FPA NEW ZEALAND

Code of Practice
for the Specification and Application of Intumescent Coatings for the Fire Protection of Structural Steel

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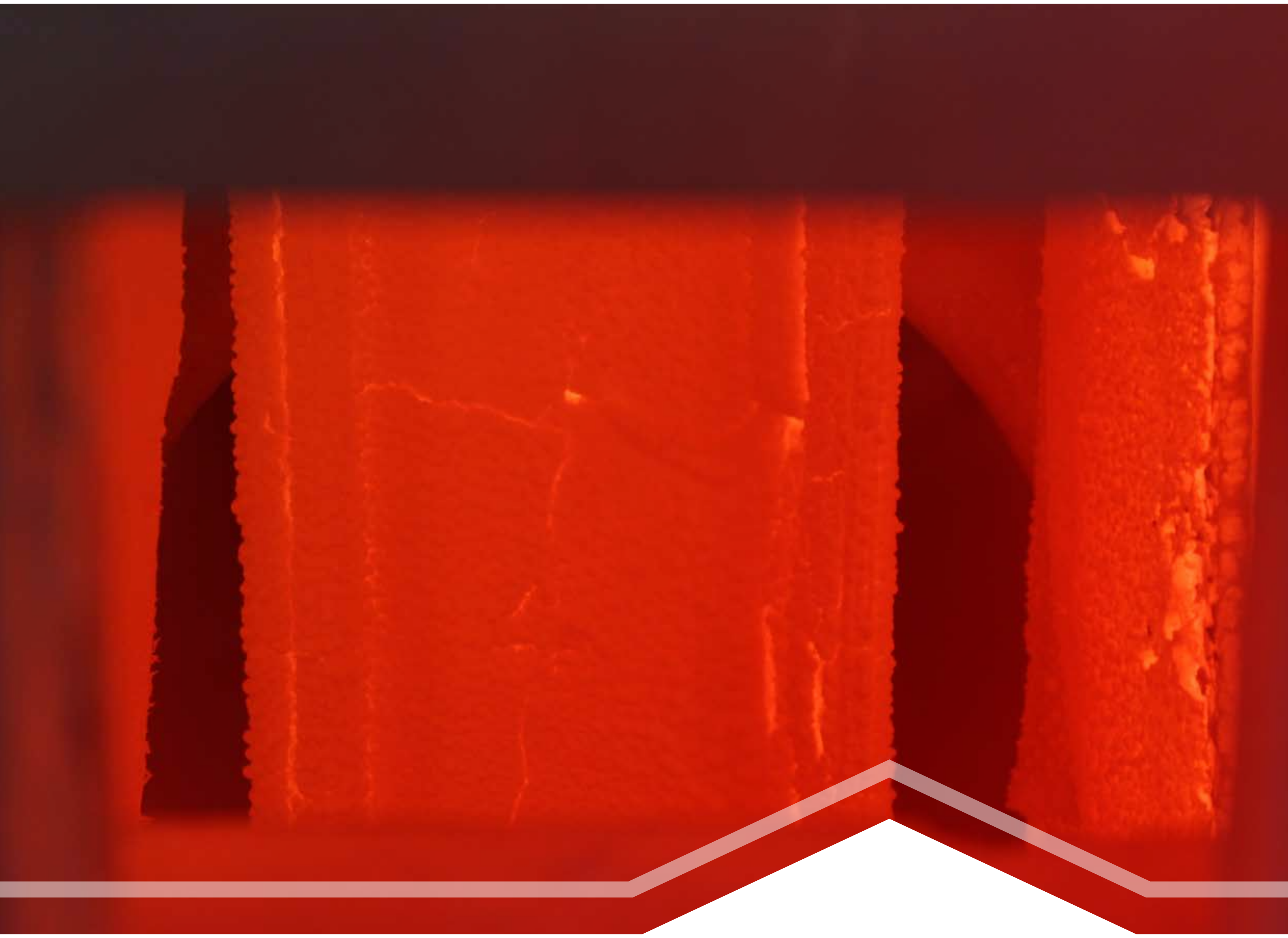

