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Technical Audit of New Zealand Fire Service Design Review Unit

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Technical Audit of New Zealand Fire Service Design Review Unit

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2. EXECUTIVE SUMMARY

2.1 Introduction

This report describes a technical audit of the work performed by the Fire Engineering Unit (Design Review Unit – DRU) of the New Zealand Fire Service (NZFS).

Section 47 of the Building Act 2004 allows the New Zealand Fire Service Commission to provide advice in a memorandum to the Building Consent Authority with respect to provision of means of escape for fire and in respect of the needs of persons authorised by law to enter the building to undertake firefighting. To perform this role, the NZFS has established a unit called the Design Review Unit (DRU) that began conducting reviews of fire engineering designs in late April 2005.

The audit has involved a review of 25 fire engineering reports and associated building consent documentation submitted to the DRU by various Building Consent Authorities in New Zealand along with the associated DRU memorandum prepared in response.

2.2 Methodology

A list of 1209 projects was supplied by the DRU, from which 25 projects were selected for review. This sample represented approximately 2% of the projects sent by BCA's to the DRU over the period of interest. New Zealand Fire Service staff had no input into the project selection process other than supplying the list of projects from which the audit sample was then selected.

The project selection process involved determining the proportion of total projects reviewed by each DRU Engineer, and the proportion of total projects undertaken by each Fire Engineering Company, such that these proportions were reflected in the sample selected for audit. The 25 projects selected for the audit included projects reviewed by 8 different DRU engineers and reports prepared by 20 different Fire Engineering Companies. The audit sample included building work for 10 new building projects, 12 alterations and 3 change of use projects. Building types included apartment, healthcare, retail, office, warehouse, childcare and education.

Similar criteria to those used in previous technical audits to assess the quality and accuracy of both the fire engineering reports and the DRU memorandum were applied. In each case, a five point qualitative scale ranging from 'poor' to 'very good' was used. Additionally, a measure of the extent to which the fire designs deviated from the compliance document C/AS1 was made.

An assessment based on categories from the confidential reporting mechanism proposed by the Institute of Professional Engineers of New Zealand was also carried out.

2.3 DRU Memorandum

The DRU memorandum for each project was assessed according to the criteria shown in the following table. The table summarises the results of the assessment with respect to the quality and accuracy of the DRU memorandum. Overall, the DRU memorandums were generally of a consistent style and good standard. This is not surprising since the DRU operates as a team and the memorandums follow a set format. The memorandums also demonstrated that the DRU engineers appear to have a comprehensive and detailed knowledge of the C/AS1 compliance document. However, in at least one case of an alternative solution, conclusions drawn in the memorandum appeared unsubstantiated.

	Percentage of reports				
Design Review Unit Memos	Poor	Incomplete	Acceptable	Good	Very Good
Legal Background specified	4%	0%	4%	92%	0%
Well presented format	0%	0%	4%	88%	8%
Technically accurate	0%	4%	25%	50%	21%
Information actionable	0%	0%	4%	83%	13%

2.4 Fire Engineering Reports

The majority of fire reports submitted to the DRU are not fire engineering reports documenting a performance-based design. Rather they are mostly fire safety reports documenting compliance of the design with C/AS1.

Two-thirds of all the audited reports were categorised as design to C/AS1 with minor, trivial or no deviations, while one-third of the audited reports were classified as being major deviations. There were no designs that could be regarded as total performance based designs and that did not make reference to the compliance document C/AS1. The following table summarises the results of the assessment with respect to the quality and methodology of fire engineering designs and report.

	Percentage of reports				
Engineering Reports	Poor	Incomplete	Acceptable	Good	Very Good
Uses IFEG as good industry practice	**88%**	**12%**	**0%**	**0%**	**0%**
Design parameter					
* *Specified*	**28%**	**39%**	**22%**	**11%**	**0%**
* *Comprehensive*	**28%**	**55%**	**11%**	**6%**	**0%**
Technical Methodologies					
* *Appropriate*	**8%**	**38%**	**46%**	**8%**	**0%**
* *Technically correct*	**8%**	**50%**	**38%**	**4%**	**0%**
Conclusions					
* *Clarity*	**0%**	**29%**	**38%**	**33%**	**0%**
* *Technically correct*	**8%**	**46%**	**38%**	**8%**	**0%**

2.5 Conclusions

- The DRU Engineers appear to have a thorough understanding of the application of the fire safety compliance document, and frequently identified areas of non-compliance in reports that had not been identified by the designers as such.
- The memorandums of advice prepared by the DRU are generally of a consistent style and good standard.
- When assessing alternative solutions the DRU generally did a competent job of critiquing the basis and implementation of the alternative solution design. However, in at least one case conclusions were drawn that were unsubstantiated.
- The ability of the DRU to provide constructive advice to the BCA (and applicant) is directly dependent on the quality of the fire engineering report and documentation supplied to them.
- The International Fire Engineering Guidelines have not gained significant uptake amongst the New Zealand fire engineering fraternity. Only one of the reports reviewed in this audit included a Fire Engineering Brief.
- In approximately 40% of cases, the investigation conducted in support of a fire 'alternative solution' design was not considered to be satisfactory or the analysis was not sufficiently rigorous.

2.6 Recommendations

- Introduce a feedback loop or communication mechanism following the issue of the DRU memorandum. Perhaps an access-controlled web-based project register for alternative solutions could be developed to record the communication and decisions regarding projects.
- Remove the need for 'alterations' or 'change of use' building work to be sent to the DRU (as per the NZ Gazette Notice) where that work results in a building that fully complies with C/AS1.
- Where designs are predominantly based on compliance with C/AS1, designers should structure the fire engineering report such that variations to the compliance document are presented and justified in a separate section of the report.
- Simplify the compliance document C/AS1 so it can be clearly interpreted without reference to specific design.
- Investigate whether DRU engineers could more actively participate in the fire engineering brief process in order to encourage practitioners to make better use of the processes described in the International Fire Engineering Guidelines. This would promote and reward better, more rigorous performance based fire safety design and as well as improve the likelihood of trouble-free processing of the building consent.

