RESEARCH REPORT

DETERMINING BARRIERS TO INDUSTRY DELIVERY OF FIRE-SAFE BUILDINGS IN NEW ZEALAND

FIRE PROTECTION ASSOCIATION OF NEW ZEALAND

The work reported here was funded by BRANZ from the Building Research Levy.

PREFACE

This project was undertaken to address concerns within the fire protection industry that the passive fire protection systems within commercial/institutional buildings were not being effectively delivered. This report summarises the ensuing investigations.

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Bob de Leur – Auckland City

Bob Campton – PBS

Greg Baker – BRANZ

Nick Saunders – DBH

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ABSTRACT

Since the introduction of a performance based Building Code in 1992 passive fire protection in New Zealand has evolved into a sophisticated design philosophy and practice for fire safety in buildings. This report describes an initiative by the Fire Protection Association of New Zealand to survey a group of sample buildings and obtain information from industry stakeholders to assess passive fire protection in practice. The survey identified a number of areas where improvements could be made to the design, installation, inspection and ongoing maintenance of passive fire protection in buildings. The report makes recommendations about how to achieve greater assurance about the ongoing performance of passive fire protection.

READERSHIP

This report is intended for those who have an interest in the performance of all the component parts of the fire protection in New Zealand buildings, namely, fire engineers, Code and Standards developers, regulators, Building Consent Authorities and Territorial Authorities, fire protection companies, insurers, product suppliers, construction companies, building owners and managers, and any other parties interested in fire protection standards in New Zealand buildings.

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1 INTRODUCTION

In November 2007, the Fire Protection Association of New Zealand (FPANZ) received funding from Building Research to carry out a research project to investigate the quality of Passive Fire Protection (PFP) in New Zealand buildings.

The first stage of the project was to conduct a pilot-scale site survey of a small number of representative buildings. The surveys were carried out by qualified fire engineers and were located in the main centres.

The site surveys found deficiencies in the quality of PFP, particularly in relation to the fire stopping of services penetrations through fire and smoke-rated barriers in the buildings.

The second stage of the project involved consultation with a cross-section of key industry representatives and stakeholders to seek their views about possible reasons for the deficiencies observed in the site surveys. These stakeholders included product suppliers, fire engineers and Building Consent Authorities (BCA’s).

The second stage also touched on the regulatory environment in New Zealand with respect to PFP and also what building Standards were in use domestically and offshore.

The regulatory regime was considered to be of a high standard with the only exception being with regard to the coverage and implementation of Compliance Schedules for PFP. The role that Standards had to play was also investigated.

The third stage of the project was to investigate the international experience of PFP. This provided insight into how similar issues are being dealt with overseas and what lessons New Zealand could learn as a result.

The research team analysed the information to identify areas for improvements in the design, installation and ongoing maintenance of PFP in New Zealand.

This report presents recommendations for actions to bring about positive changes to the industry.

2 PILOT-SCALE SITE SURVEYS

2.1 Background

An important component of the project was to conduct a small pilot-scale survey of a number of typical commercial/institutional buildings representing a broad range of PFP usage. The intent was to cover a range of different purpose groups representative of a variety of building occupancies. The actual buildings surveyed were also chosen regionally so that a broad representation of the main centres throughout the country could be obtained.

Professional fire engineers were employed for the surveys to ensure that there was a good knowledge of the applicable regulations and fire engineering principles involved. A survey format was designed to ensure consistency between the different inspectors.

2.2 Survey Procedures

2.2.1 Sample

Funding was obtained to undertake inspections of a limited number of buildings and this was augmented by the New Zealand Fire Service (NZFS) who inspected additional buildings. The sample selection was done randomly, looking at a variety of occupancies including hospitals, schools, commercial buildings and accommodation. However, some autonomy was left to the NZFS in its selection of buildings, but within the guidelines of the project.

With the exception of Inspection 9 (refer to Sub-section 2.3.9 *Inspection 9 – Apartment Building)*, the buildings were selected in a completely unbiased fashion, without any prior knowledge of the standard of PFP. The only restriction placed on the selection process was as to the location and the purpose group. On this basis the sample of buildings that were inspected, albeit not large in number, was believed to have been representative of the larger building stock.

The buildings selected fell into one of two categories: first <u>new buildings</u> where the inspection related to design and construction and compliance with the New Zealand Building Code (NZBC);[1] and secondly <u>existing buildings</u> where ongoing maintenance was also inspected.

2.2.2 Regional Coverage

The buildings to be surveyed were selected from the main centres, namely Auckland, Hamilton, Wellington, Christchurch and Dunedin, so as to ensure a nationally representative cross-section was obtained.

[1] NZ Government, *Building Regulations 1992 (SR 1992/150), Schedule 1, The New Zealand Building Code*, Wellington, 1992.

2.2.3 Inspector Qualifications

The fire engineers used by FPANZ for the site surveys were Chartered Professional Engineers. The NZFS personnel who conducted inspections had tertiary fire engineering qualifications.

2.2.4 Survey Format

The survey format was established by the principal contracted fire engineer and agreed with those undertaking the inspections. The list contained in Figure 2.2.1 was used as the guide for the PFP inspections in an effort to ensure consistency amongst the different inspectors.

A written report was provided by the inspectors for each building that was surveyed and included a number of photographs that provided pictorial evidence of what was observed.

Item	Comment
Cavity Barriers	
Ceiling Systems	
Fire & Smoke-Rated	
Compartment Walls	
Fire Doors	
Safe Paths	
Protected Stairs	
Fire Dampers in Air Ducts	
Fire Glazing	
Riser Ducts	
Fire-Rated Floors	
Fire Shutters	
Linear Gap Fire Seals	
Service Penetrations	
Seals	
Structural Frame Fire Protection	
The Building Envelope	

Figure 2.2.1 – Survey checklist

2.3 Summary of Survey Results

This section of the report provides a brief summary from the inspector's full reports for each of the individual buildings that were included in the pilot-scale survey.

The inspections were such that only obvious and easily accessed areas were seen and photographed. Because it was difficult to determine all locations where PFP may have been required many of the items were not seen, such as intumescent paint steel protection, dampers and the like. The difficulty in locating these areas has confirmed the need to be able to review plans of installed PFP prior to undertaking an inspection.

