Determination 2005/134

Single means of escape from a high-rise apartment building at 2-30 Beach Road, Auckland City

1 The dispute to be determined

1.1 This is a Determination under Part 3 Subpart 1 of the Building Act 2004 ("the Act") made under due authorisation by me, John Gardiner, Determinations Manager, Department of Building and Housing, for and on behalf of the Chief Executive of that Department. The applicant is Mainzeal Property and Construction Ltd (referred to throughout this Determination as "the applicant"). The other parties are the Auckland City Council (referred to throughout this Determination as "the territorial authority") and the New Zealand Fire Service Commission (hereinafter referred to as the "Fire Service"), who have the right or obligation to give written notice to the territorial authority in respect of these matters. The application arises from the refusal by the territorial authority to issue the third of a series of staged building consents for a multi-storey apartment block ("the apartments"), unless changes are made to its single means of escape from fire.

1.2 I take the view that the matter for Determination is whether a new apartment building with a single means of escape from fire complies with clauses C2 and C3 of the Building Code (the First Schedule to the Building Regulations 1992) as required by sections 177 and 188 of the Act.

1.3 In making my decision, I have not considered any other aspects of the Act or the Building Code.

2 Procedure

2.1 The building

2.1.1 The proposed building in question is a 16-level apartment block, which consists of a basement and 3-level podium that contains car parking for residents and retail tenancies, and a 12-level tower. Each level of the tower contains either eight or ten apartments giving a total of 106 apartments for the building. Each tower level is divided into two equal sections by means of a central solid concrete wall and each of

these sections comprises a set of apartments, together with a stairway and two lifts. No horizontal access is available between the two stairways at any tower level. For the purpose of fire safety, there are two mirror image and non-intercommunicating buildings each with a single escape route from the upper levels.

2.1.2 All the apartments open onto an internal horizontal safe path corridor, from which stairways and lifts are accessed. The building is fully sprinkler protected in accordance with NZS 4541, including smoke detectors throughout. A charged hydrant riser main is installed in each stairway, which are to be pressurised in accordance with AS 1668. A voice communication system for use by the Fire Service is also installed.

2.1.3 A typical floor plan is reproduced in Figure 1 (below).

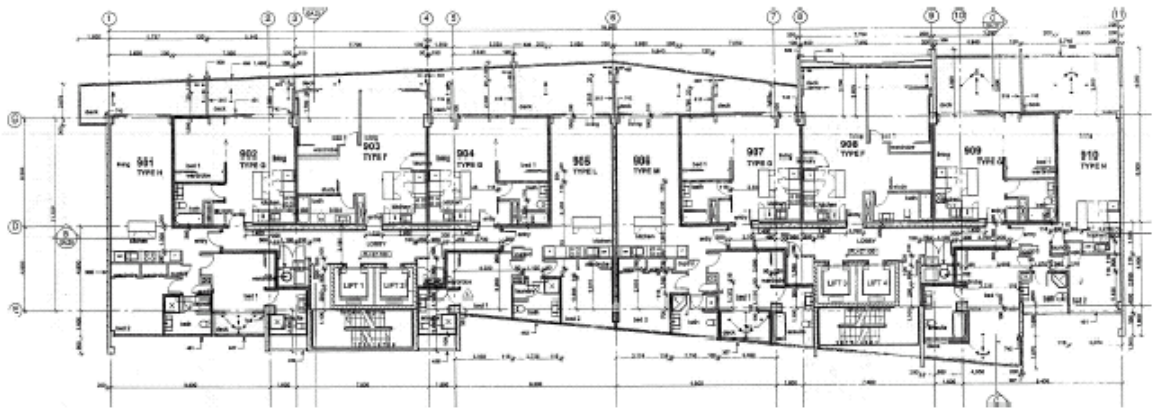

Fig. 1

2.1.4 In order to comply with the Acceptable Solution C/AS1, a sprinklered multi-unit residential dwelling (Purpose Group SR) having an escape height from fire of 43.6 m (16 floors) and containing the same apartments and rooms as the proposed building would be required to have the following significant fire safety features:

- an automatic fire sprinkler system with smoke detectors and manual call points (allowing local notification of smoke detector activation in apartments)
- two separate means of escape stairways separated by fire rated construction
- a fire cell rating of no less than F30
- fire separations of the safe path to be 30/30/30 (reduced from 60/60/60 due to provision of sprinklers)
- lifts within a protected shaft
- exit doors from apartments required to open directly onto a horizontal safe path, a pressurised vertical safe path, or a final exit

- a horizontal protected path at each floor level (other than the top floor) preceding the vertical safe path. The protected path and vertical safe path are to be separated by fire doors.

2.2 Fire safety features necessary to comply with the Acceptable Solution

2.2.1 The dispute to be determined is whether the territorial authority's decision to refuse a building consent for the third stage of the building because it was not satisfied that the single means of escape from fire complied with clauses C2 and C3 of the Building Code (First Schedule, Building Regulations 1992) is correct.

2.2.2 The relevant provisions of the Acceptable Solution C/AS1 amount to a means of compliance with the performance requirements of clauses C2 and C3 of the Building Code.