Fire Protection Association New Zealand
www.fpanz.org

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Association for Specialist Fire Protection (ASFP):

The ASFP is a UK trade association established in 1976 for manufacturers and installers of passive fire protection products. It provides technical guidance on the design, specification, and installation of passive fire protection and its first publication was the ASFP 'Yellow Book', which is referred to extensively in this publication along with other ASFP Technical Guidance Documents and Advisory notes. FPANZ acknowledges the assistance of ASFP in the production of this document by reference to ASFP publications, and both organisations mark this as the start of continued cooperation and development to improve and promote built in fire protection.

Foreword

- This Code of Practice for the Specification and Application of Intumescent Coatings was created by a working group drawn from the FPANZ Passive Fire Protection Special Interest Group (SIG), a voluntary group of leading industry professionals.

  The Passive SIG's prime function is to help maintain the highest standards within the New Zealand passive fire protection industry.

  FPANZ would like to thank the coatings working group for its vision and hard work in creating and revising this document, and acknowledges the ongoing positive effect this Code is having on the passive fire protection industry in New Zealand.

  Paul Ryan – FPANZ Vice President

- This Code of Practice has had a significant impact on the industry since its release. It is encouraging to see an initiative from within the sector bring about such a positive change, ultimately making our industry safer and more compliant every day.

  The review process has involved a working group of subject matter experts and has also included a wider construction sector input with the aim of continual improvement of this document.

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  Justin McEntyre – Passive Special Interest Group Chair/ FPANZ Board Member

About FPANZ

Established in February 1975, the Fire Protection Association New Zealand (FPANZ) is the primary organization which represents the fire protection industry in New Zealand. As a not-for-profit, its mission is:

'To provide a professional forum and be the unified voice of the fire protection industry by drawing on our expertise and collective knowledge to reduce the impact of fire in New Zealand.'

FPANZ's membership base includes those involved in fire alarms, sprinklers, hand-operated firefighting equipment, passive fire protection, system design, installation and maintenance, inspection and certification, evacuation schemes, fire equipment manufacturing and distribution, insurance, fire engineering, Fire and Emergency New Zealand, and Territorial Authorities.

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It is the intention of FPANZ that this document will be reviewed periodically.
Any reviews and feedback for future revisions can be submitted to info@fpanz.org for consideration

Table of Contents

- Acknowledgements i
- Foreword ii
- About FPANZ ii
- Copyright Notice ii
- Disclaimer ii
- Document History iii
- Amendments iv

1. Definitions 1

2. List of Abbreviations 6

3. Introduction 7
   - 3.1 Scope 7
   - 3.2 Roles and Responsibilities of Stakeholders 7
   - 3.3 Intumescent Coating System 8
     - 3.3.1 What is an intumescent coating 8
     - 3.3.2 Types of intumescent coating 8
     - 3.3.3 Suitability of an intumescent solution 9

4. Regulatory and Certification Considerations 10
   - 4.1 NZ Building Act / Code 10
   - 4.2 Regulatory Compliance 10
     - 4.2.1 Importance of the coating specification for compliance 11
     - 4.2.2 Compliance Schedule requirements 12

5. Guidance for Specifying an Intumescent Coating System 14
   - 5.1 Factors affecting performance 14
     - 5.1.1 Environmental considerations 14
     - 5.1.2 Environmental special cases 16
     - 5.1.3 Design life and Life to First Major Maintenance 16
     - 5.1.4 Repair procedure 18
     - 5.1.5 Required Fire Resistance Rating 18
     - 5.1.6 Limiting Steel Temperature 19
     - 5.1.7 Design 19
     - 5.1.8 Access 24
     - 5.1.9 Surface preparation 24
     - 5.1.10 Product selection 24
     - 5.1.11 Upgrading existing non fire-rated steelwork to an ICS 25
     - 5.1.12 Standard of architectural finish 25
     - 5.1.13 Verification and specification of Dry Film Thicknesses (Loadings) 26
   - 5.2 Considerations for management of the coating application 26

