



## Determination 2009/100

# Refusal of an amendment to the fire engineering design forming part of a building consent for a multi-storey office building at 80 Queen Street, Auckland

### 1. The matter to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004<sup>1</sup> (“the Act”) made under due authorisation by me, John Gardiner, Manager Determinations, Department of Building and Housing (“the Department”), for and on behalf of the Chief Executive of the Department. The parties to the determination are:

- the owner of the building, Brookfield Multiplex Construction Ltd (“the applicant”) acting through a firm of consulting engineers (“the consulting engineers”)
- the Auckland City Council carrying out its duties and functions as a territorial authority and a building consent authority (“the authority”).

1.2 I take the view that the matters for determination, in terms of sections 177(a) and 177(b)(vi)<sup>2</sup> are:

- a) whether the amended fire design to the basement steel frame complies with the Building Code (Schedule 1 to the Building Regulations 1992)
- b) whether the authority was correct when it refused to issue an amendment to the building consent for the work based on the amended fire design.

1.3 The applicant has stated that the specific matters to be determined are whether:

- paragraph 6.10.5 of the Acceptable Solution C/AS1 applies to the structure directly beneath and supporting the concrete floor slab within the car park firecell
- paragraph 6.14.4 of C/AS1, which prescribes a general 60 minute fire resistance to floors separating a basement cell from other fire walls above, take precedence over the calculation of the S value from paragraph 6.10.5

---

<sup>1</sup> The Building Act, Building Code, Compliance documents, past determinations and guidance documents issued by the Department are all available at [www.dbh.govt.nz](http://www.dbh.govt.nz) or by contacting the Department on 0800 242 243

<sup>2</sup> In this determination unless otherwise stated, references to sections are to sections of the Act and references to clauses are to clauses of the Building Code.



- 2.3 The steel frame to the four-level basement, as currently built and as proposed in the amended fire design, has no passive fire protection beyond its inherent period of structural adequacy. There is a concrete floor slab between the basement and the ground floor which has a 60 minute FRR.

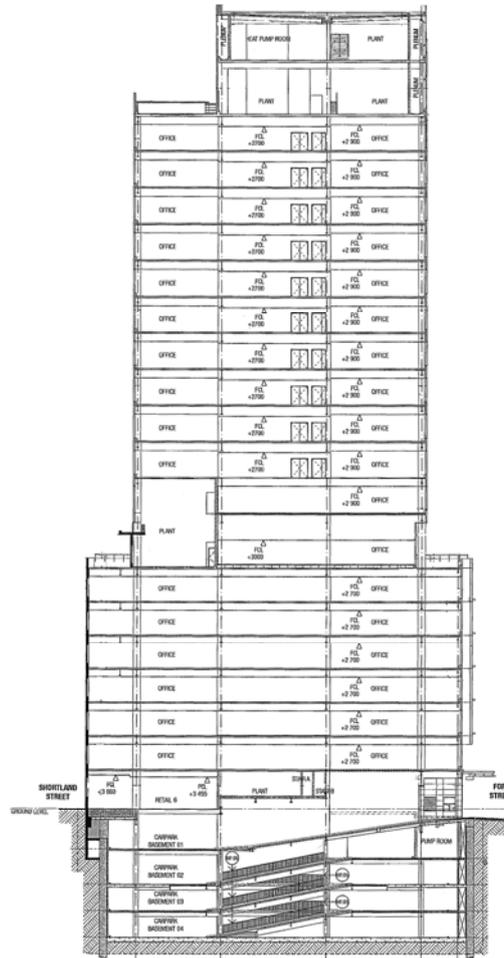


Figure 2: Section

### 3. Background

- 3.1 The original application for consent was lodged with the authority on 16 April 2008. The application included a fire-safety design (“the original fire design”) which the authority declined for reasons referred to later. The application was supported by a PS2 Producer Statement – Design Review, dated 21 December 2007 completed by the design reviewer (“the design reviewer”).
- 3.2 It appears that the original fire design was amended in order to obtain the building consent and this design (“the consented fire design”) included FRR to the columns and beams to the basement. The authority issued building consent BLD 20062960809 for the building on 11 December 2008. I have not seen a copy of the building consent.
- 3.3 Various correspondence passed between the parties in October 2008 regarding the fire rating of the basement, and on 4 November 2008 the design reviewer emailed the applicant regarding the inherent FRR of the basement structure. The design reviewer described sourced car burnout tests that had been undertaken, and described the

conditions that would apply in the event of a vehicle fire or multiple vehicle fires occurring in the basement. The design reviewer concluded that:

- there would be no post-fire deformation in the columns and it was unlikely that there would be any visible deformation in the columns at any stage during such a fire
- it was likely that there would be some post-fire deformation of the beams locally above a car fire. However, this would be minor and would not compromise the beam support or the floor fire-separation functions.
- because the building is fully sprinkled, the localised beams act as the first line of property protection and in the event of sprinkler failure, deformation is expected and acceptable. In addition, these beams can be readily replaced.
- with the beams and columns unprotected, there was no possibility that any design car fire in the basement would cause loss of function of the structure, or fire separations anywhere in the building, or disproportionate damage to the upper levels due to column deflection in the car park.

3.4 The various fire designs for the building were submitted to the NZFS Design Review Unit (“the DRU”) by the authority for comment. The DRU provided several memorandums in response (with dates ranging from 2 September 2008, to 16 December 2008), all of which concluded that the fire designs should be rejected.

3.5 On 27 March 2009 the applicant’s consulting engineers produced an amended fire design (“the amended fire design”) which was a revision of the consented fire-safety design. I note the amended fire design that is a matter for this determination was not sent to the DRU for comment at that time.

3.6 The amended fire design gave an assessment of the required fire-resistance, the basis for an alternative solution, described various fire scenarios, and listed some supplementary information. The conclusion to the amended fire design noted:

The fire resistance provided by the structure (ie. the period of structural adequacy) exceeds the design fire resistance prescribed by full burnout as quantified by the S value in C/AS1 for all possible fire locations in this building.

Therefore the fire resistance as provided by the structure in this alternative solution meets the performance criteria of the Building Code Clause C4.

Note: if there is a change of use in the basement to a use with a greater structural fire severity, this would trigger a review of the fire safety requirements for the building, including the fire resistance levels provided and required.

3.7 On 3 April 2009, the applicant wrote to the authority requesting an amendment to the consent for the amended fire design. The application acknowledged that the amended fire design was not ‘formally’ in compliance with C/AS1, but it was an alternative solution that, in the opinion of the applicant’s consulting engineers, complied with the Building Code.

3.8 On 30 April 2009 the authority emailed the consulting engineers and the applicant, listing the items that the authority considered did not meet the requirements of the Building Code. I summarise these as:

- The alternative solution did not demonstrate a level of performance equivalent to paragraph 6.14.4 of C/AS1.

- A C-factor of 0.5 is required when addressing an S rating fire separation between the basement car park and the ground floor firecell, rather than the 0.25 C-factor proposed by the alternative solution.
- Paragraph 5.6.2 of C/AS1 states that where an F rating and an S rating apply to a building element, then the higher value is to be used.

3.9 In response to a request, the design reviewer emailed the consulting engineers on 17 June 2008. The design reviewer stated that he agreed with the consulting engineers' interpretation of the provisions to be applied and their statement of the intended outcomes. The design reviewer also raised further points that were considered to be relevant to the discussion.

3.10 The application for a determination was received by the Department on 13 May 2009.

#### **4. The submissions**

4.1 A number of submissions were received from the parties, NZFS, and the various experts and consultants involved in this matter. The content of all submissions received has been considered in the preparation of this determination and some content has been summarised below or within relevant paragraphs 7.2 or 7.3.

4.2 The applicant provided copies of:

- some of the plans
- the application to amend the consent
- the amended fire design ('Report on Performance of the Steel Structure Exposed to Fire, 27 March 2009, Version C, plus 'Appendix D - Addendum: Basement Structure Alternative Solution')
- correspondence between the authority, the applicant, the consulting engineers, and the design reviewer.

4.3 The consulting engineers wrote to the Department on 8 May 2009, providing comments on the authority's correspondence relating to the consent amendment application. The consulting engineers set out in detail their arguments as to the viability of the proposed amendment.