2.2.3 In comparing an alternative solution with the Acceptable Solution it is useful to bear in mind the objectives of those Building Code clauses, which are:

Clause C2—MEANS OF ESCAPE

OBJECTIVE

C2.1 The objective of this provision is to:

(a) Safeguard people from injury or illness from a fire while escaping to a safe place, and

(b) Facilitate fire rescue operations.

Clause C3—SPREAD OF FIRE

OBJECTIVE

C3.1 The objective of this provision is to:

(a) Safeguard people from injury or illness when evacuating a building during fire.

(b) Provide protection to fire service personnel during fire fighting operations.

(c) Protect adjacent household units, other residential units, and other property from the effects of fire.

(d) Safeguard the environment from adverse effects of fire.

2.2.4 The relevant performance statements deriving from these objectives are incorporated in clauses C2.3 and C3.3 of the Building Code. I note that the applicant is required to satisfy these latter performance requirements in order to comply with the Building Code.

2.3 Fire safety features proposed as an alternative solution

2.3.1 The proposed building therefore differs from one complying with C/AS1 in that:

(a) It has a single escape route instead of the two required for a sprinklered building with an escape height exceeding 25 m.

(b) The automatic water supply for the fire sprinkler system is enhanced by a secondary electric pump.

(c) There is pressurisation of safe paths, but these are limited to the stairway only.

(d) A staged evacuation scheme that involves a voice communication system (Type 8 of C/AS1) is provided.

2.3.2 The building includes various other fire safety features that are not discussed in this Determination. However, I am satisfied that such features are not relevant to the outcome of this Determination.

2.3.3 I assume that the building is intended to comply with C/AS1 in respect of fire safety features that are not mentioned in the designer's fire report.

2.4 Sequence of events

2.4.1 The apartments were to be constructed under a staged consent regime. The first stage included approval for the overall building configuration (the "blanket consent"), plus detailed provisions for the foundations and associated drainage. The second stage included the structure of the building. Consents for both of these building stages have been issued, and construction has already commenced. The third stage of the building comprises the architectural and services content. On 3 March 2004 the applicant applied to the territorial authority for the Stage 3 building consent describing the architectural and services feature of the building. The justification for fire safety provisions of the Stage 3 building consent was provided by the design engineer.

2.4.2 On 27 January 2005, following protracted discussions between the parties, the territorial authority advised the applicant in a letter that as the building had only a single stairway for fire egress, the territorial authority was not satisfied that this building complied with the Building Code.

2.4.3 The applicant engaged a firm of fire engineers to report independently on the fire safety of the building. The fire engineers prepared a "Fire Safety Strategy Report" dated 8 March 2004 and a further "Fire Safety Strategy Report, Volume 2" dated 3 August 2005. I have commissioned an expert to undertaken a peer review in relation to these reports.

2.4.4 The applicant applied for a Determination on 30 March 2005, although the Department received the supporting information after this date.

3 The submissions

3.1 In a covering letter to the Department dated 30 March 2005, the applicant described in general terms its negotiations with the territorial authority. The applicant expressed surprise at the territorial authority's response as the Fire Service had previously agreed to the single means of escape as designed. In addition, the applicant pointed out that the alternative solution had been designed by a fire

engineer and had been peer reviewed independently. The applicant noted that 10 months had elapsed from the submission of the stage 3 architectural and services consent application until the territorial authority had raised the issue of a single means of escape. The applicant considered that the territorial authority's only issue was the number of escape routes in relation to the escape height, as described in the Acceptable Solution C/AS1. The applicant said that it would not provide further information or analysis until the territorial authority's concerns were fully identified.

3.2 As part of their submission, the owner provided copies of:

- the building plans
- a document headed "History of Application"
- a "Fire Strategy Report" prepared by a specialist fire safety engineer, dated 8 March 2005
- correspondence from the Territorial Authority's consultant dated 17 October 2003, 11 November 2003, 10 February 2005, in relation to his peer review work that it had undertaken
- a letter to the owner from the territorial authority dated 27 November 2004.

3.3 In a letter to the Department dated 9 May 2005, the territorial authority set out its reasons for refusing to grant a consent, and advised that it had suspended the consent until either:

- the applicant supplied revised drawings and a fire safety report indicating that a second means of escape would be included, or
- a Determination was provided by the Department that confirmed that a single means of escape for the building would meet the requirements of clauses C2 and C3 of the Building Code.

3.4 The territorial authority also referred to a previous draft Determination issued by the Department that signalled the need for applicants to benchmark an alternative solution against the fire safety standards of the current Acceptable Solutions. The territorial authority was of the opinion that the applicant, in submitting its Stage 3 application, had not met this criterion.

3.5 Copies of the submissions and other evidence were provided to each of the parties. Neither the owner nor the territorial authority made any further submissions in response to the submissions of the other party.

4 The relevant provisions of the Building Code

4.1 There are no Acceptable Solutions that have been approved under section 22 of the Act or section 49 of the Building Act 1991 that cover single means of escape for

buildings of this configuration and size. I am, therefore of the opinion that the system proposed to be installed must now be considered to be an alternative solution.