6. Guidance for the Application of Intumescent Coatings 27
   - 6.1 Choice of applicator 27
   - 6.2 Preparation of the substrate and primer 27
     - 6.2.1 Handling, transportation, and storage of shop-primed steelwork 28
     - 6.2.2 Remedial works of primed steel on site 28
     - 6.2.3 Preparation of galvanised steelwork and bolted connections 30
     - 6.2.4 Thermal Metal Spray coatings 30

Table of Contents *cont.*

6.3 Preparation for the Application of the Intumescent Coating 30
- 6.3.1 Allocation of responsibility 30
- 6.3.2 Interaction with other services 30
- 6.3.3 Health and Safety 30
- 6.3.4 Material supply 31
- 6.3.5 Storage 31
- 6.3.6 Equipment 31
- 6.3.7 Environmental conditions 31

6.4 Application 32
- 6.4.1 Pre-inspection 32
- 6.4.2 Mixing 32
- 6.4.3 Thinning 32
- 6.4.4 Environmental monitoring 33
- 6.4.5 Masking and overspray 33
- 6.4.6 Application of the intumescent coating 33
- 6.4.7 Film thickness determination 34
- 6.4.8 Repair of intumescent dry film thickness deficiencies 35
- 6.4.9 Application of sealer and/or topcoats 35
- 6.4.10 Repair of the complete Intumescent coating system 35
- 6.4.11 Change in Fire Rating Requirements or extending life of intumescent coating 37

6.5 Quality Assurance 37
- 6.5.1 Quality Management System 38
- 6.5.2 Quality control considerations and equipment 38
- 6.5.3 Intumescent coating quality assurance 39
- 6.5.4 Quality plan 39
- 6.5.5 Dry Film Thickness measurement 40

7. Records 44

8. Post-Project Completion 45

8.1 Maintenance and Inspection 45
- 8.1.1 Internal coatings 45
- 8.1.2 Exterior coatings 45

9. References 46

- **Appendix A: Key Stakeholder 'Chain of Responsibilities' during a typical Project 49**
- **Appendix B: LSTs 53**
- **Appendix C: Intumescent Coating Systems – Regulatory Documentation Requirements 55**
- **Appendix D: Sample Site Quality Plan 57**
- **Appendix E: Sample onsite application Inspection and Test Plan 59**
- **Appendix F: Example of Fire testing requirements to gain conformance to standards for intumescent coatings 60**

1.1 General requirements 60
1.2 Expression of the results 60
1.3 Test specimen size 61
1.4 Permissible variations to the tested prototype 61
1.5 Test report 62
1.6 Assessment report 63

1. Definitions

Accredited Testing Laboratory	An organization that has been independently accredited by an internationally recognized accreditation body, such as IANZ in New Zealand or NATA in Australia, to NZS ISO/IEC 17025 with a scope that includes structural steel elements of construction.
Applicator	The company responsible for the application of the intumescent coating system.
Accidental Limit State (ALS)	Corresponds to the ability of the structure to resist accidental loads and to maintain integrity and performance. NOTE: Some international Standards (for example EN) reference Accidental Limit State (ALS) for calculations on steel loads during a fire. ALS is not currently used within the New Zealand Building Code (NZBC) Acceptable Solutions; however, a structural engineer may choose to consider it as part of their design strategy.
Architect (Designer)	The person(s), part of the design team, typically responsible for specifying what fire protection will be used to meet the requirements in the Building Code and Fire Engineer's Design.
Base Coat	See Intumescent Coating.
Building Consent Authority (BCA)	Has the meaning ascribed to it by section 7 of the Building Act 2004 and undertakes the roles described in section 12 of the Act. A building consent authority performs the following statutory functions: › issues building consents (except consents subject to a waiver or modification); › inspects building work for which it has granted a building consent; › issues notices to fix; › issues code compliance certificates; and › issues compliance schedules.
(Building) Owner	An Intumescent Coating or Intumescent Coating System having current evidence or a formal opinion from an accredited testing laboratory certifying that it has been tested and/or assessed as providing a fire resistance rating for the protection of structural steel in accordance with AS 1530.4 or NZS/BS 476 part 21.
Certified Intumescent Coating System (ICS)	An Intumescent Coating or Intumescent Coating System having current evidence or a formal opinion from an accredited testing laboratory certifying that it has been tested and/or assessed as providing a fire resistance rating for the protection of structural steel in accordance with AS 1530.4 or NZS/BS 476 part 21.
Coatback	An overlap of intumescent material onto otherwise unprotected steelwork that is used to limit heat transfer. See 5.1.7.5.
Coating Manufacturer/ Supplier	The company or companies who manufacture or distribute the materials used in the intumescent fire protection system applied by the Applicator.