2.3.1 Inspection 1 – Hospital Building

This building was in the new building category. In summary, the construction management processes were considered to be of a very high standard in this particular building, and PFP to a commensurately high standard. In discussion with the hospital's consultant fire engineer, it was understood that the basis of any construction or services contract documentation is part of the building consent with processes to ensure review of all stages of fire-rating work. There were no areas of PFP that were considered to not meet the NZBC requirements. There were some very effective systems and procedures in place, as follows:

- Fire barriers stencilled with fire-rating requirements
- Fire dampers tagged with Compliance Schedule requirements
- Any work involving fire cell penetration required a Building Consent application to be lodged.

2.3.2 Inspection 2 – Hospital Support Building

This building came under the same jurisdiction as the building surveyed in Inspection 1 but was in the existing building category. The findings were identical to those covered in Sub-section 2.3.1 with sound maintenance procedures in place.

2.3.3 Inspection 3 – Tertiary Institution Accommodation Building

This building was in the existing building category, dating from the 1980's and hence prior to the introduction of the NZBC. In summary, construction management processes were considered to be of a good standard. The building was in an overall good state of repair. The major area of PFP non-compliance consisted of a combination of non-rated vertical service shafts and unrated services penetrations at floor level.

2.3.4 Inspection 4 – Office Building

This building was in the existing building category. The building manager (a designated staff member) had no building construction management experience and was not aware of the Compliance Schedule requirement to maintain PFP in regard to new services installations through fire-rated floors. With no ongoing maintenance of the building's PFP, subsequent services installation has compromised integrity, with no management awareness of the matter or system in place that will prevent this from occurring. As there was no PFP item on the building warrant of fitness (BWOF) to sign off it has not been considered as part of this procedure.

2.3.5 Inspection 5 – Office Building

This building fell into the new building category. The building was constructed in 1927 and recently had a major refurbishment under the NZBC. It was assessed to be a high quality building in the CBD. The building had a sprinkler system with riser hydrants in addition to PFP subdividing the building floors, plant room, riser ducts and safe paths. The building had some aspects of specific design in regard to fire cell construction such as the sprinkler drenched toughened glass atrium to occupied space doors. It was considered to be fully compliant with the NZBC.

2.3.6 Inspection 6 – Rest Home Building

This building was in the existing building category. The building consisted of an older single-storey portion that was pre-NZBC and then a new two-storey part constructed in the late 1990's to the NZBC. The building had a Type 7 fire safety precaution (automatic sprinkler system with smoke detectors and manual call points) and was totally reliant on sprinkler control as the prime means of prevention of fire spread.

The building was regarded as an Alternative Design in the context of the NZBC framework, as fire cell separations were not a feature of the building design. There appeared to be some inconsistency in this regard in that there were some PFP systems in otherwise un-rated construction.

2.3.7 Inspection 7 – Tertiary Institution Accommodation Building

This building was classified as an existing building. The building was constructed in the 1990's to the NZBC. In summary, construction management processes were considered to be of a good standard. Management were prepared to learn from this exercise about any perceived deficiencies in building management. The building was maintained in an overall good state of repair. This concrete building provided very effective passive fire separation but this was seriously compromised with riser pipes through concrete floors that had no fire stopping.

2.3.8 Inspection 8 – Tertiary Institution Building

The building in this inspection was an existing building in the context of this project and was constructed prior to the NZBC in the 1980's. Building management had limited specific knowledge of PFP and indicated that they depended on professional consultants for this aspect of BWOF requirements. However there was no specific tick box on the BWOF for PFP. This concrete building was generally maintained in a very good state of passive fire separation. The significant area of non-compliance related to from riser pipes through concrete floors and data cable penetrations with no fire stopping. Fire-rated doors were original to the building (1980's) and without the fire tag system that is now required under current regulations.

2.3.9 Inspection 9 – Apartment Building

When inspected in 2003/04, this building was in the new building category. For the purposes of this project a previous inspection, undertaken at the owner's request, was the basis for the report summarised herein. The building had been previously inspected following the Code Compliance Certificate being issued. The detailed inspection had culminated in over $1M being expended on (primarily) services penetrations not having been fire stopped correctly. This rectification work was very invasive.

The building was done to the barest minimum standard of documentation and inspection. The BWOF regime included the inspection of only some PFP features. There were no building management procedures associated with subsequent work that impacted upon the PFP of the building. This building was a body corporate-managed building – as such the corporate managers understood the requirements of the Compliance Schedule for the building. The body corporate managers had a legal responsibility to the body corporate members to comply with the requirements of the Building Act.[2]

2.3.10 Inspection 10 – Office and Retail Building

This building was classified as being an existing building. The building was originally built in the late 1960's but stage 1 of a two-stage redevelopment was completed in 2004. This first stage of the redevelopment project consists of a hotel with commercial occupancy also.

The building had a BWOF in place via a national contract. When new work was commissioned, a local fire engineer was involved. Site management appeared to have only limited knowledge of PFP and Compliance Schedule requirements. The major area of non-compliance related to fire stopping between fire-rated elements and at services penetrations.

2.3.11 Inspection 11 – Residential Apartments

This building fell into the new building category and dated originally from 1902 but was reconstructed in 2006. A fire engineer was employed whenever a new purpose group tenancy fit-out was proposed. Contracted experts were relied upon for previous building compliance work. The major area of non-compliance related to fire stopping which was found in some spaces to be inadequate.

2.4 Survey Findings

The surveys of the buildings that were carried out clearly demonstrated that there are a number of significant and serious problems with regard to the quality of PFP in New Zealand buildings.

Although it is acknowledged that the number of buildings surveyed was small in comparison to the total building stock, the trends indicated from the pilot strongly signal major shortcomings.

[2] NZ Government, *The Building Act 1991 (PA 1992/150)*, Wellington, 1991.

The fundamental problem with PFP is that a very minor omission can have catastrophic consequences in respect of overall fire safety for building occupants in the first instance – in other words there is often very little if any redundancy. This is in stark contrast to general building construction where minor omissions are dealt with very effectively by factors of safety and general redundancy in design.

The most regular area of non-compliance with the buildings that were surveyed was in relation to services penetration through fire-rated elements. There would in most cases appear to have been a total lack of coordination of different trades installing services in buildings. This applied both for new construction as well as services installed during the life of the building.

The surveys also highlighted significant knowledge gaps across the spectrum including installers, building officials and building managers. Examples of this included a clear lack of awareness of the need for a Building Consent when doing work that affected the integrity of fire barriers.