4.2 Alternative solutions and Acceptable Solutions

4.2.1 The applicant contends that the design is an alternative solution complying with the Building Code but not with the Acceptable Solution C/AS1.

4.2.2 With regard to this contention, I note that the Authority said in Determination 2004/5:

> "5.2.2 As for the proposed alternative solutions, the Authority's task is to determine whether they comply with the performance-based Building Code. In doing so, the Authority may use the Acceptable Solution as a guideline or benchmark[1].
>
> 5.2.3 The Authority 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 Authority 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."

4.2.3 In the light of comments made separately, I then stated:

> "I accept that the Authority'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.
>
> (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."

"[1] *Auckland CC v NZ Fire Service* [1996] 1 NZLR 330."

4.2.4 Referring to the manner in which a comparative analysis is carried out, I note that in Determination 2004/65 the Authority has said:

> "6.1.1 The Authority takes the view that as a matter of law this Determination is binding only on the parties and only in respect of the building concerned.
>
> 6.1.2 Nevertheless, the Authority recognises that people considering other buildings will frequently use a Determination for guidance. The Authority therefore tends to set out its reasoning in more detail than may be strictly necessary for the particular case, in the hope that the reasoning, as distinct from the conclusions, will be of use as an example of the process of arriving at a decision in a different case involving comparable circumstances.
>
> "I take the same view in this case, but also note that this building and particularly its floor layout are not common. Any broader interpretation of the conclusions of this Determination must acknowledge that fact."

5 The experts' report

5.1 The Department commissioned an independent firm of fire engineers ("the experts") to prepare a report ("the experts' report"), which provides specific information on the single means of escape from fire in the building. The experts reported on 18 August 2005. The main features of the experts' report can be summarised under the following general headings:

- Introduction
- Description of the building
- Design philosophy
- Methodology
- Risk identification
- Risk analysis
- Risk evaluation
- Results
- Outcome

5.2 Introduction

5.2.1 The experts used documents provided by the Department, including the reports prepared on behalf of the applicant, to evaluate the application. These documents

included the two "Fire Safety Strategy Reports" prepared by a fire-engineering consultant. The experts did not consider that the documents provided sufficient evidence to show on reasonable grounds that the building was code compliant.

5.3 Description of the building

5.3.1 The experts described the building in relation to its fire safety aspects and noted the features that the designers had introduced for the deletion of one means of escape (stairway). In particular, this involved the addition of Type 8 (Voice Communication) and Type 13 (Safe Path Pressurisation) systems and the secondary electric pump installed to supplement the performance of the sprinkler system.

5.3.2 For the purposes of analysis, the experts modelled the building as two mirror image buildings using one as the subject building, referred to hereinafter as Building A. This building is then compared with an "idealised" building, referred to as Building C in the risk assessment. Building C is of the same height, plan area, and occupant load as Building A but as it has two stairways, it complies with C/AS1.

5.3.3 Because the "protect in place" evacuation strategies are not currently widely accepted, the benefits of the Type 8 (Voice Communication System) system is not quantified in this analysis.

5.3.4 Figures 3 and 4 (below) show the floor plans for Building A (the applicant's proposal) and Building C (the corresponding building deemed to comply with C/AS1).

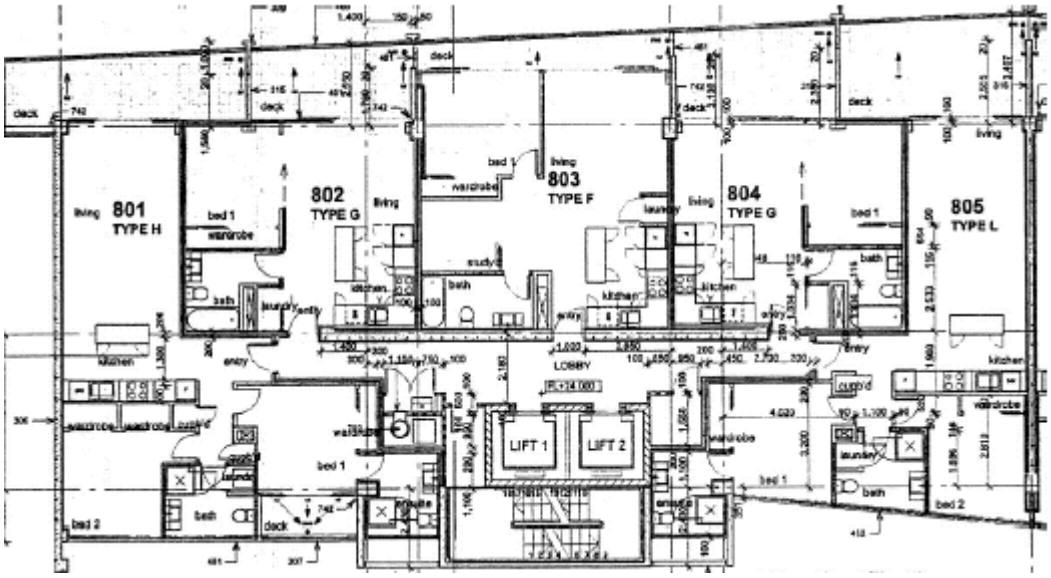

Fig. 3. Proposed building – Building A.