3. INTRODUCTION

3.1 Scope

This report describes a technical audit of the work performed by the Fire Engineering Unit (Design Review Unit – DRU) of the New Zealand Fire Service (NZFS).

The audit has involved a review of 25 fire engineering reports submitted to the DRU by various Building Consent Authorities (BCA's) along with the associated DRU memorandum prepared in response. The sample represents approximately 2% of the total number of eligible reports that were to be covered by the audit.

This audit does not constitute a peer review of the projects or reports concerned. Due to a limited period of time set aside for each project review, at best the audit determined the basis for the design, a brief review of the report and spot checks on calculations and methods of compliance. The audit did not necessarily identify all relevant issues or matters relating to any specific project. Neither the fire designer nor the DRU engineer was consulted with regard to any of the audit projects.

3.2 Background

The Building Act 2004 [1] is the overarching legislation relating to building work in New Zealand (Figure 1). The New Zealand Building Code contained within Schedule 1 of the Building Regulations 1992 sets out the performance requirements that all new building work must meet including fire safety.

A building owner is required to apply for a building consent if s/he intends to undertake any building work. The requirements to be met vary with the type of work to be undertaken. For an alteration, section 112 of the Building Act requires the owner to only consider the means of escape from the complete building. However, a change of use or an extension of design life of a building (section 115) requires the owner to consider means of escape, protection of neighbours property, structural stability in fire and fire fighting features. A new building must comply with all clauses of the Building Act.

Section 46 of the Building Act requires the Chief Executive of the Department of Building and Housing to specify the type of buildings that will be forwarded to the New Zealand Fire Service Commission by a Building Consent Authority (BCA). The building types were notified in the New Zealand Gazette. A copy of the gazette notice is provided in Appendix C. In general, it refers to buildings described in section 21A of the New Zealand Fire Service Act 1975 [2] (see Appendix D) that have not been designed to the applicable compliance document if new, or for alterations or change of use if the work has more than a minor effect on fire safety systems.

Section 47 of the Building Act allows the New Zealand Fire Service Commission to provide advice in a memorandum to the BCA with respect to provision of means of escape for fire and in respect of the needs of persons authorised by law to enter the building to undertake firefighting. The advice offered in the memorandum cannot exceed the performance requirements of the Building Code.

Copies of Section 46 and 47 of the Building Act 2004 are reproduced in Appendix A.

Copies of Section 112 and 115 of the Building Act 2004 are reproduced in Appendix B.

To perform this role, the NZFS has established a unit called the Design Review Unit (DRU). This unit began conducting reviews of fire engineering designs in late April 2005. Because the NZFS reviews performance based designs, the unit is staffed with qualified fire engineers. Their advice relating to the fire engineering design of designated buildings and contained in the written memorandum covers the following matters:

- Provision for means of escape
- The needs of the fire service to enable it to undertake fire fighting

Section 48 of the Building Act requires the BCA to have regard to the NZFS Commission advice when deciding to issue or decline a building consent.