There were also some systemic problems highlighted by the inspections, particularly in relation to Compliance Schedules and the non-involvement of qualified professionals at crucial stages of the construction and approval process.

2.5 Additional Information

In addition to the surveys that formed part of this project, a copy of a report was provided to the researchers, on the condition of anonymity, and was reviewed as part of the project. The report had been commissioned to determine how well telecommunications penetrations were handled in typical multi-storey buildings. In the 15 buildings inspected the report revealed that these penetrations were similar to all other trade penetrations in that in most cases no attempt had been made to seal penetrations through fire separation walls. The report specifically mentioned that, in general, the older the building the worse the condition of the telecommunications pathway within the building. This was due to the accumulation of redundant cabling left when tenants vacate their lease or update services, but do not have the old systems removed. The end result of this was vertical riser penetrations and cable trays that had no available space for new or additional services.

The report went on to note that fire stopping generally was an area of concern. Either there was a lack of it or the fire stopping membrane has been penetrated and the fire stopping was then not reinstated to the requirements of the NZBC. Further investigation of the New Zealand Standards revealed that there did not appear to be a related Standard applying to the installation of fire stopping materials. There was, however, one relating to the testing of fire stop materials.

3 INDUSTRY CONSULTATION

3.1 Background

In addition to a pilot scale programme of site surveys the second major component of the research project was a series of interviews with key industry stakeholders. Those interviewed included a number of passive fire protection product suppliers, independent fire engineers and local authority representatives.

3.2 Interview Design

The interviews were done in such a way so as to ensure that a broad coverage of both PFP product types was achieved as well as a good geographical variation with the available funding.

3.2.1 Sample

A total of seven product suppliers were interviewed in the course of this phase of the project. The nature and size of some of those suppliers interviewed resulted in significant coverage of the PFP industry being achieved. Staff from four BCA's were interviewed. As part of the BCA interviews other staff with direct responsibility for Independent Qualified Person (IQP) activities in approximately 25-30 Territorial Authority (TA) areas were interviewed. Two fire engineers were also included in the industry consultation part of the project.

3.2.2 Regional Coverage

Staff from BCA's in three of the major metropolitan areas were interviewed in the course of this research, as well as one regional BCA. The former was done intentionally to ensure coverage of the areas where larger scale development has taken place. Whilst the product suppliers interviewed were Auckland-based, they all had nationwide distribution chains. The fire engineers were all based in Auckland but represented companies which operate both nationally and internationally.

3.2.3 Interview Format

The industry representatives interviewed had a standard series of questions posed with the intention of addressing aspects in a consistent manner. In all cases the interviewee's opinion was sought as to the deficiencies in the design and installation of PFP materials. They were also invited to make suggestions about how they believed the installation and maintenance of PFP could be improved.

The questions asked at interview covered the following topics:

- Compliance Schedules and documentation

- Third party vetting of fire resistance performance

- Adequacy of specifications by industry professionals
- Industry knowledge in the following areas:
  - Performance-based design
  - Statutory requirements
  - Installation methods
  - Understanding of NZBC requirements
- Quality of training throughout the industry
- Site controls for subsequent inspections
- Need for proper Component Listing
- The role of IQP's.

3.3 Interview Results

A number of fire engineers, PFP product suppliers and BCAs were interviewed and these interviews are summarised in this section of the report.

3.3.1 Fire Engineer 1

In interviewing this engineer, his primary concern was the gap between what designers require and what is ultimately built, particularly with drywall construction. This included such things as floor to ceiling construction, especially in some of the modern flexible concrete floors, and how they will sag in a fire and affect drywall non-load-bearing fire partitions. Air conditioning ductwork, fire and electrical cabling were often installed as well before the firewall went in. Ducts in particular may finish up with fire dampers in areas unrelated to the actual wall construction.

There was also generally a lack of information about how to properly fire stop around services. There is little coordination between those installing services and those carrying out the firewall installation. The question was posed, "*Once installed and painted how does anyone know which is the firewall and which is a simple partition?*" In the opinion of the fire engineer interviewed, there was a need for fire engineers to be involved with the architects in specifying firewalls, to be on-site during construction and to sign off when construction is complete. In effect, fire engineers needed to be on the design team and paid properly for their input.

This fire engineer provided a summary of the key role played by the fire engineer in the design process.

PFP comprised all the building elements that were designed and constructed to withstand the effects of a fire for the duration (minutes or hours) that the particular building element had been shown to achieve using a recognised fire test procedure.

Some examples were:

- Fire barriers such as fire-rated walls and floors
- Fire doors
- Fire stopping materials for services penetrating fire barriers, and fire windows.

The PFP requirements of a building were determined by the design fire engineer who established:

- What fire cells were required
- The fire resistance rating to be applied to each fire cell, and
- How the fire resistance rating was achieved.

Having done this it was essential that these requirements were clearly documented on plans, in specifications and by calculations.

Where plans and specifications covering passive fire protection elements were prepared by other building design disciplines, such as architects, structural engineers etc, it was imperative that the design fire engineer checked the plans and specifications, and confirmed that they correctly articulated the PFP requirements of the fire engineering design.

The role of the fire engineer did not stop there but had to continue right through to the end of the construction of the building. This was because the fire engineer needed to carry out construction monitoring to check that the PFP requirements of the design (as documented on the plans and specifications) had been properly constructed.

Such monitoring included:

- Construction of the fire-rated walls
- Applied fireproofing to structural steel beams and columns
- Fire doors and fire windows
- Fire stopping
- Fire dampers in HVAC ductwork etc.

Many BCA's now required construction monitoring by the design fire engineer as a condition of the Building Consent and a *Producer Statement – PS4 – Construction Review*[3] from the fire engineer at completion of the construction.

[3] ACENZ, IPENZ and NZIA, *Producer Statement – PS4 – Construction Review,* Wellington and Auckland, 2007.

A professional registered fire engineer was not able to provide a construction review producer statement unless they had carried out the appropriate level of construction monitoring, guidance on which was given by the Association of Consulting Engineers NZ (ACENZ) and the Institution of Professional Engineers NZ (IPENZ).[4]

Also during the construction phase, variations occurred and alternative construction methods may be suggested, all of which impacted on the PFP provisions and thus required the involvement of the design fire engineer.

The engineer also provided a summary of the how the various sections of the Fire Safety Acceptable Solution (C/AS1)[5] related to the requirements for the inclusion of PFP features in Compliance Schedules.