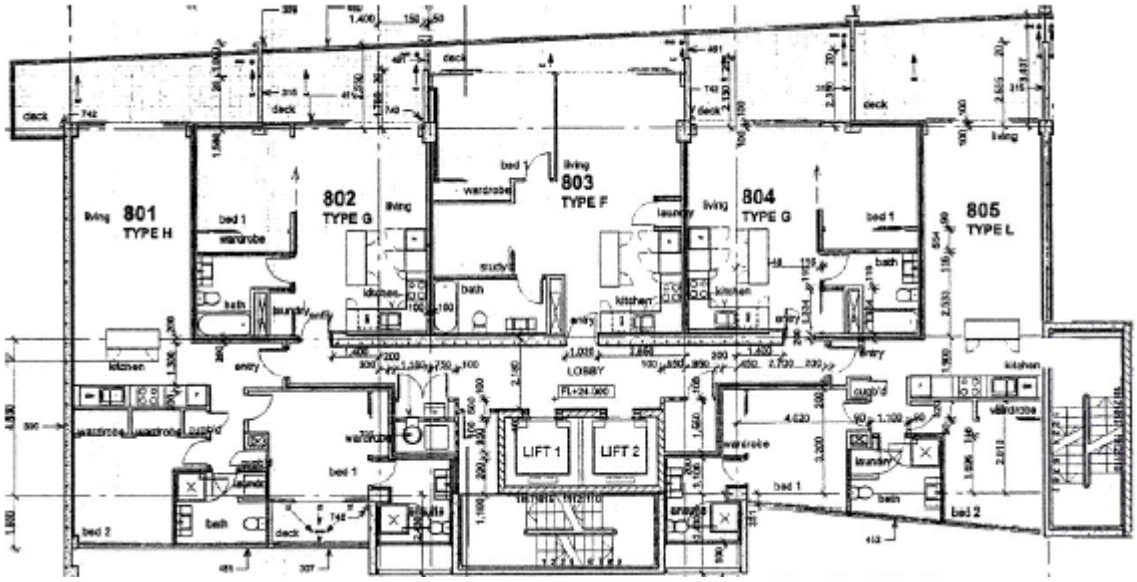

Fig. 4. Compliant building – Building C.

5.4 Design philosophy

5.4.1 In the experts view, it is a fundamental requirement that a quantitative analysis of the alternative solution is undertaken. The key issue is whether the single means of escape, incorporating the compensating features, which are the improvements to the sprinkler system and the stairway pressurisation system, are sufficient to offset the loss of the second stairway. In the experts view, the most suitable methods of analysis to establish the impact of these various elements are probabilistic-comparative or probabilistic-absolute. The experts then referred to Determination 2005/109, which established that a probabilistic-comparative approach is the more appropriate analysis method for cases such as this, without precluding the probabilistic-absolute approach. This Determination 2005/109 had considered the fire safety compliance of an 18-storey multi-unit apartment building with a smaller floor plate area in terms of how its features compare with the corresponding (C/AS1) Acceptable Solution building. Specifically at paragraph 6.2.4 of that Determination, I said:

"…I consider that the type of comparative risk analysis used in the assessment is an appropriate method for deciding whether an alternative solution is effectively equivalent to the corresponding Acceptable Solution in terms of fire safety. In particular, I accept the following comment from Expert D (a consultant engaged for that matter) as below:

In considering changes to the fire safety system in a building of the sort proposed, (deletion of a stairway, improvements to the sprinkler system, stairway pressurization, etc) it needs to be understood that each of these changes affects the level of fire safety in the building in different ways. Consequently the only way of comparing these changes is on a risk basis – how much (and in which direction) each of them changes the level of safety in the building."

5.4.2 In the current case the experts noted that the "Fire Safety Strategy Report", despite being based on an appropriate analysis method, was deemed to be insufficient in content to justify the applicant's design. According to the experts, this report did not provide sufficient grounds to determine code compliance. The report however was produced before Determination 2005/109 was issued.

5.5 Methodology

5.5.1 The experts stated that the assessment of the single means of escape for the apartments is a risk-based approach that involves the designer undertaking a risk assessment. Risk assessment is defined as the overall process of:

- risk identification
- risk analysis
- risk evaluation

5.5.2 This process and structure is consistent with that defined in AS/NZS 4360 "Risk Management". I describe these more fully in the following sections.

5.6 Risk identification

5.6.1 The experts defined risk identification as "the process of determining what, where, when, why, and how something could happen". The risk identification in the context of the report is primarily concerned with the impact on life safety, taking into account the escape stairway contribution within the applicant's Building A, as compared to the corresponding compliant Building C.