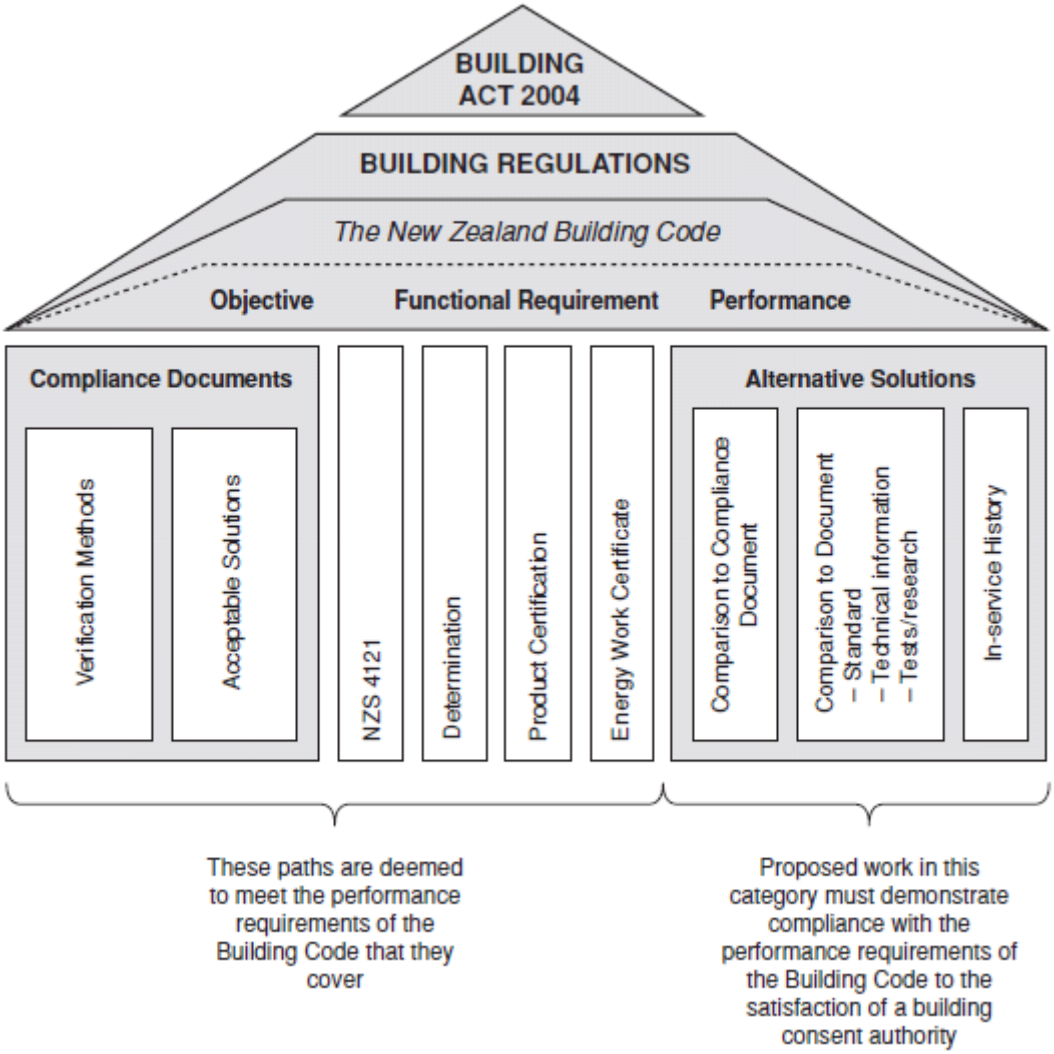

Figure 1. New Zealand Building Control Framework (extracted from ref [6])

4. METHODOLOGY

4.1 Projects Selected for Audit

A list of 1209 projects was supplied by the DRU, from which 25 projects were selected for review. This sample represented approximately 2% of the projects sent by BCA's to the DRU over the period of interest. New Zealand Fire Service staff had no input into the project selection process other than to supply the full list of 1209 projects from which the audit sample was to be selected.

The project selection process involved determining the proportion of total projects reviewed by each DRU Engineer, and the proportion of total projects undertaken by each Fire Engineering Company, such that these proportions would be reflected in the sample of projects selected.

Projects where either the name of the DRU engineer or the name of the Fire Engineering Company was not recorded on the list of projects supplied by the DRU were excluded from further consideration.

Due to the 25 project limit, DRU engineers who had reviewed only a few projects (<8) and Fire Engineering Companies that had only a few projects (<13) sent to the DRU were not included in the sample selected for auditing. This resulted in eight DRU engineers being included in the audit sample, with each of those engineers having reviewed at least 16 projects from the total available. This also meant the sample was not unduly influenced by DRU engineers who only conducted a few reviews from time to time, for whatever reason. The number of projects in the sample reviewed by any one DRU engineer was also in proportion to the number of total projects that they had reviewed. In addition, no more than one project authored and reviewed by the same combination of fire engineering company and DRU engineer was allowed in the audit sample.

Table 1 shows the number of projects reviewed by each DRU engineer and the number of allocated projects included in the audit sample for each engineer.

The original list of projects was then sorted by Fire Engineering Company and ranked by the number of projects sent to the DRU. Some company names were edited to ensure any spelling variations of the company name did not result in multiple references to the same company. The proportion of projects by each company of the total number of projects was used to determine the number of projects by that company to be included in the audit sample. This resulted in four projects from Company 1, two projects from each of Company 2 and 3 and just one project each for the next 17 highest ranked companies.

This resulted in Fire Engineering Companies who had less than about 13 projects sent to the DRU not being included in the sample selected for auditing. A total of twenty Fire Engineering Companies were included in the audit sample, with each of those companies having being the author of at least 13 reports from the total available. This also meant the sample was not influenced by Fire Engineering Companies (or any company preparing fire safety design reports) who only had a few reports sent to the DRU. The number of projects in the sample prepared by any one Fire Engineering Company was also approximately in proportion to the number of total reports sent to the DRU they had authored. The Fire Engineering Companies included in the audit therefore can be assumed to be companies who were regularly carrying out fire safety designs and who were generally active in the fire safety engineering industry in New Zealand. Those same twenty companies were also

responsible for almost 70% of the total fire safety reports sent to the DRU.

Table 2 shows the number of projects submitted by company and the number of projects determined to be included in the audit sample for each company.

Table 1: Projects selected for audit listed by DRU Engineer

DRU Engineer	No. Projects Reviewed	% of Total	No. Projects to Sample
DRU Engineer A	234	19.4%	5
DRU Engineer B	220	18.2%	5
DRU Engineer C	202	16.7%	4
DRU Engineer D	142	11.8%	3
DRU Engineer E	141	11.7%	3
DRU Engineer F	90	7.4%	2
DRU Engineer G	78	6.5%	2
DRU Engineer H	16	1.3%	1
DRU Engineer I	7	0.6%	0
DRU Engineer J	7	0.6%	0
DRU Engineer K	4	0.3%	0
DRU Engineer L	4	0.3%	0
DRU Engineer M	4	0.3%	0
DRU Engineer N	3	0.3%	0
DRU Engineer O	1	0.1%	0
Name not given or no memo	56	4.6%	0
	1209	**100%**	**25**

Table 2: Projects selected for audit listed by Fire Engineering Company

Fire Design Company	No. Projects Submitted	% of Total	No. Projects to Sample
Company 1	206	17.4%	4
Company 2	86	7.1%	2
Company 3	59	4.9%	2
Company 4	48	4.0%	1
Company 5	47	3.9%	1
Company 6	43	3.6%	1
Company 7	40	3.3%	1
Company 8	38	3.1%	1
Company 9	35	2.9%	1
Company 10	32	2.7%	1
Company 11	25	2.1%	1
Company 12	24	2.0%	1
Company 13	24	2.0%	1
Company 14	21	1.7%	1
Company 15	19	1.6%	1
Company 16	18	1.5%	1
Company 17	15	1.2%	1
Company 18	14	1.2%	1
Company 19	14	1.2%	1
Company 20	13	1.1%	1
Other Companies < 14 projects each	362	29.3%	0
Name not given	26	2.2%	0
	1209	**100%**	**25**

Given the above constraints, the original list of 1209 projects was reduced to a shortlist of 770 projects being only those projects where the fire engineering company was one of Company 1 - 20 and the reviewer was one of DRU engineer A – H.