3.3.2 Fire Engineer 2

The main parts of the discussion with this fire engineer were about penetrations through floors and walls with particular regard to accommodation buildings. The use of fire stopping and fire collars was noted but observed that they were frequently incorrectly installed. The outcome should fire occur would have meant that the fire stopping was of no consequence.

An example was plastic pipe penetrations through plasterboard walls where fire collars were fitted. The fire collars had been screwed into the plasterboard with no supporting framework behind and this meant that when the collar would try to expand to fill the void left by the melted pipe, it would actual break away from the wall leaving an opening through the firewall.

3.3.3 Product Supplier 1

This supplier's major point was that the specifications for glass used in windows and doors were inadequate and specifiers were inadequately trained. Interpretation of requirements was not consistent as to what was needed within the building envelope. In terms of installation there was little knowledge by the builder about how and why fire glass and fire windows needed to be installed. Often they did not realise that the window frame was a vital part of the approved fire-rated system.

The supplier did not feel that BCA staff were able to inspect adequately and they relied entirely on producer statements by installers. The opinion was also given that the capability of fire engineers varied greatly. Providing knowledge through training was recommended as the best means to overcome the deficiencies in this area.

[4] ACENZ and IPENZ, *Guideline on the Briefing and Engagement for Consulting Engineering Services*, 1st ed., Wellington, 2004.

[5] Department of Building and Housing, *Compliance Document for New Zealand Building Code Clauses C1, C2, C3, C4 Fire Safety*, Wellington, 2005.

3.3.4 Product Supplier 2

The person being interviewed indicated that the major difficulties experienced were in relation to concepts and performance-based design which seemed to be based on an engineer's opinion with little acknowledgement of risk by architects, and often the fire engineer's involvement in design was none other than that of specifier. There was little cohesion between the fire engineer and the designer.

Additionally, many of the actual products used were not those which were specified and may not have been tested or properly installed by the constructor. There was also some concern where BRANZ have fire tested a product, but certificates were no longer released to the distributor and therefore cannot be supplied to the specifier or constructor. In effect although a product was tested, BRANZ would not supply a certificate to support the product.

The supplier believed that in other countries specific traders undertake fire stopping of penetrations, but in New Zealand it is unskilled people doing things they know nothing about. The gaps in his opinion were design, installation and use of correct product. Obviously additional involvement of fire engineers in installation and inspection would assist, but training of designers and installers was essential.

3.3.5 Product Supplier 3

The overall outcome of the interview with Product Supplier 3 was similar to that with Product Supplier 2 in that the designer and constructor had inadequate knowledge and the product was either not tested or certified or was used incorrectly by the installer.

3.3.6 Product Supplier 4

The major areas of concern were indicated as being lack of industry knowledge, in relation to performance-based design in particular, poor installation methods and poor NZBC knowledge. The particular concern expressed was the "amazing" number of services installed through firewalls without any attempt to seal the penetrations correctly. They also believed there needs to be a better link between fire engineers and architects.

Product Supplier No 4 indicated that the company had a helpdesk receiving between 50 and 60 calls per day asking how to achieve certain elements of PFP installation. There was a poor grasp of practical knowledge of PFP in the construction industry.

3.3.7 Product Supplier 5

This supplier's major concern was that passive products were still being self-certified and the BCA's were still accepting a producer statement generated by the installer. In general it was felt that fire engineers installing their products had reasonable knowledge but specifiers – in particular architects – had little knowledge of PFP and no-one apparently looked at test results and whether they were relevant to the product being used. For example, a product was specified but a different product was used in the actual construction and then the fire test on the original specified product was used in documentation relating to the construction, although the actual product used may not have met the test results.

This supplier strongly believed that a formal list of approved products was necessary to aid specifiers and that this would resolve 90% of the issues. There needed to be a register set up for fire doors, fire windows, cladding and penetration seals. This would help the PFP industry and overcome some of the knowledge gaps that were apparent. Final inspection by competent parties was also strongly recommended.

3.3.8 Product Supplier 6

This fire door supplier was concerned with installation capability and requirements, but also with the use of Standards mentioned within the NZBC. It was suggested that the New Zealand industry could adopt the Australian Standard for smoke control,[6] but there was a preference to amend AS/NZS1905.[7] However, like all Standards in New Zealand there could be issues with the availability of money to undertake this development.

Additionally concerns were expressed with hardware used on doors and it was suggested that "... *hardware approvals needed to be adopted and these needed to be tested with the doors, they needed to be checked with the closing forces and the closing and opening tests were not being done* ...". Overall there were significant concerns with door hardware control. The improvements suggested by this supplier were:

- AS/NZS1905 needed to be upgraded
- there needed to be a process to list approved doors
- installers needed to be adequately trained
- manufacturers needed to provide better installation instructions
- the process of inspection needed improvement.

In the case of this company in question, several hundred doors had been sent out but the declaration required that the installation was complete was never returned. The supplier suggested that while on average some 80% of doors fitted in a building were the correct items, the constructors tended to cheat on the rest. Currently, anyone could make a smoke stop door and no declaration was required.

[6] Standards Australia and Standards New Zealand, *Australian/New Zealand Standard, AS/NZS 1668.1: 1998, The use of ventilation and airconditioning in buildings – Fire and smoke control in multi-compartment buildings*, Sydney and Wellington, 1998.

[7] Standards Australia and Standards New Zealand, *Australian/New Zealand Standard AS/NZS 1905.1: 1997, Components for the protection of openings in fire-resistant walls Part 1: Fire-resistant doorsets*, Sydney and Wellington, 1997.

The supplier noted that NZS 4232,[8] which was used prior to AS/NZS1905, allowed self-made doors and this practice had continued. Third party inspections were strongly recommended by the supplier.

3.3.9 Product Supplier 7

A supplier of intumescent paints discussed the lack of controls in this industry and pointed out that people did not even know that intumescent paint required a correct undercoat to be applied to ensure that the product was effective.

3.3.10 Building Consent Authority – Northern Region

The concerns voiced by the BCA were similar to those of the suppliers in that specifications were brief or vague, and the BCA received very little information on a firewall or penetration construction. There were a variety of products for which limited information was provided and for which no specifications were readily available. Price was seen to control the type of material being used rather than its suitability for use. Even where a product may be specified, the installer was able to make changes. For instance, in dry wall construction, once it had been installed and painted there was no way of knowing what had actually been used.