5.6.2 The experts repeated the exercise applied in Determination 2005/109, where it is assumed that if a fire developed elsewhere than in an apartment of fire origin and threatened the single stairway, then the occupants should at least have a "protect in place" option available to them. The results of this exercise showed:

> "A hazard arises where occupants enter a seemingly tenable stairway, only to meet asphyxiated or toxic conditions at a lower level. The occupants need to be able to re-enter the corridor at each level to be protected in place."

5.7 Risk analysis

5.7.1 Design philosophy

5.7.1.1 The experts followed the Determination 2005/109 risk analysis process and noted that for this current exercise:

> "The basic premise is that Building A lacks a second stairway in comparison with (the compliant) Building C. To compensate it has an enhanced sprinkler system and stairway pressurisation system. Given that most fatalities are in the apartment of fire origin, the small increase in [the] effectiveness of the sprinkler system gains (a) disproportionate (premium on) safety to offset the loss in safety once the fire and smoke spread beyond the apartment, The increase in the safety of the sprinklers alone,

may yet result in a safety deficit, so in addition a stairway pressurisation system is installed providing further safety to the point that Building A can be shown to be comparable to, or better than, Building C."

5.7.2 Event tree analysis

5.7.2.1 The experts developed an event tree for both Building A (termed "Event Tree "A" or "ET-A") and for Building C ("ET-C"). A sequence of events, including their probability distributions, resulted in a number of outcome scenarios. The events are summarised in 'Table 3' from the experts' report, as reproduced below:

Summary of Events

Event	Description of event (yes)
1	Ignition occurs (initiating frequency)
2	Fire origin is in an apartment
3	Fire growth is limited, ie; not a flaming fire that would cause detection in an operating detector and untenable conditions are not reached
4	The occupant is awake
5	There is manual suppression or the fire self extinguishes and untenable conditions are not reached
6	The automatic suppression system (sprinkler system) is effective and untenable conditions are not reached
7	There is automatic alarm is effective and warning is given
8	The first fire separation (barrier 1) between the apartment and corridor is effective
9	Given that the first fire separation (barrier 1) has failed, the second fire separation (barrier 2) is effective between the corridor and Stairway I
10	Given that the first fire separation (barrier 1) has failed, the second fire separation (barrier 2) fails or not, the third fire separation (barrier 3) is effective
11	The pressurisation system is effective

5.7.3 Probabilities

5.7.3.1 The event trees for each building are simplified, share the same layout, and are based on the same template. The experts noted that the probabilities varied between the tables, particularly as regards the comparable sprinkler systems, the number of stairways and the barriers. The "ET-A" and "ET-C" buildings are constructed to test the points of difference between the two buildings. These points of difference (or compensation) are:

- that the back-up pump to the sprinkler system in Building A enhances that system when compared with that of Building C

- the masonry apartment/corridor fire separations in Building A being more efficient compared to those in Building C, which are of lightweight construction

- the substitution of a pressurisation system in Building A to compensate for the lack of a second stairway within Building C.

5.7.3.2 The report gave an in-depth explanation of the probability data used in the analysis for events 4 and 6 to 11 within the "Events Summary" table. For each event the probability was identified in two components; viz reliability and efficacy. Reliability is defined as the probability that the system operates on demand and efficacy is defined as the degree to which a system achieves that objective given that it operates. The conclusions reached for each of these events are summarised in 'Table 6' from the experts' report, as reproduced below:

Events Summary

Event	Description	Probability
4	Occupant awake	The probability assumption is a Normal distribution with a mean of 0.79 and standard deviation of 0.08.
6	Sprinkler system effective	For Building A, the efficacy is .95 with a Uniform reliability function over the range 0.94 to 0.98 For Building C, the efficacy is .95 with a Uniform reliability function over the range 0.93 to 0.97
7	Automatic alarm	The efficacy is taken as 0.90 with the reliability as a normal distribution with a mean of 0.90 and a standard distribution of 0.05
8, 9, 10	Barrier effective	For Building A (Masonry construction) the efficacy is 1.00 with a Uniform reliability distribution over the range 0.55 to 0.75 For Building C (Lightweight partitions), the efficacy is 1.00 with a Uniform reliability distribution over the range .48 to .68.
11	Pressurisation effective	The efficacy is .90 with a uniform reliability distribution from .50 to 1.

5.7.4 Consequences available safe egress time (ASET) vs required safe egress time (RSET)

5.7.4.1 The following definitions apply:

Available Safe Egress Time

The available safe egress time is the time between the start of a fire and the time to untenable conditions, ie the time to when escape is no longer deemed possible.

The mathematical expression for ASET is:

$$ASET = S \times U_s$$

Where S is the time to untenable conditions, and U_s is an uncertainty factor.

Required Safe Egress Time

The required safe egress time is the time that is actually needed for the occupants to evacuate to a place of safety.

The mathematical expression for RSET is:

$$RSET = t_d + t_i + t_r + t_e$$

Where:

- t_d is the time to detection:
- t_i is the investigation time
- t_r is the occupant response time
- t_e is the occupant movement time

The required result for a safe building is that ASET is greater than RSET so that the available safe egress time is longer than the time for the occupants to escape before untenable conditions are experienced.