4.4 In an email to the Department dated 13 May 2009, the authority noted that, apart from the completed D2 form, it had no further information to submit.

4.5 In a clarification letter forwarded to the Department on 18 May 2009, the consulting engineers set out the specific matters described in paragraph 1.3 and noted that the design reviewer had carried out a peer review and had provided a Producer Statement (PS2) in regard to the steel structure for the building.

#### **The first draft determination**

4.6 The first draft determination was sent to the parties for comment on 23 June 2009. I have amended the draft in response to those comments as I consider appropriate.

4.7 The NZFS responded to the draft in a letter to the Department dated 7 July 2009.

4.8 The applicant, through its consulting engineers responded to the submission of the NZFS (above) in a letter to the Department dated 7 July 2009.

- 4.9 On 21 August 2009, the design reviewer emailed a further submission to the Department. The submission is summarised in paragraph 7.2.3. The design reviewer also provided a submission commenting on the second expert's report, and noted that the cost for fire-rating the steelwork has been estimated as being in the order of \$250,000.
- 4.10 In an email to the Department dated 24 August 2009, the authority raised the issue of defining the S rating of the work in question. However, based on the resulting correspondence from and on behalf of the applicant, I consider that the question S rating was more in the context of a certificate of public use, rather than a matter arising from this determination.
- 4.11 In the same email the authority also noted its concern that the design reviewer, who had provided the authority with a peer review of the structural design for the building, was now undertaking the role of an adviser representing the applicant. The applicant's consulting engineers have noted that the design reviewer's comments were independent from the applicant and were produced as part of the regulatory review process. Having noted the authority's concerns, I accept that the design reviewer's comments are of assistance to me in determining the matter in question.
- 4.12 I have amended the draft in response to those comments as I consider appropriate.

#### **The second draft determination**

- 4.13 The second draft determination was sent to the parties for comment on 15 September 2009. The authority accepted the second draft without comment on 19 October 2009.
- 4.14 The applicant did not accept the second draft determination. The submission from the consulting engineers, dated 28 September 2009, reiterated their previous position that the fire design complied with C/AS1 and that the determination should focus on the interpretation of C/AS1. The submission said:

The fundamental issue with this Determination centres on whether the design [basement steel structure fire resistance] satisfies the requirements of [C/AS1].

[C/AS1] requires the structure in the sprinklered basement carpark (regardless of whether the structure is steel or concrete) to achieve a fire resistance rating of no more than 23 minutes ... or 17 minutes ...

[The second draft determination agrees] that C/AS1 Para 6.14.4 does not take precedence over C/AS1 Para 6.10.5 ... this supports the applicant's claim that the original design (hence the amendment to the design) fully comply with C/AS1.

[The second draft determination says] that the building tower structure supported by the carpark columns ... could collapse in a fire... The actual fire resistance provided by the columns in the basement is more than 25 minutes.

- 4.15 In response to the second draft determination, the NZFS accepted the decision but reiterated its previous position that:
- ... it is an extremely serious matter to propose that an 18 storey building may be supported on exposed steel structure that only has a 15 minute fire rating ... this is not the intent of the compliance documents. [NZFS is] unaware of any building code internationally that would allow such a low fire rating in a basement beneath a sprinklered tall building.

The NZFS also strongly disagreed with the draft determination's stated position that paragraph C6.14.4 of C/AS1 does not take precedence over paragraph C6.10.5, saying:

Allowing C6.10.5 to take precedence takes absolutely no account of what is above the car park, and therefore fails to recognise any consequences of structural failure in terms of the threat to the life of occupants, people in the vicinity and, most particularly, fire-fighters.

- 4.16 I acknowledge these comments and have amended the determination as I consider appropriate.

## 5. The expert's reports

### 5.1 The first expert

- 5.2.1 As stated in paragraph 1.6, I commissioned a fire safety engineer, who is a chartered professional engineer and an expert in fire-safety design ("the first expert"), to provide me with a report on the matter to be determined as presented by the applicant. The first expert provided me with a report dated 11 June 2009.