A procedure for selecting the audit projects was then developed which involved:

- randomly selecting a project from the shortlist
- before accepting the project, checking that the maximum number of sampled projects desired for a particular DRU engineer or fire engineering company was not exceeded and also checking that the combination of DRU engineer and company had not already been matched.
- If the engineer or company quota was exceeded then that project was discarded and another was randomly selected from the shortlist.
- This was repeated until 25 projects were chosen.

The 25 projects selected for audit therefore included projects reviewed by 8 different DRU engineers with reports prepared by 20 different Fire Engineering Companies as shown in Table 3.

The name of the individual fire engineer/designer (within the fire engineering company), the building occupancy, and the type of building work did not feature in the project selection process.

The audit sample included 10 new building projects, 12 alterations and 3 change of use.

Project 25 was subsequently dropped from the analysis due to inadequate documentation (no fire report) having been provided to allow an assessment. The associated DRU memorandum referred the BCA to another previous memorandum from a different project file (not supplied) relating to the building. Therefore only 24 projects were included in the statistics given in this report.

Table 3 Projects Selected for Audit

Project	Fire Engineering Company	DRU Engineer	Project Type
1	18	A	Alteration, education
2	7	A	New, offices
3	17	A	New, education
4	2	A	Alteration, retail
5	13	A	Alteration, offices
6	3	B	Change of use, retail/offices
7	19	B	New, apartments
8	14	B	Alteration, offices
9	1	B	Alteration, office
10	15	B	New, retail/offices
11	5	C	New, apartments/retail
12	9	C	Alteration, apartments/hotel
13	10	C	New, childcare
14	1	C	New, apartments
15	3	D	Alteration, restaurant
16	1	D	Change of use, residential
17	2	D	Alteration, retail
18	6	E	New, warehouse
19	11	E	Alteration, childcare
20	4	E	New, education
21	20	F	Alteration, assembly
22	12	F	New, healthcare
23	16	G	Change of use, warehouse
24	8	G	Alteration, education
25	1	H	Alteration, retail

4.2 Assessment Method and Criteria

Criteria similar to those used in previous technical audits to assess both the fire engineering reports and the DRU memorandum were also included in this audit. In each case, a scale of five rating categories ranging from 'poor' to 'very good' were used (as shown later in Tables 5 and 7).

For the DRU memorandums, the relevant criteria were:

- Legal background specified?
- Well presented format?
- Technically accurate?
- Information actionable?

For the fire engineering reports the relevant criteria were:

- Uses IFEG as good industry practice model?
- Design parameter – specified?
- Design parameter – comprehensive?
- Technical methodologies – appropriate?
- Technical methodologies – technically correct?
- Conclusions – clarity?
- Conclusions – technically correct?

The International Fire Engineering Guidelines (IFEG) [4] promote a consultative approach to design with close liaison with stakeholders. The development of an initial Fire Engineering Brief (FEB) is called for. The brief is a preliminary qualitative design report intended to identify all the key issues and facilitate effective communication and negotiation related to design and approval issues amongst the stakeholders.

Since it is apparent that the compliance document C/AS1 [3] is highly influential as the initial basis for fire designs in New Zealand including alternative solutions, additional criteria to assess the extent to which proposed alternative solutions varied or deviated from the compliance document was thought to be a useful additional measure to include.

In addition, the client also wished an assessment to be made in relation to the confidential reporting mechanism proposed by the Institute of Professional Engineers of New Zealand (IPENZ) [5]. For this purpose, the following 11 areas of concern were included: investigation not thorough enough; analysis or design not sufficiently rigorous; inappropriate use of software; ambiguous or unusual computer results; use of unproven materials or techniques; conflict with regulations or codes of practice; inadequate checking, reviewing or quality assurance (QA); taking disproportionate risks; designs not sufficiently robust; insufficient detail in drawings; and compliance document applied incorrectly.

5. ANALYSIS & DISCUSSION

5.1 Fire Engineering Reports

The majority of fire reports submitted to the DRU are not fire engineering reports documenting a performance-based design. Rather they are mostly fire safety reports documenting compliance of the design with C/AS1. Where the design varied from the compliance document, discussion and analysis may have been included in the report to justify the variation or deviation.

In order to illustrate this point, the fire design basis for each of the reports was noted and summarised as shown in Table 4. The lack of total performance based fire designs is not surprising given that is not possible to calculate performance for all fire safety measures provided in buildings and inevitably the prescriptive compliance document becomes the default starting point in developing a code compliant solution. Notwithstanding this, any noncompliance with C/AS1 constitutes an 'Alternative Solution'.

Two-thirds of all the audited reports were categorised as design to C/AS1 with minor, trivial or no deviations, while one-third of the audited reports were classified as being major deviations. There were no designs that could be regarded as total performance based designs that did not make reference to the compliance document C/AS1.

Table 4 Fire Design Basis for Audited Reports

Fire Design Basis	%
C/AS1 with trivial or no deviations	8
C/AS1 with minor deviations	59
C/AS1 with major deviations	33
Total performance based design	0

What constitutes minor versus major deviation from the compliance document?

The division between what was considered a minor and major deviation was a subjective assessment by the author, and depended both on the number of deviations as well as the nature and extent of the change.

Some examples of minor deviations were:

- Changes to dry riser coverage
- Building separation distance calculations
- Changes to surface finish fire properties
- Changes in carpark ventilation

Some examples of major deviations were:

- Substituting fire doors with non-closing solid core doors and sprinklers in a retirement facility
- Changes to egress capacity supported by smoke control calculations
- Horizontal safe paths interconnected at different levels via an atrium void

In some cases where multiple 'minor deviations' existed in the one project, the category was changed to be a 'major deviation'.