5.7.5 Calculation of risk

5.7.5.1 The calculation is made for the range of credible scenarios identified by the event tree. For each of these scenarios the risk calculation would have calculated a probability that the escape time margin is less than zero. In any risk analysis of this sort the risk is calculated by multiplying the cumulative probability of the specific scenario by its severity. The severity is the probability of a negative escape time margin (G) multiplied by the number of people exposed. The total risk is then the summation of all the partial risks.

5.7.5.2 Obviously the calculation of total risk is complex. For this analysis a computer programme (@RISK) was used. The analysis is probabilistic, using stochastic rates rather than discrete values, using a Monte-Carlo calculation engine to compute the values.

5.8 Risk evaluation

5.8.1 The experts report notes that the risk evaluation criterion is comparative-probabilistic. The risk profiles of the two buildings are directly compared, and Building A is deemed to succeed where "the risk profile is less than that that of Building C, with the inclusion of a safety margin". The "individual risk of fatality" is the risk measure used in the expert's analysis, and was the one used in Determination 2005/109.

5.8.2 This assessment assumes that injury is proportional to fatality, that is that if Building A has a lower risk of fatality than Building C, then the injury rate is also lower. The assessment also does not include events upstream of the fire event in an apartment. The unit of risk is not related to frequency and the measure of risk is not a complete profile. However, this approach is valid in terms of a comparative analysis.

5.9 Results

5.9.1 General

5.9.1.1 The results from the experts' analysis of the subject Building A in comparison to the C/AS1 compliant building (Building C) are given graphically in Figure 4 (below). The graphs are generated from the outputs from the @RISK computer programme. The risk profiles of the two buildings are overlaid on each other from the @RISK computer analysis to show the risk profiles of the buildings in relation to each other. This shows the risk profile for the proposed building (Building A) sitting to the left of the corresponding profile of the control building (Building C), and indicates that Building A has a lower risk in the event of fire. The second graph shows the risk margin, and is the net risk profile of Building C minus the net risk profile of Building A. The result shows that there is a risk margin of 79% in the base case, reducing to 55% in the most critical sensitivity case.

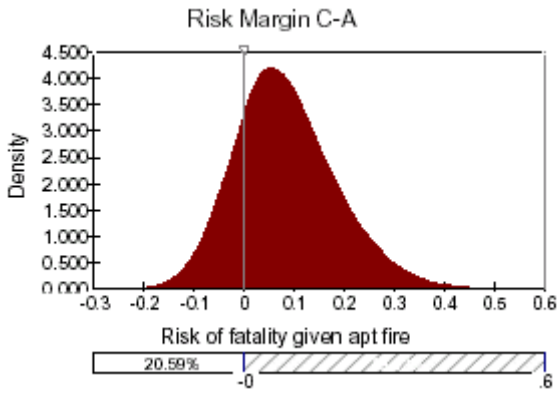

Fig. 4. Risk comparison of Building C and Building A.

5.9.2 Sensitivity

5.9.2.1 The experts noted that the results include safety margins and that two comparable or equivalent buildings will have a margin of 50%. The possibility that things will go randomly wrong in Building A compared with things going right in Building C is covered by the variability in the input parameters. While a margin of ≥50% is sought, I note the comments made in Determination 2005/109 in this context:

> "6.2.5 I recognise that there is as yet inadequate data for fire engineering to achieve the accuracy that is expected from, for example, structural engineering. In particular, the probabilities used for a fire analysis must be based on fire statistics derived from a comparatively small data pool of mainly overseas buildings of unknown design. That applies not only to fire scenarios but also to the proper functioning of critical systems including the sprinklers, the pressurisation system, the smoke detectors and fire alarms, the automatic drop windows, and the door closers. There appears to be no certainty as to the extent to which those statistics and probabilities are appropriate for use in the New Zealand context.
>
> 6.2.6 That does not mean that the method cannot be used in New Zealand, but it does mean, in my view, that the results of such analyses need to establish a high probability that an "alternative solution" building would be safer than the corresponding "Acceptable Solution" building in all relevant fire scenarios and across a realistic range of probabilities.
>
> 6.2.7 In this case, I do not consider that the 51 to 74% probability mentioned (in the Determination 2005/109 building analysis) is high enough."

5.9.2.2 The experts point out that in Determination 2005/109, a safety margin of 51% to 74% was not considered high enough. By comparison, the corresponding margin for Building A in the current analysis is 55% and 79%, ie somewhat better.

5.10 Outcome

5.10.1 The experts report concluded that, in his view, there are reasonable grounds to assume that the proposed alternative solution as represented by Building A, complies with the Building Code. Building A is equivalent to, or is better than, a comparable building that complies with the prescriptive solution. These conclusions were subject to the following conditions:

- the stairway pressurisation system is to be commissioned to the satisfaction of the territorial authority
- the fire engineer is to monitor construction and provide a "Producer Statement of Construction Review" to the satisfaction of the territorial authority
- doors are not to be locked from the stairway side in a manner that would prevent occupants from being able to enter any floor level from the stairway in fire alarm conditions.