### 5.2 The second expert

- 5.2.1 I also engaged a second safety engineer who is also a chartered professional engineer and an expert in fire-safety design ("the second expert"), to provide me with a further report. This report considered the broader fire-safety aspects in terms of whether the proposed fire design complied with the requirements of the Building Code, how the requirements of C/AS1 applied to the building, and the comparable requirements of other building controls regimes. The second expert provided me with a report dated 30 July 2009.
- 5.3 Both experts' reports were sent to the parties for comment.

## 6. The legislation

- 6.1 The relevant clauses of the Building Code include:

### 6.1.1 Clause B1: Structure

#### Performance

**B1.3.1** *Buildings, building elements and sitework* shall withstand the combination of loads that they are likely to experience during *construction* or *alteration* and throughout their lives.

**B1.3.3** Account shall be taken of all physical conditions likely to affect the stability of *buildings, building elements, and site work*, including

- (i) *Fire*
- (r) Removal of support.

**B1.3.4** Due allowance shall be made for:

- (a) The consequences of failure,

### 6.1.2 Clause C4: Structural stability during fire

#### Objective

**C4.1** The objective of this provision is to:

- (a) Safeguard people from injury due to loss of structural stability during *fire*, and ...

#### Functional requirement

**C4.2** *Buildings* shall be constructed to maintain structural stability during *fire* to:

- (a) Allow people *adequate* time to evacuate safely

- (b) Allow fire service personnel *adequate* time to undertake rescue and firefighting operations, and
- (c) Avoid collapse and consequential damage to adjacent *household units* or *other property*.

### Performance

**C4.3.1** Structural elements of *buildings* shall have *fire* resistance appropriate to the function of the elements, the *fire load*, the *fire intensity*, the *fire hazard*, the height of the *buildings* and the *fire* control facilities external to and within them.

**C4.3.2** Structural elements shall have a *fire* resistance of no less than that of any element to which they provide support within the same *firecell*.

**C4.3.3** Collapse of elements having lesser *fire* resistance shall not cause the consequential collapse of elements required to have a higher *fire* resistance.

6.2 The relevant clauses of Acceptable Solution C/AS1 include:

### Determining the FRR

**5.6.1** Having determined the F and S *ratings*, choosing the appropriate numbers for the *FRR* involves:

- c) Checking whether specific requirements are imposed elsewhere in this Acceptable Solution for a particular *purpose group* or *building function* ...

**5.6.2** Following this analysis an appropriate *FRR* may be assigned to each *building element* (see examples given in Paragraph 5.2.1). If an *F rating* and an *S rating* apply to a *building element*, use the higher of the two.

### Car parking

**6.10.3** Car parking spaces within a *building* ... shall be separate *firecells*. Within the car park *firecell*, all floors (including *intermediate floors*) and their supporting structures shall be *fire* rated.

**6.10.5** *FRRs* for *building elements* in car parking spaces shall be based on the *S rating* as derived from the formula:

$$S = Ct_e$$

Where:

$t_e$  (equivalent time of fire exposure in minutes) is derived from Table 5.1, and C is a variable having the following values:

For fire separations between firecells:

C.. = 1.0 if unsprinklered, or  
= 0.5 if sprinklered.

For floors and supporting elements within the carpark firecell:

C.. = 0.5 if unsprinklered, or  
= 0.25 if sprinklered.

### Basement floors

**6.14.4** *Basement firecells* shall be separated from one another, and from the lowest *firecell* above ground level, by *fire separations* having a *FRR* of no less than 60/60/60. This does not apply to *purpose group* SH or within *household units* of *purpose group* SR.

## **7. Evaluation for compliance with the Building Code**

7.1 The approach in determining whether the building work complies with Clause C4 the Building Code, is to examine the design of the building and the design features that are intended to prevent the loss of structural stability of the building.

### **7.2 Application of the Compliance Document C/AS1**

7.2.1 The relevant provisions of C/AS1 amount to a means of compliance with the performance requirements of clauses C of the Building Code.

