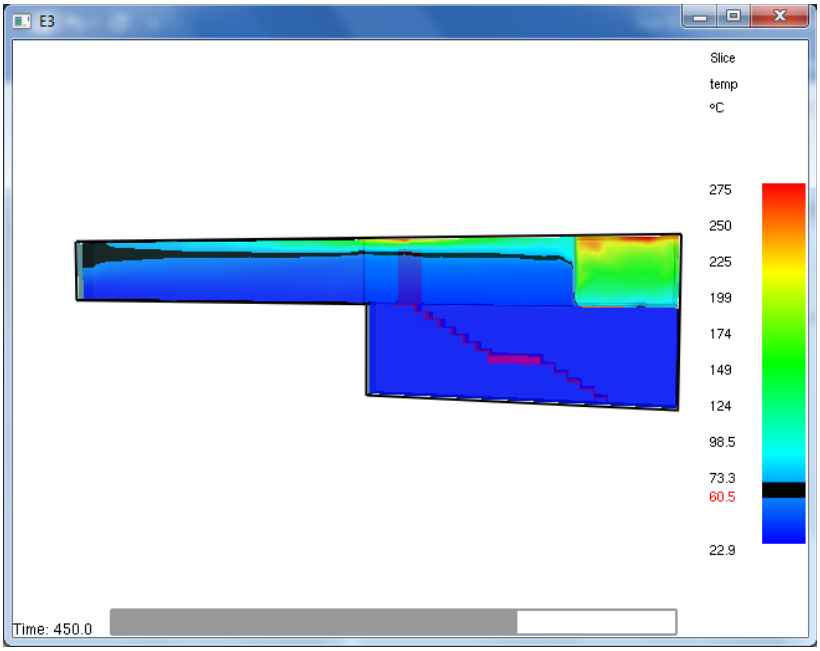


Figure 9. Scenario (3). Temperature in the corridor in **7.7 minutes** after ignition. Black colour marks temperature of **60.5°C**.

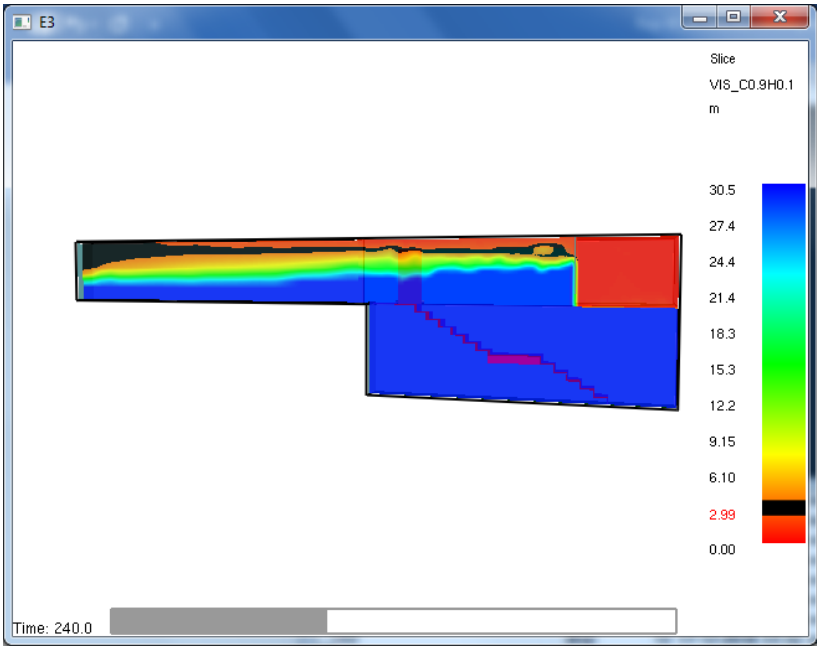


Figure 10. Scenario (3). Visibility in the corridor in **4 minutes** after ignition. Black colour marks visibility of **2.99 m**.

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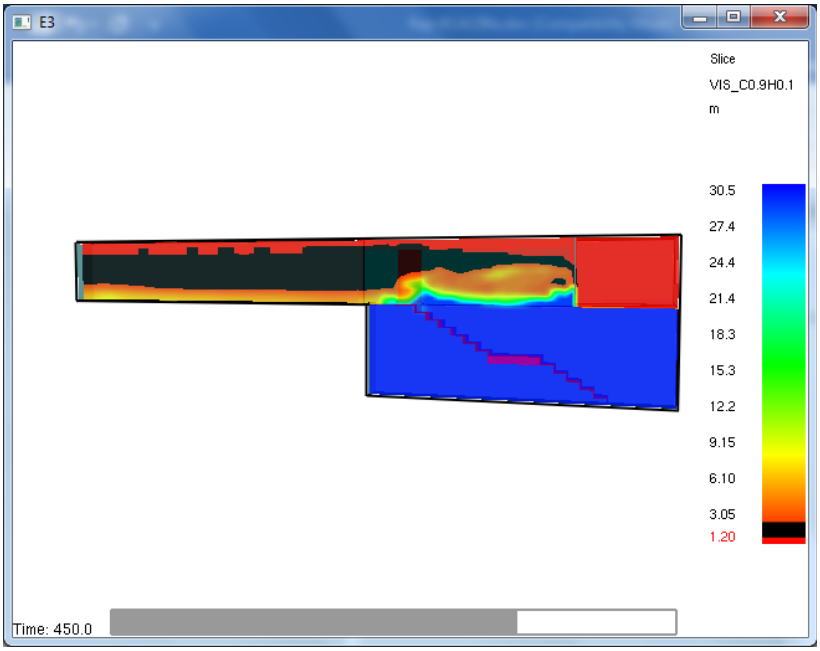


Figure 11. Scenario (3). Visibility in the corridor in **7.5 minutes** after ignition. Black colour marks visibility of **1.2 m**.

## APPENDIX 1.
## Sources of information

1. Drawings by Urbaine Architecture "Proposed alterations and additions at No 70 The Corso" dated 28/02/2019:

| | |
|---|---|
| Site location | Drawing No. A001 |
| Site survey | Drawing No. A002 |
| Existing floor plans | Drawing No. A003 |
| Existing exterior elevations | Drawing No. A004 |
| Existing sections | Drawing No. A005 |
| Proposed floor plans | Drawing No. A006 |
| Proposed exterior elevations | Drawing No. A007 |
| Proposed sections | Drawing No. A008 |
| Proposed sections | Drawing No. A009 |
| Photo montage 1 | Drawing No. A010 |
| Photo montage 2 | Drawing No. A011 |

2. Building Code of Australia Consultants Report "*70 The Corso, Manly*" dated 28 December 12/2018.

3. Inspection of the existing building by Dr Victor Shestopal 13 December 2018.

## APPENDIX 2.
## References

1. "International Fire Engineering Guidelines", Edition 2005. International Code Council.
2. "Valorisation Project. Natural Fire Safety Concept". CEC Agreement 7215-PA/PB/PC-042 and CEC Agreement 7215-PA/PB/PC-057, 1999 – 2001.
3. Skelly, M.J. and Roby, R.J. "An experimental investigation of glass breakage in compartment fires". J. of Fire Prot. Engr., 1991, 3(1), pp 25 – 34.
4. Moulen, A.W. & Grubits, S.J. "Water-curtains to shield glass from radiant heat from building fires". Tech. Record TR 44/153/422, Experimental Building Station, Dept. of Housing & Construction. North Ryde, July 1975.