5.11 Comments on experts report by the parties

5.11.1 Copies of the experts' report were provided to each of the parties. The territorial authority and the applicant accepted the report without comment.

5.11.2 The Fire Service, by letter dated 15 September 2005, made a number of comments on the experts methodology, recording in particular their view that:

"analysis of major departures from the Approved Documents must be assessed by quantitative risk assessment techniques", but that, as noted in paragraph 6.2.5 of Determination 2005/109, "the chief drawback associated with this technique at present is the lack of adequate data".

5.11.3 With regard to the process of establishing the probability that the alternative solution (Building A) is at least as safe as the Acceptable Solution (Building C); they said:

"given the uncertainty in the assumed data, this amounts to an attempt to establish the confidence or margin associated with an ascertain that the alternative design is at least as safe as a compliant design. Determination 2005/109 states that a probability range, ie the margin, of 51% to 74% is not high enough. The question remains as to what is high enough. The independent expert has assumed that a margin of 79% is enough to demonstrate compliance with the Building Code. The Fire Service cannot comment on whether this value is correct, as it would require an extensive study of the uncertainties in the assumptions. Such a general study is clearly required as a matter of urgency if alternative solutions of this type are to be approved."

5.11.4 With respect to the "arson scenario", they state:

"Single means of escape buildings are more vulnerable than buildings with two stairways to an arson attack, or other fire, in the stairway… Rather than being a "one-off hazard check", as undertaken by the independent expert, the fire within stairway scenario should have been integrated into the risk analysis, modifying the calculated "margin"."

5.11.5 With regard to "active fire systems", they recommended that:

"…the compliance schedule for the building includes an appropriate testing and inspection regime complying with relevant standards for all active systems to ensure ongoing compliance…" and noted that they supported the approach I had taken in Determination 2005/109."

6 Discussion

6.1 General

6.1.1 I have considered the submissions of the parties, the experts' report and the other evidence presented in this matter. The approach in determining whether building work complies with clauses C2 and C3 is to examine the design of the building and the design features that are intended to prevent the loss of life. 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.

6.2 Is the building code compliant?

6.2.1 I have considered the comparative analysis undertaken by the experts, alongside the other information provided to me about the building, and note the following.

(a) The Department's expert has indicated a comparative probability of 55% to 79% against a target "break even" situation of 50%.

(b) A general review of the buildings design indicates that, taken overall, critical elements (such as the stairway pressurisation system) appear to be well designed and robust.

6.2.2 There are a number of issues to be evaluated in determining whether the building is code compliant or not in this case. Firstly there is the question of the comparative probabilistic risk assessment and the results of it. More specifically what does the margin mean and how does it relate to other compliance measure? Secondly there is a consideration of the on-going compliance of this building with the Building Code.

6.2.3 Whilst this current result is, on the face of it, superior to that reported earlier for the building described in Determination 2005/109, that of itself is not sufficient to provide me with reasonable grounds on which to decide compliance. It is clear that, taken overall, the safety of occupants within a building of this type hangs on whether the most critical compensation component, namely the pressurisation system, is well designed and robust. This is clearly a first order effect, to be evaluated before efficacy and reliability tests are applied.

6.2.4 With regard to the probabilistic risk assessment, my expert has recommended that I accept 75% as the threshold for the margin. To put it another way, this means that there should be a 25% increase in probability that the alternative building will be better than the compliant building. This extra buffer is required in part because the actual probability distribution may not be pure random variable as assumed, in experts' analysis. As noted in the Fire Service comments, more analysis is required before a numerical value can be described to an appropriate margin. Even once one has been developed, this will not take away the need for other factors such as the quality of the overall fire design to be factored into the acceptance criteria.

6.2.5 On balance on this case, I believe that the buildings design is sufficient in this regard, and that the same inspection and testing regime should be applied as in Determination 2005/109.

6.2.6 Accordingly, I find that I do have reasonable grounds on which to decide that the subject building, whilst adopting a different fire safety concept than that used by the corresponding Acceptable Solution C/AS1, does achieve an equivalent standard of code compliance.

6.3 "Protect in place" strategy

6.3.1 This building has been designed to include a "protect in place" strategy. This means that occupants in apartments above a fire will be held in their apartments while the fire service fights the fire. The safe egress evaluation conducted by the expert was based on a total (one-out all-out) evacuation and concluded that the design was sufficient before "protect in place" concepts needed to be incorporated.

6.3.2 I am aware that there are arguments for and against the appropriateness of "one-out all-out" and "protect in place" egress strategies for apartments. The relative merits of the two strategies also change when considering either single or multiple egress buildings or specialised situations such as hospitals or prisons. There is a view that until such time as research, technology and building practices prove otherwise that the occupants should be evacuated from a single means of escape building in the most expedient and timely manner, i.e. "one-out all-out". The counter view is that a "protect in place" strategy gives the Fire Service the ability to evacuate people as and if required thereby minimising the possibility of evacuated or evacuating occupants disrupting fire fighting. It also minimises disruption to those not effected by a fire or even a false alarm.