7.2.2 Before discussing the merits of the arguments presented to me, I have considered the C/AS1 provisions relating to car parks as follows:

- Most of the requirements for C/AS1 relate to car parks within buildings, rather than stand-alone buildings. This is confirmed by paragraph 6.10.3 of C/AS1 that refers to “car parking spaces within a building”. This paragraph also effectively refers to car parking below ground level.
- While C/AS1 does not distinguish between car parks above or below ground, for general requirements paragraph 6.10 of C/AS1 notes that there are additional requirements depending on whether they are basement or rooftop areas.
- Only paragraph 6.10.5 relates to fire ratings within a car parking firecell.
- As a car park’s purpose group is IA, and table 4.1 does not give F ratings for a IA Purpose Group, there is no F rating applicable to a car park. Instead, the notes direct a user to paragraphs 6.10.3 to 6.10.6.
- As described in paragraph 5.6.1(c) of C/AS1, there are other requirements for car parks (as in paragraph 6.10) that provide the FRR requirements based on an S rating.

7.2.3 In the opinion of the design reviewer (refer paragraph 4.9):

- The proposed design is in accordance with C/AS1 as it covers basement floors that are a car park. Paragraph 6.10.6 of C/AS1 states that FRRs for building elements within these spaces are to be based on the S rating derived from a formula that produced a conclusion for the floors and supporting elements within the firecell,  $F=S=15$  minutes.
- The fire separation between the top floor of the basement and the floor above would be 30/30/30. However, taking into account paragraph 6.14.4, a more conservative figure would be 60/60/60.
- The fire separation is the floor slab, not the supporting beams, and the latter, in accordance with paragraph 6.10.5, are exposed to a structural fire severity within the firecell of 15 minutes.
- The conclusion reached was that the FRR for the floor slab between the basement and the firecell above is 60/60/60 and that for the floors and supporting elements within the car park is 15/-/- minutes. As all the elements in question achieve these fire resistances, the design complies with C/AS1.

### **Relative precedence of paragraphs 6.10.5 and 6.14.4 of C/AS1**

- 7.2.4 It was noted by the first expert that interpretation of paragraph 6.10.5 of C/AS1 was ambiguous as shown by the differing opinions of the parties. However, given the background information provided by the consulting engineers and the design reviewer, the expert believed that the consulting engineers' design and interpretation complied with paragraph 6.10.5 of C/AS1 (refer also paragraph 7.3.4). The first expert also referred to the email of 17 June 2008 forwarded to the consulting engineers by the design reviewer (refer paragraph 3.9).
- 7.2.5 As noted in paragraph 5.2.1, I requested the second expert to investigate the code-compliance of the fire design in broader terms as to whether the design as a whole complied with the Building Code. The second expert supported the first expert's findings that paragraph 6.10.5 of C/AS1 applied to the structure directly beneath and supporting the concrete floor slab; I discuss this point later in paragraph 7.2.10. The second expert also agreed with the consulting engineers and the design reviewer that fire loads do not follow gravity loads. It was reasonable therefore, in terms of the below-slab structural system, to accept that paragraph 6.14.4 does not take precedence over paragraph 6.10.5.
- 7.2.6 In requiring a 60 minute fire rating between basement and ground level firecells, paragraph 6.14.4 of C/AS1 is not ambiguous. However, there is no guidance in C/AS1 as to whether this paragraph overrides the requirements of paragraph 6.10.5. If read literally, paragraph 6.14.4 would indeed take precedence but it is a generalised paragraph that could apply to other uses, such as office, retail or storage areas. On the other hand, paragraph 6.10.5 is very specific to car park use, the use to which the basement will be put. While the consulting engineers' fire design does not strictly comply with paragraph 6.14.4, they have provided persuasive reasoning why the design should be considered to be an alternative solution.
- 7.2.7 I accept the opinions of the two experts that paragraph 6.10.5 of C/AS1 applied to the structure directly beneath, and supporting, the concrete floor slab. I also accept the arguments presented that paragraph 6.14.4 of C/AS1 does not take precedent over paragraph 6.10.5. This addresses the first two specific matters raised by the applicants as set out in paragraph 1.3.
- 7.2.8 I acknowledge position of the NZFS with respect to the precedence of paragraph 6.14.4 over 6.10.5 (refer paragraph 4.15), but my view of the matter remains the same. The determination has exposed an anomaly in C/AS1 when it is applied to buildings of this particular nature. However, irrespective of this it is my view that the fire design of the basement structure is an alternative solution.
- 7.2.9 The determination has brought this anomaly to the attention of the Department which it will need to remedy by the appropriate means. However, I observe that in situations such as this when there is difficulty interpreting a compliance document, practitioners should be guided by the mandatory performance requirements of the Building Code itself.