The nature of the reports made it difficult to fairly assess some of the criteria in Table 5. For example 'Uses IFEG as good industry practice model' is not particularly relevant in the case of reports based on C/AS1 with no, trivial or very minor deviations. In those cases it seems unnecessary for the fire engineer to be expected to prepare a fire engineering brief that does no more than note that the design will be in compliance with C/AS1. In these cases, assessing each fire report against use of the IFEG [4] would result in a 'poor' rating for those reports that were essentially documenting compliance with C/AS1, by virtue of no reference having been made to the IFEG.

Notwithstanding that, of the eight projects where major deviations from C/AS1 existed and where the IFEG might have been expected to be usefully applied none of the designs appeared to make use of the IFEG to an acceptable standard. In all 24 projects reviewed there was only one fire engineering brief prepared and that was for a C/AS1 design with minor deviation. Based on this audit sample, clearly use of the IFEG has not gained any significant uptake amongst the fire engineering fraternity.

The factors given in Table 5 were generally assessed with the 'alternative solution' part of the engineering report in mind rather than for the entire design and report (most of which dealt with showing compliance with the various parts of the compliance document C/AS1). However in practice it was often difficult to clearly differentiate between the two.

Table 5 Assessment of Fire Engineering Reports – Summary Results

	Percentage of reports				
Engineering Reports	Poor	Incomplete	Acceptable	Good	Very Good
Uses IFEG as good industry practice model [1]	7/8 **88%**	1/8 **12%**	0/8 **0%**	0/8 **0%**	0/8 **0%**
Design parameter [2]					
* *Specified*	5/18 **28%**	7/18 **39%**	4/18 **22%**	2/18 **11%**	0/18 **0%**
* *Comprehensive*	5/18 **28%**	10/18 **55%**	2/18 **11%**	1/18 **6%**	0/18 **0%**
Technical Methodologies [3]					
* *Appropriate*	2/24 **8%**	9/24 **38%**	11/24 **46%**	2/24 **8%**	0/24 **0%**
* *Technically correct*	2/24 **8%**	12/24 **50%**	9/24 **38%**	1/24 **4%**	0/24 **0%**
Conclusions [4]					
* *Clarity*	0/24 **0%**	7/24 **29%**	9/24 **38%**	8/24 **33%**	0/24 **0%**
* *Technically correct*	2/24 **8%**	11/24 **46%**	9/24 **38%**	2/24 **8%**	0/24 **0%**
	Each line adds up to 100%				

CRoMiE Confidential Reporting on Matters in Engineering

The Institute of Professional Engineers of New Zealand (IPENZ) have developed a mechanism for Confidential Reporting on Matters in Engineering (CroMiE) [5]. It was developed in order to provide a totally independent, confidential (not anonymous) reporting system for all individuals employed in or associated with the provision of engineering work. The intention was to highlight any problems or threats to safety that occur in the provision of engineering activities, regardless of engineering discipline. “Engineering matters” refers to the work done during a project that requires the input and authorisation of an engineer. It relates to the application of best practice in the procurement, design, manufacturing or construction, operation, maintenance and decommissioning of an item produced by an engineering activity.

[1] Based on reports deemed to be ‘C/AS1 with major deviations’ or ‘total performance based design’

[2] Based on all reports except those deemed to be ‘C/AS1 with trivial or no deviations’

[3] Based on all reports

[4] Based on all reports

In relation to the fire design process, areas of concern may include the following:

- investigations not thorough enough
- analysis or design not sufficiently rigorous
- inappropriate use of software
- ambiguous or unusual computer results
- use of unproven materials or techniques
- conflict with regulations or codes of practice
- inadequate checking, reviewing or quality assurance (QA)
- taking disproportionate risks
- designs not sufficiently robust
- insufficient detail in drawings
- compliance document applied incorrectly

Each of the project reports in the audit sample was assessed against these areas of concern with the results summarised in Table 6. The areas of biggest concern were the first two – 'Investigation not thorough enough' (42%) and 'Analysis or design not sufficiently rigorous' (38%). When developing and documenting alternative solutions fire engineers need to take greater care to ensure appropriate methods of analysis are selected, those methods are used within any limits of application and their sensitivity to key inputs are considered. They also need to ensure that the design and analysis is well documented.

Examples of poor design and analysis included:

- Justifying combustible ceiling materials (not meeting compliance document flame spread and smoke developed criteria) on the basis of a calculated average upper layer temperature not reaching critical levels. Temperature variations within the layer e.g ceiling jets were not considered and the sensitivity and consequence should the material become involved was not explored.
- Designating an upper floor as an intermediate floor to take advantage of lesser FRR requirements in C/AS1, and then proposing to delete the compensatory smoke control measures required in C/AS1 for intermediate floors on the basis they are deemed to be unnecessary. The prudent approach would have been to design the upper floor as a full floor in the first place.
- Choosing to use an overseas code or standard as the basis of a fire protection measure because it allows a more lenient requirement rather than providing first principles analysis to support the case being made.
- Restricting occupant load to 'tenant of first use' rather than using the higher generic design occupancy density value from the compliance document (or other relevant source) for the applicable activity or purpose group.
- Arbitrarily deleting a requirement of the compliance document because, in the opinion of the engineer, it is not necessary, with no additional supporting analysis.

A common issue arising with building alterations was the failure to establish that the complete building complied with the Building Code as required by section 112 of the Building Act. In many cases, the application appeared only concerned with that part of the building undergoing the alteration and there was insufficient evidence of compliance for the rest of the building.