6.3.3 The expert has also commented that the doors are not be locked from the stairway side in manner that would prevent occupants from being able to enter any floor level from the stairway in fire alarm conditions. This, in effect, enables a "safe refuge" concept as an enhancement feature to be added to the basic fire safety design already evaluated, thereby contributing to the overall robustness of the design.

6.3.4 However, I note in particular the experts' comments in this regard with regard to the risk evaluation for the subject building:

"The impact of the Type 8 voice communication system is not quantified in this analysis, as "protect in place" evacuation strategies are not currently widely accepted, and certainly not in single escape route buildings."

6.4 Is a modification of the Building Code required?

6.4.1 Life safety issue

6.4.1.1 As noted in 2.2 previously, this building has been legally constructed up to this stage. In that regard, the situation is not dissimilar to that which I addressed in Determination 2005/109, where I said:

"Cancelling this consent, or substantially modifying the design within, will have very significant commercial consequences for the Owner. Of course such consequences carry much less weight than consideration of life safety."

6.4.1.2 In such a situation, I could vary the terms of the original building consent by issuing a modification to clause C2 of the Building Code, and would have considered that had I believed that there was no life safety issue. In this particular case, for reasons set out above, I find that I do not need to do so.

6.4.2 "Protect in place" strategy

6.4.2.1 As discussed above the "protect in place" concept is not one I believe was contemplated by the Acceptable Solution C/AS1, or I would suggest, by provisions C2 and C3 of the Building Code itself.

6.4.2.2 In my view, the objective of the "means of escape" provision within clause C2 of the Building Code is clearly to "safeguard people from injury or illness from a fire whilst escaping to a safe place". Clause A2 of the Building Code defines a "safe place" as a place of safety in the vicinity of a building from which people may safely disperse after escaping from the effects of fire. It may be a place such as a street, open space, public space, or an adjacent building.

6.4.2.3 Consequently, if a "protect in place" concept was to be relied on in this building as a primary means of ensuring safety of building occupants then a modification of clause C2 would be required, solely on the grounds that the safeguards put in place to protect people from the effect of fire were not aimed at achieving exit to a safe place.

6.4.3 Summary

6.4.3.1 Therefore, two options are available to the owner. One is to change the evacuation strategy to a "one-out all-out" system which the analysis has shown to be acceptable. Alternatively, if the owner wishes to maintain a "protect in place" strategy (and there may well be benefits in doing so), then it would be necessary for the territorial authority to modify clause C2.1(a) of the Building Code accordingly.

7 Ongoing Compliance

7.1 As noted in 6.2.3, the pressurisation system is critical to the overall effectiveness of the fire safety systems in the building. Accordingly it is important that the system be maintained and monitored to a high standard. For this to occur, the compliance schedule needs to include a specific requirement for on-going testing of the system. Determination 2005/109 provides a useful template for an appropriate schedule. I do not expect that the inspections, maintenance standard, person responsible and additional requirements will be to a lower standard than applied in that case.

7.2 As noted in 6.3.3, the expert also recommended a condition be included that the doors are not be locked from the stairway side in manner that would prevent occupants from being able to enter any floor level from the stairway in fire alarm conditions. This is an important feature that needs to be carried through in the detail design of the building systems, consequential commissioning and inclusion in the compliance schedule to ensure testing in the building warrant of fitness checks.

8 Conclusion

8.1 I consider that the buildings design, as supported by the analysis included in the experts' report, establishes to my satisfaction that the alternative solution for the apartments with a single means of escape from fire complies with clauses C2 and C3 of the Building Code.

8.2 It is emphasised that each Determination is conducted on a case-by-case basis. Accordingly, the fact that a particular design or system has been established as being code compliant in relation to a particular building does not necessarily mean that the same system will be code compliant in another situation.

8.3 I decline to incorporate any waiver or modification of the Building Code in this Determination unless the owner advises the territorial authority that they wish to pursue a "protect in place" strategy.

9 The decision

9.1 In accordance with section 188 of the Act;

(a) I determine that the building complies with clause C2 of the Building Code subject to the following conditions:

(i) The stairway pressurisation system is to be commissioned to the satisfaction of the territorial authority.

(ii) The fire engineer is to monitor construction and provide a "Producer Statement of Construction Review" to the satisfaction of the territorial authority.

(iii) The evacuation strategy is a "total evacuation" system.

(iv) Doors are not to be locked from the stairway side in a manner that would prevent occupants from being able to enter any floor level from the stairway in fire alarm conditions.

(v) The compliance schedule for the building shall define escape route compliance schedules performance and monitoring standards.

(b) I instruct the territorial authority to issue a building consent for the third stage of the apartments.

(c) I require the territorial authority to provide me with a report within two months of issuing the compliance schedule giving confirmation that these conditions have been met.

(d) Should condition 9.1(a)(iii) not be met, instruct the territorial authority to issue a modification on clause C2 of the Building Code.

Signed for and on behalf of the Chief Executive of the Department of Building and Housing on 22 September 2005.

John Gardiner
Determinations Manager