### **The requirements of Building Code Clause C4.3.3**

- 7.2.10 In paragraph 7.2.5, the second expert has agreed in principle with the consulting engineer and design reviewer that fire loads do not follow gravity loads. It is reasonable therefore, in terms of the structural system below the ground floor slab, to

accept that paragraph 6.14.4 does not take precedence over paragraph 6.10.5. By extension, C4.3.3 is therefore satisfied 'in principle'.

7.2.11 However, in matters of detail, I note the following:

- The consulting engineers state as a 'design philosophy' in their amended fire design report that:

Local instability of one or two members in an extreme event is an acceptable structural performance.
- There are structural elements shown as unprotected, for example circular hollow section columns, elements which are known to have limited fire resistance.
- All basement beams are unprotected based solely it appears, on the qualitative statement that these elements '... will maintain stability without applied fire protection...' This is in contrast to the upper levels where calculations based on the HERA Report R4-131<sup>3</sup> are referenced.
- Where fire protection to the basement columns is shown, the manner in which the protection is applied is not specified. Instead alternative methods are offered some of which are described as 'partial protection' which appear not be supported by detailed analysis.

7.2.12 For the reasons stated in 7.2.11 it is not clear that C 4.3.3 has been satisfied. The unprotected columns, beams and the consequence of any 'local instability' require proper engineering calculations to be carried out.

7.2.13 This also reinforces my view that the design is an alternative solution, with implications beyond those narrow matters the applicant requested be determined 1.3.

### **7.3 The amended fire-safety design as an alternative solution**

#### **General**

7.3.1 In response to the first draft determination the NZFS, in summary, stated:

- The draft determination did not address the central issue of whether the building will comply with the performance requirements of Clause C4. As the fire design was an alternative solution, there was insufficient information to support the application.
- The issues of Clause C3.3.9 have not been addressed at all and the proposed design does not facilitate the needs of Fire Service personnel
- The consequences of structural failure are so high that the chances of failure have to be shown to be commensurately low.
- Connections and fixing details are extremely important considerations in respect of the fire performance of steel structures and the analysis needs to include these details.
- While there may be sound engineering arguments to support the approach that an 18-storey building may be supported on a steel structure with a 15 minute fire-rating, these are not apparent in the fire design.

---

<sup>3</sup> HERA Report R4-131 Design of Composite Steel Floor Systems for Severe Fires (March 2006) Incorporating SPM0306 software)

- All calculations need to be presented and reviewed, a sensitivity analysis required to be carried out, and a range of scenarios should be explored.

7.3.2 In a letter to the Department dated 7 July 2009 responding to the NZFS's submission of the same date, the consulting engineers acknowledged that the design was an alternative solution. However, in the opinion of the consulting engineers it does not follow that each design solution not in terms of a compliance document requires justification via a performance-based design prepared from first principles. The consulting engineers maintain that:

- the alternative solution meets the performance criteria of Clause C4 and it is not required to follow a performance based design prepared from first principles.
- the determination should be specifically about the application of the Compliance Document C/AS1 and not about the acceptance of a fire engineering design based on first principles.
- the NZFS was consulted about issues arising from Clause C3.3.9 and the DRU did not raise any issues at that time, nor had the authority.
- It would appear that the NZFS has misunderstood the term "performance document". What matters from the fire design viewpoint is that the performance requirements for building elements are indicated in the fire safety documentation. Performance in terms such as fire resistance rating applies, regardless of the method of determining the required level of fire resistance.
- The NZFS statement regarding the 15-minute fire resistance rating of the basement columns is misleading in terms because:
  - the 15-minute rating is approximately the same rating that is obtained from the application of C/AS1
  - the structure supporting the upper levels of the building achieves a fire-resistance rating of no less than 22 minutes and for most columns it is significantly more than this. This represents a margin of more than 30% greater than the value obtained from an application of C/AS1
  - the steel structure in the basement that supports the upper floors is much more resistant to fire if it is supporting an 18-level building than if it were supporting a 4-level building above.