There were also concerns expressed with fire reports where there was great variation in the quality, and the reports could often change on-site and have a number of revisions with the final one provided as an ‘as built’.

Overall, the knowledge and training of those involved in the PFP industry was limited. Often the outcome of cost minimisation requirements was the use of non-certified products, the effectiveness of which was not known.

3.3.11 Building Consent Authority – Southern 1

This BCA appeared to have a stronger control on the construction of PFP in that it was insisted that the fire engineer doing a specification signed-off on the work that had been completed. There were also a number of inspectors looking at new buildings and in particular those where a fire engineer has not been employed. This BCA did not rely on producer statements from the builder.

The biggest problem experienced was penetrations through firewalls and that many of these were missed. In terms of dampers in ducts, most of these would be in buildings where fire engineers were employed and sign-off would be required by the engineer, and similarly for fire doors and smoke doors. In common with other locations, intumescent paints were seen as a problem, mainly because it could be painted over or applied without anyone having knowledge of undercoating or other factors which affected its fire spread suppression capabilities.

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[8] Standards New Zealand, *New Zealand Standard NZS 4232.1: 1988, Performance criteria for fire resisting enclosures – Internal and external fire doorsets*, Wellington, 1988.

The new Compliance Schedule requirements[9] had picked up a lot of the requirements for fire and smoke stop separations. However IQP assessment did not at this stage include the competence of the IQP to undertake PFP inspections.

3.3.12 Building Consent Authority – Central

This BCA basically differentiated its PFP procedures based on the size of the project. Those projects which involved fire engineering design required construction monitoring and sign-off by the fire engineer responsible. On smaller projects, the BCA carried out its own inspection and required a sign-off by the builder and the PFP installer/applicator.

Once again, after completion by one trade, penetrations by the various other trades were a significant problem.

The other area where this BCA had problems was with non-consented work. A lot of alteration work was being undertaken without consent. The problems found by the BCA in doing random inspections with IQP's included firewalls which did not penetrate the ceiling and people removing door closures.

An effort was made by this BCA to obtain floor plans indicating the location of firewalls and other PFP requirements, and an attempt was made to hold this on the owner's compliance file.

3.3.13 Building Consent Authority – Southern 2

The major problem identified by this BCA related to penetrations through fire-rated elements and in particular the failure of the trades people to properly seal with the appropriate methods and materials where services had passed through fire-rated walls, floors or ceilings. This occurred particularly in concealed spaces which passed largely unnoticed by building users and inspectors.

3.3.14 Building Officials – IQP Appointments

The officials interviewed processed IQP applications for in excess of 25 BCA districts. Interviews with those responsible for appointing IQP's concluded that there was currently no recognised national process in place to assess or appoint IQP's for PFP. It was indicated that people not specifically qualified were accepted as IQP's capable of undertaking PFP inspections. It was considered by those interviewed that those previously approved under the old Compliance Schedule regime for the CS 13 *Means of Escape*[10] inspections would be accepted as competent to do this work but without any specific qualification or experience. In one case this was a provisional appointment with a six-month probationary period at which point they had to demonstrate competency. The problem introduced through the changes in the Building Act 2004[11] requiring the change from an IQP to Licensed Building Practitioner (LBP)

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[9] Department of Building and Housing, *Compliance Schedule Handbook*, Wellington, 2007.

[10] Building Industry Authority, *The New Zealand Building Code Handbook*, Wellington, 2001.

[11] NZ Government, *Building Act 2004 (PA 2004/72)*, Wellington, 2004.

had meant that development work on improvements in the appointment of IQP's was yet to materialise.

3.4 Interview Findings

The section of the project report discusses the various issues and trends that were highlighted during the interview process.

3.4.1 Designer Involvement

The interviews with the fire engineers indicated that there were no apparent problems with the design process and C/AS1 as such, but the area of primary concern was the fact that in few cases was the original designer required to inspect and sign-off the completed work – in other words there was no end-to-end continuity in the process. This was a matter of significant concern.

3.4.2 Trade Coordination

A major problem identified during the vast majority of the interviews was the complete lack of comprehensive coordination of the many and varied trades working on any one building site. There was no doubt that this led to significant potential – real and imagined – for there to be gaps in the process and things that should happen simply did not because there was no one point of holistic responsibility.

In reality different trades came along to do their work as required but where this interfaced with fire-rated elements it was clear that there was little understanding of the need to make good – particularly in the area of penetrations through fire-rated elements.

3.4.3 Product Knowledge

Incorrect use of PFP products was another major area of concern expressed to the researchers in that a number of PFP products were often used incorrectly. The primary issue was a lack of product knowledge – what to use and where and how individual products should be correctly used.

Intumescent paints were one area in this regard mentioned by interviewees – the research team decided to explore these concerns with installers of these products. The view expressed was that in the majority of cases intumescent paint systems in commercial/industrial-scale situations were installed correctly by professional contractors. There was, however, a lack of independent checking of work and often the work was not specifically included in the main project planning and at times was treated as almost an afterthought.

3.4.4 Product Substitution

Product substitution was also a widespread practice. This is not necessarily a problem per se in that a superior product may actually be substituted, but the real issue was in relation to checking that the substituted product was suitable for its application. Individuals not qualified to make substitution choices were subjectively replacing specified products for purely financial reasons.

Often these changes were made without notification to the BCA. Strictly speaking, every time this occurred the terms of the Building Consent were being breached. BCA's were then often issuing Code Compliance Certificates unknowingly certifying non-compliant work. It was impossible to expect BCA's to identify non-complying work after the fact – substituted wall board is a good illustration of this point. The real weakness was that there was total reliance upon the integrity and product expertise of the contractors to choose an equal or superior product to that originally specified. This was a totally unrealistic expectation and highlights why there were major issues and concerns in this area.

3.4.5 Installer Competence

The typical supply chain dynamics in the New Zealand industry meant that often products were sold over the counter and unqualified and inexperienced people were installing PFP products on-site.

In one case mentioned during the interviews, the contractor employed a manufacturer and experienced installer directly and this provided a high standard of passive fire protection in the completed project.