The audit sample included several cases of computer fire models being used (e.g. branzfire, cfast and FDS) to calculate ASET. No egress computer models were used, but simple hand calculations of RSET were.

A number of engineers had developed spreadsheet methods for calculating S Ratings based on eurocode formula and these calculations were generally well done, closely following the methodology used in the compliance document and in the New Zealand Fire Engineering Design Guide [6].

Given the nature of the audit and the limited amount of time allocated to each project details relating to potential conflicts with regulations and codes of practice were not explored in much depth, however on the basis of what was examined, there were no particular concerns raised in this area.

A few cases of inadequate checking were noted. For example calculation input error by a sole practitioner leading to under-design relating to boundary fire spread calculations. QA procedures in larger companies resulted in many reports being countersigned by a checker within the company. In a small number of cases an external peer reviewer was evident.

A widespread practice observed amongst most reports was to provide a ‘menu’ or direction for the architect regarding the required fire properties such as FRR’s, SFI or SDI instead of noting the actual products and providing evidence of their compliance with fire property requirements. It was very common for the report to reproduce requirements from C/AS1 e.g. for the internal surface finish properties without noting what actual materials are to be used and whether they meet the stated requirements. This is understandable where the final selection of materials and properties has not been finalised, however for building consent purposes, the Building Act 2004 requires final and complete specifications for systems and products to be submitted to the BCA.

The quality of drawings showing implementation of the fire design was quite variable with almost one-third of the audit sample considered to be unsatisfactory as shown in Table 6. The understanding and interpretation of the fire report can be greatly enhanced by informative drawings.

Table 6 Assessment using IPENZ confidential reporting criteria

	Area of Concern	Cases	%
1	Investigation not thorough enough	10/24	42
2	Analysis or design not sufficiently rigorous	9/24	38
3	Inappropriate use of software	1/24	4
4	Ambiguous or unusual computer results	1/24	4
5	Use of unproven materials or techniques	1/24	4
6	Conflict with regulations or codes of practice	0/24	0
7	Inadequate checking, reviewing or quality assurance (QA)	3/24	13
8	Taking disproportionate risks	2/24	8
9	Designs not sufficiently robust	3/24	13
10	Insufficient detail in drawings	7/24	29
11	Compliance document applied incorrectly	3/24	13

5.2 DRU Memorandum

The DRU memorandum for each project was assessed according to the criteria shown in Table 7. This format had also been used in previous technical audits.

Overall, the DRU memorandums were generally of a consistent style and good standard. This is not surprising since the DRU operates as a team and the memorandums follow a set format.

The memorandums also demonstrated that the DRU engineers appear to have a comprehensive and detailed knowledge of the C/AS1 compliance document.

It would be useful to further refine the criteria for building work that triggers an application to be sent to the DRU, particularly those involving alterations of change of use and where the building work is in full compliance with the Building Code. At least one of the audited fire reports for new building work deviated from the compliance document only in respect of protection of neighbouring property (boundary fire spread). It was therefore beyond the scope of the matters on which the DRU are required to provide advice.

Table 7 Assessment of DRU Memorandum – Summary Results

	Percentage of reports				
Design Review Unit Memos	Poor	Incomplete	Acceptable	Good	Very Good
Legal Background specified	4%	0%	4%	92%	0%
Well presented format	0%	0%	4%	88%	8%
Technically accurate	0%	4%	25%	50%	21%
Information actionable	0%	0%	4%	83%	13%
	Each line adds up to 100%				

While DRU Engineers might be criticised for relying too heavily on the compliance document for their reviews, it appears quite appropriate that they should assume C/AS1 is the basis of a design, unless the designer has specified some other methodology for demonstrating compliance with the Building Code.

When assessing alternative solutions the DRU did a competent job of critiquing the basis of the alternative solution design. However, in some cases their comments and conclusions appeared unsubstantiated.

By way of an example, an alternative solution proposed the use of non self-closing unrated doors between serviced apartments and a shared exitway but with the addition of both sprinklers and automatic smoke detection (Type 7 system). The DRU engineer made many valid comments regarding inadequacies in the proposed alternative solution including the failure of the designer to demonstrate that the solution met the performance requirements of the Building Code (there was no quantitative analysis, only qualitative discussion by the designer), however the DRU engineer went on to strongly conclude that the design would significantly reduce fire safety in the building.

Such a conclusion was not substantiated and seemed rather speculative given that the alternative solution required both sprinklers and smoke detection be installed whereas the compliance document required only fire doors and a manual fire alarm. The key point however, was that the level of analysis undertaken by the designer to demonstrate that the performance requirements were met was inadequate and therefore the degree to which the level of fire safety may have differed (up or down) from the compliance document had not been established.

The work of the DRU could be classified as ‘Regulatory Review’ according to IPENZ Practice Note No 2 [7]. That document confirms that the regulatory reviewer’s role is to identify areas of the design that need to be addressed and to invite the designer to resolve them to the peer reviewer’s satisfaction, however the peer reviewer does not become involved in resolving the issues. The note further states that access to the designer by the regulatory reviewer is important. The practice note also states that the review does not assess the design objectives, process, options, assumptions or methods, but only the submitted design, testing the outcome against regulatory parameters.

I would contend that evaluating a performance based fire engineering design without assessing the appropriateness of the assumptions or method of analysis would be unrealistic and unwise given the current state of the art.

It is also worth noting that the Department of Building and Housing has specifically stated that the DRU's advice should not be considered a 'peer review' of a fire design [8].

At the current time, once the DRU has issued the memo to the BCA, their involvement usually ends. The BCA decides to act (or not) on the advice given in the memo and advises the applicant accordingly of their decision or requirements. Meantime, the DRU may be completely unaware of what changes or explanations have been made to address the concerns they raised. The process does not encourage a collegial resolution of issues. Rather, basic misunderstandings can easily escalate and create antagonisms between the parties involved. A better means of communication and feedback throughout the process would be helpful to all.