7.3.3 The consulting engineers contend that the design is an alternative solution complying with the Building Code.

7.3.4 The first expert considered the arguments presented by the consulting engineers to support the alternative solution for the amended fire design that applied the requirements of paragraph 6.10.5 of C/AS1 over those of paragraph 6.14.4. The first expert was of the opinion that the application of paragraph 6.10.5 had been correctly applied, however, this view was tempered by the observation that there was a lack of clarity in C/AS1 as to the relative precedence of paragraph 6.10.5 and 6.14.4.

7.3.5 In the second expert's opinion the current Building Code of Australia<sup>4</sup> ("BCA") could assist in evaluating the amended fire-safety design. The expert noted that:

- The 'deemed to satisfy' ("DTS") provisions of the current BCA provide a comparable reference to the Compliance Document C/AS1. The BCA provides a concession that would allow unprotected steel in certain cases of open or sprinkler-protected car parking buildings. However, this concession would not apply in the case of the subject building. The Guide to the BCA includes the statement:

This concession is not applicable if the steel columns support any other part of the building that is not used as a car park.

- In addition, in the DTS provisions of the BCA, where structural adequacy is required, it is never less than 60 minutes (time equivalent). Accordingly, there are no 15 or 30 minute 'S Ratings' in the provisions.

7.3.6 The second expert was of the opinion that the design did not reasonably demonstrate compliance with the Building Code. The second expert also noted that:

- It was appropriate that a calculative approach be undertaken in this case to consider both fire severity and fire resistance. Alternatively, other such agreed methodology and acceptance criteria could be used.
- The expert had been directly involvement in the Cardington Tests referred to by the design reviewer.
- It was not generally appropriate for fire designers to draw conclusions directly from test results
- If the Eurocode<sup>5</sup> was applied to the building as a whole, including the concession factors (eg sprinklers, fire detection) the fire severity could exceed 30 minutes.

7.3.7 In response to the second expert's report, the design reviewer commented that in general terms, the basement structure would remain stable in both the case of the building consent design and the alternative design. The sprinkler system provides a first and very effective line of defence against fully developed car fire occurrences and local damage. The design reviewer also commented that:

- reference made to BHP<sup>6</sup> tests is only in regard to building performance from these tests, not the BCA provisions. This determination is not to the BCA and any mention of it is irrelevant
- the second expert has not quoted any supporting clauses of the IFEG in support of the qualitative approach argument, because none exist. The IFEG does not specify the pertinent details necessary for a quantitative design
- the qualitative approach presented is sufficient to establish code-compliance
- Regarding the fire studies referred to by the second expert:
  - There is no inference in regard to the tests that justifies unprotected steel "ipso facto".

---

<sup>4</sup> The Building Code of Australia, published by the Australian Building Codes Board, 2009

<sup>5</sup> European Committee for Standardisation, Eurocode 1 Part 1-2: General actions, Actions on structures exposed to fire

<sup>6</sup> From 1985 to 1989, BHP Research, Melbourne, conducted a series of fire tests on car park structures.

- While the requirement of protecting all columns in FHC2 or FHC3 fires is very relevant, it is not so for car park design fires which is an isolated fire affecting one column at a time.
- As the Cardington<sup>7</sup> tests had no relevance to car park fires, they are irrelevant to the determination.
- The Eurocode was not able to be used to determine the fire severity of a car park fire cell (I note that C/AS1 allows such an approach). The design reviewer agreed that the current C-factor concession used in C/AS1 should be reviewed.