3.4.6 IQP Competence

There did not appear to be any criteria for recognising competence of IQP's in regard to PFP inspections. It was understood from interviews that the process to appoint IQP's was generally done by accepting those previously approved to undertake inspections for the former CS 13 *Means of Escape* under the former Compliance Schedule regime. The Building Act 2004 signalled that IQP's would become LBP's and the competency assessment of these would be through a centralised process controlled by the Department of Building and Housing (DBH). Currently there are transitional arrangements for IQP recognition up until 30 November 2009.

3.4.7 Specified Systems and Compliance Schedules

Schedule 1 of the Building (Specified Systems, Change of Use and Earthquake-prone Buildings) Regulations 2005[12] prescribes fire separations and smoke separations as specified systems (Specified system SS15 in the *Compliance Schedule Handbook*) for the purposes of the Building Act 2004 if there are other fire-related specified systems in the building.

The *Compliance Schedule Handbook* clarifies that this is in relation to <u>means of escape</u>.

A fire separation is defined in the NZBC as "*any building element which separates fire cells or fire cells and safe paths, and provides a specific fire resistance rating"* while a smoke separation is defined as *"any building element able to prevent the passage of smoke between two spaces".*

Means of escape is defined in the NZBC as "*b) all active and passive protection features required to warn people of fire and to assist in protecting people from the effects of fire in the course of their escape from the fire".*

[12] NZ Government, *Building (Specified Systems, Change of Use and Earthquake-prone Buildings) Regulations 2005 (SR 2005/32), Schedule 1, Specified Systems*, Wellington, 2005.

Therefore walls, ceilings, floors, hinged doors, roller shutters, glazing elements and dampers in ductwork are all examples of building elements that could be part of a fire separation that needed to be included in a Compliance Schedule.

Not all PFP systems though are part of a fire or smoke separation and hence are arguably not included in Compliance Schedules. Examples given to the researchers were fire-rated glazing on external walls and flame barriers for foamed plastics.

From a different perspective, in order to undertake meaningful and ongoing inspections in a consistent manner it is essential that the Compliance Schedule documentation includes building drawings which clearly identify fire and smoke-rated elements. This is so that the IQP, which is conducting the ongoing compliance inspections, is readily able to identify fire and smoke compartment barriers.

3.4.8 Building Work

Another important issue to be highlighted, in addition to the content of Compliance Schedules, is the question of building work and penetrations that are done after the building is completed. From a practical perspective the issue is the control, through the Building Consent process, of work in existing buildings which affects the PFP. Then there is the issue of what constitutes building work and hence requires a Building Consent. The common practice would be that work such as data cabling, which can significantly compromise fire-rated elements in a building, is not treated as building work and hence does not trigger Building Consent and Compliance Schedule processes. Although Section 2, Paragraph 1.3 *Amendment of a compliance schedule*, in the *Compliance Schedule Handbook* clearly details responsibility for Compliance Schedule amendments, it was apparent from a number of those interviewed that the reality is somewhat different.

3.4.9 Standards

Mention was made by some of those interviewed about the role of Standards. The research team investigated this issue further.

Under the Acceptable Solution route for demonstrating NZBC compliance product testing Standards are listed (refer Appendix C of C/AS1). From a PFP perspective, C/AS1 is a prescription about how to design a building and not how to ensure it continues to perform. Maintenance etc is generally addressed by Compliance Schedule provisions. With regard to ongoing inspections and maintenance, the *Compliance Schedule Handbook* does list, for example, Standards such as AS1851:2005 *Maintenance of fire protection systems and equipment.*[13] In this particular Standard, sections 17 and 18 provide a thorough method of inspecting/maintaining passive fire and smoke containment systems and cover vertical and horizontal compartment barriers together with any openings, fire doors, fire shutters, service penetrations and control joints which prevent the passage of fire and smoke to other compartments.

[13] Standards Australia, *Australian Standard AS 1851:2005, Maintenance of fire protection systems and equipment,* Sydney, 2005.

Similarly AS/NZS 1905 is listed in the *Compliance Schedule Handbook*. The indication from industry was that this is potentially an example of a Standard that requires review and amendments or revision.

However, the reader's attention is drawn to the fact that Standards listed in the *Compliance Schedule Handbook* are non-mandatory guidance.

4 INTERNATIONAL APPROACH

PFP has received considerable attention in other developed countries. This section of the report summarises some of the information that is published overseas that is relevant to the scope of this research project.

4.1 Australia

In Australia AS1851:2005 is cited in the Building Code of Australia,[14] with sections 17 and 18 referring to the maintenance of passive fire and smoke containment systems. Section 17 of the Standard states that the basis of maintenance for compartment integrity is: to identify the respective vertical and horizontal barriers and their respective fire resistance rating or smoke containment requirements; and to ensure all openings or service penetrations and control joints in these barriers do not compromise the performance requirements relating to fire and smoke compartmentation.

Section 17 also states that: the basis of maintenance for structural fire resistant elements is to identify all the structural elements (beams, columns, girders and trusses) and their respective fire resistance rating requirements; and to ensure adequate fire protection coverings are incorporated at the correct thickness and that they are in good condition.

Section 18 sets out the requirements for inspection, test, preventive maintenance and survey of fire and smoke control features and of HVAC systems in buildings.

The Fire Protection Association Australia (FPAA) is the peak industry body representing the fire protection sector and has a proactive special interest group dealing with passive fire safety issues, Technical Committee TC18. The FPAA also contributes to improving PFP, largely in the area of training and the publication of technical literature. FPAA is also heavily involved in the Standards development process in relation to PFP.

Also at industry level, additional focus on PFP has been achieved by the Alliance for Fire and Smoke Containment which has raised the profile of PFP and produced a comprehensive document entitled *A Practical Guide to the Maintenance of Passive Fire and Smoke Containment Systems*.[15]

These initiatives have been supported by Accredifire, Certifire and Firas which are examples of private schemes established to undertake training and accreditation of products and installers.

[14] Australian Building Codes Board, *Building Code of Australia 2007*, Canberra, 2007.

[15] Alliance for Fire and Smoke Containment, *A Practical Guide to the Maintenance of Passive Fire and Smoke Containment Systems, v 1.0*, Sydney, 2007.

4.2 United Kingdom

In the United Kingdom a trade association – the Association for Specialist Fire Protection (ASFP) – produced a Guidance Document sponsored by the Department of Trade and Industry entitled *Ensuring Best Practice for Passive Fire Protection in Buildings*.[16] This guide is provided for all parties involved and took some three years to prepare.