It would also be desirable if DRU engineers could more actively participate in the fire engineering brief process in order to encourage practitioners to make better use of the processes described in the International Fire Engineering Guidelines and/or other best practice guidance. This would promote and reward, better and more rigorous performance based fire safety design, as well as increase the likelihood of trouble-free processing of the building consent. The present situation encourages the DRU to exhibit risk-adverse behaviours that favour use of the compliance document as the path of least resistance for designers and building owners. Operating at arms length from the designers and building owners has the side-effect of the DRU perhaps being too cautious or conservative when considering alternative ways of achieving compliance with the Building Code since they have no real interest in the economic implications of various decisions and solutions. Becoming more engaged in the whole process might help to achieve a more appropriate balance of duties and responsibilities.

6. CONCLUSIONS

Based on the sample of 24 projects included in this audit, the following conclusions are drawn.

DRU Memorandum

- The DRU Engineers appear to have a thorough understanding of the application of the fire safety compliance document, and frequently identify areas of non-compliance in reports that have not been identified by the designers as such.
- The memorandums of advice prepared by the DRU are generally of a consistent style and good standard.
- When assessing alternative solutions the DRU did a competent job of critiquing the basis and implementation of the alternative solution design. However, in some cases conclusions were drawn that appeared unsubstantiated.
- The ability of the DRU to provide constructive advice to the BCA (and applicant) is directly dependent on the quality of the fire engineering report and documentation supplied to them.

Fire Engineering Design and Documentation

- Two-thirds of all the audited reports were categorised as design to C/AS1 with minor, trivial or no deviations, while one-third of the audited reports were classified as being major deviations. There were no designs that could be regarded as total performance based designs that did not reference the compliance document C/AS1.
- Very few fire-engineering reports indicated that the processes in the International Fire Engineering Guidelines had been followed. Only one report included a Fire Engineering Brief, thus it appears that the IFEG has not gained significant uptake amongst the New Zealand fire engineering fraternity.
- The quality of drawings showing implementation of the fire design was unsatisfactory in almost one-third of cases.
- In approximately 40% of cases, the investigation conducted in support of the design was not thorough enough or the analysis was not sufficiently rigorous.

7. RECOMMENDATIONS

- Simplify the compliance document so it can be clearly interpreted without reference to specific design. This should have the effect of reducing the number of projects sent to the DRU and allow simple designs to the compliance documents to be more efficiently documented by architects etc. It would also make it easier to more clearly distinguish those designs that are fully based on the compliance documents versus those comprising alternative solutions.
- Introduce some form of feedback loop or communication mechanism following the issue of the DRU memorandum. Perhaps an access-controlled web-based project register for alternative solutions could be developed to record the communication and decisions regarding projects. This would still allow the DRU to avoid becoming engaged in ongoing debate with individual designers, yet allow the parties involved to check each other's understanding of the basis and assumptions supporting a design and ensure that all relevant information has been supplied by the BCA to the DRU.
- Remove the need for 'alterations' or 'change of use' building work to be sent to the DRU (as per the NZ Gazette Notice) where that work results in a building that fully complies with C/AS1.
- Where designs are predominantly based on compliance with C/AS1, designers should structure the fire engineering report such that variations to the compliance document are contained, discussed and documented in a separate section of the report rather than including discussion and justification of the alternative solution in the main body of the report.
- Investigate whether DRU engineers could more actively participate in the fire engineering brief process in order to encourage practitioners to make better use of the processes described in the International Fire Engineering Guidelines. This would promote and reward better, more rigorous performance based fire safety design and as well as improve the likelihood of trouble-free processing of the building consent.

8. REFERENCES

1. Building Act 2004. New Zealand Government.
2. New Zealand Fire Service Act 1975. New Zealand Government.
3. Compliance Document for New Zealand Building Code Clauses C1, C2, C3, C4 Fire Safety. Department of Building and Housing. 2008.
4. International Fire Engineering Guidelines (IFEG). Australian Building Codes Board. 2005.
5. Confidential Reporting on Matters in Engineering (CroMiE). www.ipenz.org.nz/ipenz/practicesupport/CROMiE June 2008.
6. Fire Engineering Design Guide. 3rd Edition. New Zealand Centre for Advanced Engineering. July 2008.
7. Peer Review – Reviewing the work of another engineer. IPENZ Practice Note 02. The Institute of Professional Engineers New Zealand. June 2003.
8. Means of establishing compliance: alternative solutions. Department of Building and Housing, October 2008.

APPENDIX A SECTION 46 & 47 BUILDING ACT 2004

46 Copy of certain applications for building consent must be provided to New Zealand Fire Service Commission

(1) This section applies to an application for a building consent that is of a kind specified by the chief executive by notice published in the *Gazette*.

(2) A copy of the notice must be given by the chief executive to every building consent authority as soon as practicable after it is so published.

(3) A building consent authority must, on receipt of an application to which this section applies, provide a copy of the application to the New Zealand Fire Service Commission.

47 New Zealand Fire Service Commission may give advice on applications under section 46

(1) The New Zealand Fire Service Commission may, within 10 working days after receiving a copy of an application for a building consent under section 46, provide the building consent authority concerned with a memorandum that sets out advice on the following matters in respect of the building to which the application relates:

- (a) provisions for means of escape from fire:
- (b) the needs of persons who are authorised by law to enter the building to undertake fire-fighting.

(2) The New Zealand Fire Service Commission must not, in the memorandum referred to in subsection (1), set out advice that provides for the building to meet performance criteria that exceed the requirements of the building code.