### **Evaluation of the amended fire-safety design as an alternative solution**

- 7.3.8 In comparing an alternative solution with an Acceptable Solution it is useful to bear in mind the objectives of the relevant Building Code clauses. The approach in determining whether building work complies with Clause C4 is to examine the design of the building and the design features that are intended to prevent the loss of structural stability of the building. I have described this process previously in Determination 2005/109, which addressed a similar matter, and I have taken that material into account in the current Determination.
- 7.3.9 I note that the antecedent of the Department, the Building Industry Authority (“the BIA”), said in Determination 2004/5:
- 5.2.2 As for the proposed alternative solutions, the [BIA’s] task is to determine whether they comply with the performance-based Building Code. In doing so, the [BIA] may use the Acceptable Solution as a guideline or benchmark<sup>8</sup>.
- 5.2.3 The [BIA] sees the Acceptable Solution C/AS1 as an example of the level of fire safety required by the Building Code. Any departure from the Acceptable Solution must achieve the same level of safety if it is to be accepted as an alternative solution complying with the Building Code.
- 5.2.4 As in several previous Determinations, the [BIA] makes the following general observations about Acceptable Solutions and alternative solutions:
- (a) Some Acceptable Solutions cover the worst case so that in less extreme cases they may be modified and the resulting alternative solution will still comply with the Building Code.
  - (b) Usually, however, when there is non-compliance with one provision of an Acceptable Solution it will be necessary to add some other provision to compensate for that in order to comply with the Building Code.
- 7.3.10 In determination 2005/109 the Department stated:
- 6.2.3 ... I accept that the [BIA’s] reference to “the worst case” is too broadly worded in an application of this type. A better formulation would be:
- (a) Some Acceptable Solutions cover the worst case of a building closely similar to the building concerned. If the building concerned presents a less extreme case, then some provisions of the Acceptable Solution may be waived or modified (because they are excessive for the building concerned) and the resulting alternative solution will still comply with the Building Code.

<sup>7</sup> The Cardington Fire Tests were a series of large-scale fire tests conducted in 2000 by the BRE Centre for Fire Safety Engineering on steel-framed structures at the village of Cardington, England.

<sup>8</sup> “*Auckland CC v NZ Fire Service* [1996] 1 NZLR 330.”

- (b) Usually, however, when there is non-compliance with one provision of an Acceptable Solution it will be necessary to add some other provision or provisions in order to comply with the Building Code.

7.3.11 I accept these comments made by the BIA have applied them in the context of this determination.

### **Conclusions**

- 7.3.12 In my opinion the amended fire design is an alternative solution. In my view the basis for this statement is that while the consulting engineers have focussed on the interpretation of fire severity to determine the required fire resistance, they have then used a calculation method, which is outside the application of C/AS1, in order to determine the aforementioned fire resistance.
- 7.3.13 The NZFS considers that the main issue is demonstrating compliance with Clause C4 and that there was insufficient evidence provided by the applicant to support such compliance.
- 7.3.14 In my view any building is required to comply with all the relevant provisions of the Building Code. In this case I note that Clause B1.3.3 requires account to be taken of all physical conditions likely to affect the stability of buildings and building elements including fire and the removal of support.
- 7.3.15 In the second expert's opinion, due to a lack of a robust process and methodology the proposed alternative solution does not reasonably show compliance with the Building Code. The second expert concluded that the authority was correct when it refused to issue an amendment to the building consent.
- 7.3.16 As stressed by the NZFS and supported by the second expert, the research evidence provided by the consulting engineers is dated. The NZFS maintains that recent research shows that higher car fire temperatures can be reached that was previously estimated and that multiple car fires must also be taken into account. In this respect, I cannot agree with the statement by the design reviewer (refer paragraph 7.3.7) that car park design fires are always to be considered as being isolated fires affecting one column at a time.
- 7.3.17 A lack of detailed design calculations prevents me from reaching a definitive conclusion that full code-compliance of the basement structure has been established. Accordingly, in terms of an overall analysis of Clause C, and in the interest of the fire safety of the building as a whole, I cannot accept that the fire design in its present form is fully code-compliant.
- 7.3.18 I agree with the opinion of the second expert that C/AS1 is less conservative, with respect to this particular building, than the source documents that C/AS1 cites as references, and comparable internationally-published technical literature. I need to take this into account when evaluating any alternative solution framed around C/AS1, because to do otherwise could lead to an unsafe outcome as a result of a fire event in the basement.
- 7.3.19 As a final comment, I do not believe that the building as proposed is necessarily unsafe.

## **8. The decision**

8.1 In accordance with section 188 of the Act I determine that:

- (a) the proposed amended fire protection requirements to the basement steel frame do not comply with Clause C of the Building Code
- (b) the authority's decision to refuse to issue an amendment to the building consent is confirmed.

Signed for and on behalf of the Chief Executive of the Department of Building and Housing on 13 November 2009.

John Gardiner  
**Manager Determinations**