The introduction states that "*this subject is too large, and the range of materials and building domains too complex, for all the details to be provided in one document. The Egan report published in 1998 identified the confrontational and competitive situation that exists in the construction industry and the need for training and improved skills at all levels*". The ASFP's Guidance Document also goes on to suggest that using price competition as the main criteria for selection encourages contractors to submit low tenders to win contracts. As a result, once contractors have secured the contract, they strive to increase profitability by applying pressure on their sub-contractors to further reduce prices.

The performance, in practice, of all construction materials is dependent upon the way in which the product is installed. The guidelines were developed to provide designers, regulators, building owners and occupiers with a simple reference document that provides basic guidance on the many forms of PFP found in buildings.

4.3 Applications for New Zealand

The issues in overseas countries are similar to those uncovered in local investigations. As a result, research of overseas publications has identified that a large amount of their content could well be applied to New Zealand and used both as reference and training material.

[16] Association for Specialist Fire Protection, *Ensuring Best Practice for Passive Fire Protection in Buildings*, BRE, Watford, UK.

5 CONCLUSIONS

This section of the report draws together all the information that was gathered and analysed during the project and presents a series of recommendations on changes that it is believed are required to improve the standard of PFP in New Zealand buildings.

The original premise on which the project was based – that there were significant concerns about the quality of PFP in New Zealand buildings – has been borne out by this project.

Although it was tempting to immediately focus blame on one particular sector, it was discovered that a wide range of industry participants both contribute to, and will be the solution to, the problem.

In confirming that these issues are real, however, a clear way forward to address the problems has been developed which it is anticipated will go a long way towards rectifying the current state of the PFP industry.

5.1 Summary Discussion

In the majority of the buildings inspected shortcomings in the potential effectiveness of PFP were very easily identified. The sample of buildings inspected could not be claimed to be statistically relevant. Nevertheless the findings of this project demonstrate some alarming trends indicating widespread problems due to poor knowledge, application, systems and processes.

While in some aspects of construction there is significant redundancy, with PFP systems there is often none. For example, a single collar missing from a services penetration in a multi-storey building could lead to smoke and fire spread, resulting in multiple fatalities and significant property damage.

Fortunately serious fires in buildings which put the PFP systems 'to the test' are rare events. There is reason to assume that based on the work undertaken during this project, a large number of buildings in New Zealand would fall well short of the level of fire safety performance expected from the NZBC, due to inadequacies in the PFP systems. There would be a lot of merit in conducting further research to quantify the true extent of the issues highlighted in this project.

In earlier sections of this report, discussion is presented about the findings from the project and is not repeated in this section. The reader is referred to Sections 2.4 *Survey Findings*, 3.4 *Interview Findings* and 4.3 *Applications for New Zealand*.

In summary Section 2.4 *Survey Findings* indicated that the most common area of poor practice was in relation to services penetrations. There were general knowledge gaps across the board, some systemic issues with regard to Compliance Schedules, and a lack of involvement from suitably qualified professional such as fire engineers throughout the construction process.

Summarising 3.4 *Interview Findings* these areas were all discussed in detail – designer involvement, trade coordination, product knowledge, product substitution, installer and IQP competence, specified systems and Compliance Schedules, what constitutes building work and the place and role of Standards.

Section 4.3 *Applications for New Zealand* suggested that there was a lot of international information that could be readily applied to the New Zealand context.

This section of the project report also provides some photographic examples of both poor and good trade practice.

5.1.1 Poor Practice

In Figure 5.1.1, the larger hole was drilled in the precast concrete floor panel, and an intumescent wrap was placed around the plastic waste pipe. While obviously an attempt had been made to provide integrity of the fire-rated floor element, the wrap was designed for a 100 mm hole, while the actual hole was 200 mm diameter. In a fire the wrap would have been totally ineffective – the gap was so large that the underside of the shower base could be clearly seen from the fire cell below. The other issue is that it is understood that this type of product had not been tested with the partially hollow precast flooring system into which it was installed.

Figure 5.1.1 – Oversize hole for shower waste pipe

In Figure 5.1.2, a large number of electrical cables pass through an unprotected penetration in a ceiling – the common ceiling provided a concealed space by which fire could spread to other fire cells. Concealed spaces can be dangerous from a fire safety perspective in that fire can spread unseen and unexpectedly. Another issue that is common above ceilings is fire-rated walls that, instead of being continuous up to the underside of the floor, stop at the underside of the ceiling.

Figure 5.1.2 – Electrical cables in ceiling

Figure 5.1.3 shows a typical example of a cable tray which passes through a fire-rated wall with no attempt to fire stop the penetration. As illustrated in the photograph, this is a large unprotected opening that significantly compromises the integrity of the fire-rated construction and renders the wall ineffective in achieving its intended functionality.

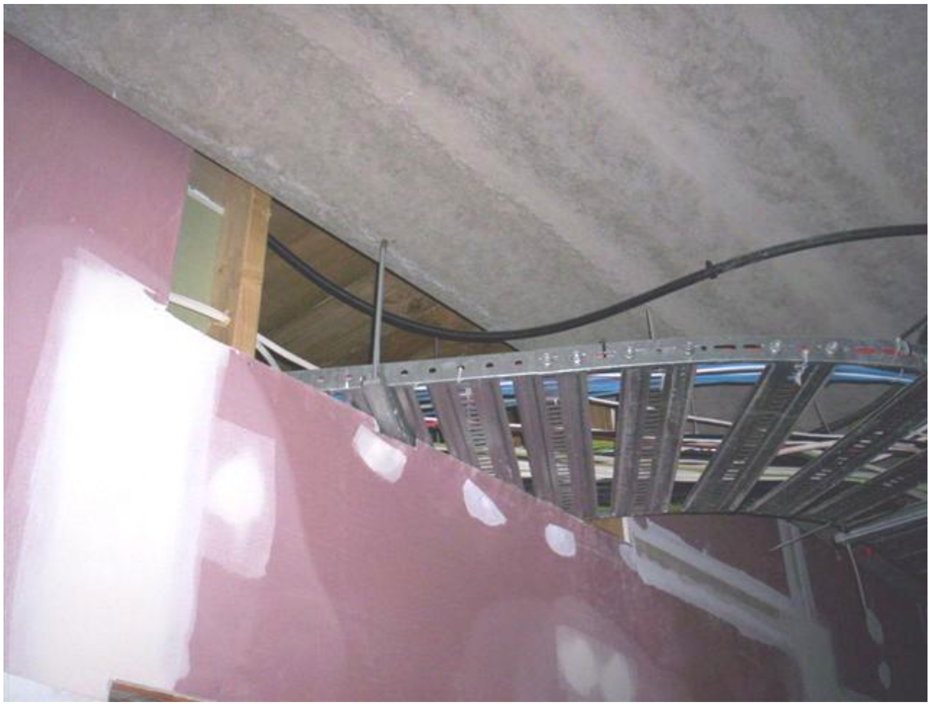

Figure 5.1.3 – Large cable tray penetration in fire-rated wall

While a very good job has been done in fire stopping the plastic pipe penetration shown in Figure 5.1.4, it has been undone by an un-rated penetration immediately adjacent.