(3) If the New Zealand Fire Service Commission does not provide a memorandum within the period specified in subsection (1), the building consent authority may proceed to determine the application without the memorandum.

APPENDIX B SECTION 112 & 115 BUILDING ACT 2004

112 Alterations to existing buildings

(1) A building consent authority must not grant a building consent for the alteration of an existing building, or part of an existing building, unless the building consent authority is satisfied that, after the alteration, the building will—

- (a) comply, as nearly as is reasonably practicable, with the provisions of the building code that relate to—
  - (i) means of escape from fire; and
  - (ii) access and facilities for persons with disabilities (if this is a requirement in terms of section 118); and
- (b) continue to comply with the other provisions of the building code to at least the same extent as before the alteration.

(2) Despite subsection (1), a territorial authority may, by written notice to the owner of a building, allow the alteration of an existing building, or part of an existing building, without the building complying with provisions of the building code specified by the territorial authority if the territorial authority is satisfied that,—

- (a) if the building were required to comply with the relevant provisions of the building code, the alteration would not take place; and
- (b) the alteration will result in improvements to attributes of the building that relate to—
  - (i) means of escape from fire; or
  - (ii) access and facilities for persons with disabilities; and
- (c) the improvements referred to in paragraph (b) outweigh any detriment that is likely to arise as a result of the building not complying with the relevant provisions of the building code.

Compare: 1991 No 150 s 38

Section 112(1)(a): amended, on 14 April 2005, by section 12 of the Building Amendment Act 2005 (2005 No 31).

115 Code compliance requirements: change of use

An owner of a building must not change the use of the building,—

- (a) in a case where the change involves the incorporation in the building of 1 or more household units where household units did not exist before, unless the territorial authority gives the owner written notice that the territorial authority is satisfied, on reasonable grounds, that the building, in its new use, will comply, as nearly as is reasonably practicable, with the building code in all respects; and
- (b) in any other case, unless the territorial authority gives the owner written notice that the territorial authority is satisfied, on reasonable grounds, that the building, in its new use, will—
  - (i) comply, as nearly as is reasonably practicable, with every provision of the building code that relates to either or both of the following matters:
    - (A) means of escape from fire, protection of other property, sanitary facilities, structural performance, and fire-rating performance:
    - (B) access and facilities for people with disabilities (if this is a requirement under section 118); and
  - (ii) continue to comply with the other provisions of the building code to at least the same extent as before the change of use.

Compare: 1991 No 150 s 46(2)

Section 115(b)(i): substituted, on 14 April 2005, by section 13 of the Building Amendment Act 2005 (2005 No 31).

APPENDIX C NEW ZEALAND GAZETTE NOTICE NO. 1648

Title:
Notice that Copies of Certain Applications for Building Consent to be Provided to the New Zealand Fire Service Commission

Notice Text:
Notice That Copies of Certain Applications for Building Consent Must be Provided to the New Zealand Fire Service Commission Pursuant to section 46 (1) of the Building Act 2004, I give notice that copies of the following kinds of application for a building consent must be provided to the New Zealand Fire Service Commission:

1. An application for a building consent that relates to building work to be carried out in respect of any type of building or part of a building described in section 21A of the Fire Service Act 1975 regardless of whether the building or part of the building is sprinkler protected.
2. For the purpose of clause 1, an application for a building consent for building work means an application:

   (a) where compliance with clauses C1-4, D1, F6 or F8 of the Building Code will be established other than by compliance with the provisions of an applicable compliance document; or
   (b) that involves a modification or waiver of clauses C1-4, D1, F6 or F8 of the Building Code, under section 67 of the Building Act 2004; or
   (c) that involves an alteration, change in use or subdivision and affects the fire safety systems, including any building work on a specified system relating to fire safety, except where the effect on the fire safety system is minor.
3. Clause 1 does not apply to an application for a building consent for building work to be carried out in respect of:

   (a) single household units;
   (b) buildings in which every fire-cell is a household unit separated vertically from the other fire-cells, and each fire-cell has independent and direct egress to a safe place outside the building;
   (c) an internal fit-out, unless the fit-out relates to a change of use under clause 2 (c);
   (d) outbuildings or ancillary buildings.
4. This notice comes into force on 22 April 2005.
   Dated at Wellington this 14th day of March 2005.

APPENDIX D SECTION 21A FIRE SERVICE ACT 1975

21A Relevant building defined for purposes of sections 21B to 21H

(1) In sections 21B to 21H, **relevant building** means a building or part of a building used for 1 or more of the following purposes:
- (a) the gathering together, for any purpose, of 100 or more persons:
- (b) providing employment facilities for 10 or more persons:
- (c) providing accommodation for more than 5 persons (other than in 3 or fewer household units):
- (d) storing or processing hazardous substances in quantities exceeding the prescribed minimum amounts:
- (e) providing early childhood facilities (other than in a household unit):
- (f) providing nursing, medical, or geriatric care (other than in a household unit):
- (g) providing specialised care for persons with disabilities (other than in a household unit):
- (h) providing accommodation for persons under lawful detention (not being persons serving a sentence of home detention, or community detention, or serving a sentence of imprisonment on home detention, or on parole subject to residential restrictions imposed under section 15 of the Parole Act 2002).

(2) However, in sections 21B to 21H, **relevant building** does not include—
- (a) a Crown building, or class of Crown building, that is specified by the Minister by notice in the *Gazette*; or
- (b) premises of the mission (as defined in Schedule 1 of the Diplomatic Privileges and Immunities Act 1968).

Section 21A: substituted, on 1 October 2006, by section 8 of the Fire Service Amendment Act 2005 (2005 No 52).
Section 21A(1)(h): amended, on 1 October 2007, by section 58 of the Sentencing Amendment Act 2007 (2007 No 27).