Figure 5.1.4 – Hole in fire-rated floor

5.1.2 Good Practice

Figure 5.1.5 shows an example from an institutional building where fire-rated elements have been clearly labelled with the fire resistance rating and an instruction to seal future penetrations appropriately. In the opinion of the authors, this is an excellent example of simple but practical and effective measures that can be taken to lift awareness.

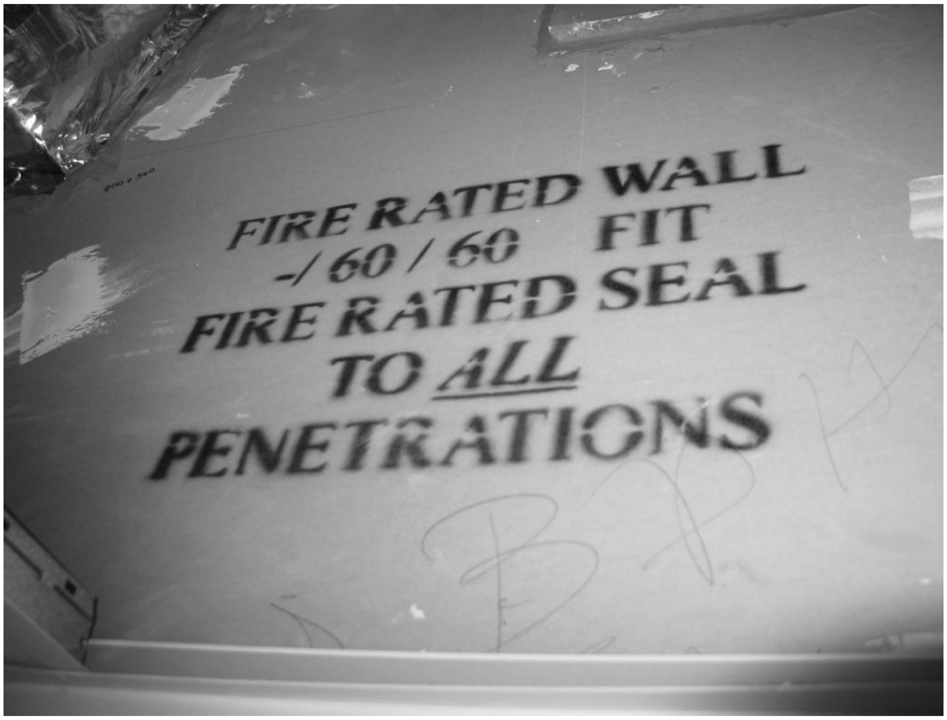

Figure 5.1.5 – Labelling of fire-rated wall

The electrical services shown in Figure 5.1.6 illustrate how such a penetration through a floor can and should be fire stopped. The key to successfully achieving continuity in integrity is the correct product applied with systematic attention to detail.

Figure 5.1.6 - Fire stopping of penetration through a floor

5.2 Recommendations

A number of important recommendations result from the research reported herein. These recommendations apply broadly across the PFP industry.

The authors of this report recommend that:

Industry Awareness

FPANZ coordinate an industry programme with DBH to increase awareness of the importance of PFP and the need for the PFP systems in buildings to be installed correctly, inspected and maintained.

Industry Skills

A generic PFP unit standard is developed and added to all trade certificate qualifications involved in the building industry and associated building work (including telecommunications).

Options for development and delivery of the effective training for those involved in PFP construction and application are investigated without delay.

Industry Practice

FPANZ coordinate the development of an Industry Code of Practice for the Installation, Inspection and Maintenance of Passive Fire Protection. This could include:

- The permanent marking of fire and smoke rated elements with ratings and penetration advisory message

- Appropriate commissioning, inspection and testing of PFP products be carried out

Manufacturers or suppliers of specific PFP products develop approved applicator or installer procedures.

The designer who carried out the fire safety design for the building also be employed to provide specific content for the Compliance Schedule in relation to PFP, and that the Compliance Schedule documentation include building drawings which clearly identify fire-rated elements.

Occupational Licensing

FPANZ make a submission to DBH regarding occupational licensing for IQP's and restricted work.

Regulatory Compliance

TA's review and strengthen their practices with respect to BWoF's.

5.3 Further Action

The research which is reported herein constitutes Phase 1 of a larger project aimed at improving the standard of PFP in New Zealand buildings. It was stated in the original funding proposal (for Phase 1) that the primary focus of Phase 2 would consist of wide communication of the findings to industry.

5.3.1 Technology Transfer

The FPANZ plans to proactively raise awareness of the findings from this research project. This programme will include, but is not limited to, the following:

- A keynote address at the annual FPANZ FireNZ Conference, held in Auckland in September 2008
- A keynote address at the Annual BOINZ Conference being held in Christchurch in April 2009
- Publicity of the findings in industry publications
- Inclusion in the Standards New Zealand Industry Advisory Group (IAG) process through the Fire Protection IAG
- Continue to proactively champion improvement of standards in the industry through the work and activities of the PFP Group within the FPANZ.

5.3.2 Training Initiatives

The FPANZ also plan the following in relation to industry training:

- Initiate discussions with Industry Training Organisations (ITO's) so as to gain acceptance of the requirement for a generic PFP unit standard
- Consultation with the relevant ITO's with a view to developing a formal National Certificate qualification for PFP.

5.3.3 End-Use Uptake

There are a number of initiatives that the FPANZ plan in relation to industry implementation of project recommendations, as follows:

- The development and implementation of a formal Product Listing Scheme for PFP products and systems.
- Obtain agreement from product suppliers to introduce accreditation of applicators/installers of their product and develop the necessary infrastructure.