1. Definitions *cont.*

Composite/Non-Composite	Describes the interaction between structures. Typically, where there is no interaction between steel beams and concrete floors and the structures act independently of each other they are deemed to be Non-Composite. Composite systems include steel/concrete structures that show a high level of mechanical interactions, which generally improve the level of fire performance of the structures. In respect of trapezoidal-profiled flooring systems, if the steel beams are connected to the concrete slab in such a way that the two act as one unit, the beam is called a composite beam. Composite beams are similar to concrete T-beams where the flange of the T-beam is made of concrete slab and the web of the T-beam is made of steel section.
Competent person	A person who is able to demonstrate that they have acquired, through suitable qualifications, training and/or experience, the knowledge and expertise necessary to be able to design, install, test and/or maintain the required system(s) in a thorough and workmanlike manner in accordance with sound trade practice. Such a person is expected to work only within their area of knowledge and expertise.
Compliance Documents	The term 'Compliance Documents' had a particular meaning in the Building Act 2004 in relation to documents issued by MBIE. The Act was amended in November 2013 and that collective term was replaced by the terms 'Acceptable Solution' and 'Verification Method'. Acceptable Solutions and Verification Methods are issued by MBIE and, if followed, must be accepted by a building consent authority (BCA) as evidence of compliance with the Building Code.
Compliance Schedule	A document that contains specific information about, and procedures for, specified systems within a building as required under section 100 of the Building Act 2004. Under section 103 of the Building Act, a compliance schedule must: a) state and describe each of the specified systems covered by the compliance schedule, including a statement of the type and (if known) make of each specified system; and b) state the performance standards for the specified systems; and c) describe the inspection, maintenance, and reporting procedures to be followed by independently qualified persons or other persons in respect of the specified systems to ensure that those systems are capable of, and are, performing to the performance standards.
Contract Administrator	The person responsible for co-ordinating the various requirements of the contract and ensuring that all documentation is completed and in order. The contract administrator may be a nominee of the client or specifier, but more often would be appointed by the contractor.
Decorative Coat	A coating applied over the intumescent coat for decorative purpose only. A decorative coat may also act as a sealer or topcoat.
Designer – Design Team	The team consisting of the architect, fire engineer, structural engineer, and potentially structural fire engineer, that outline the structural members requiring fire rating, the required fire resistance level, and the protection method to be adopted. Refer individual definitions.

1. Definitions *cont.*

Designer – Coatings	The person(s) who details the actual proposed coating systems (surface preparation, primer, intumescent coating system, and sealers/topcoats) and the required DFTs of both the protective coatings products and the ICS.
Dry Film Thickness (DFT)	The thickness of a fully dried coating, usually in microns (µm).
DFT Reading	A single instrument DFT reading, often performed with an electronic DFT gauge, taken on the surface at least 25mm away from any edge or weld.
Fire Engineer (Designer)	The person(s), part of the design team, typically responsible for defining what needs fire protection and specifying the Fire Resistance Rating (FRR) needed to meet the requirements in the Building Code.
Fire Resistance Rating (FRR)	The minimum fire resistance required of primary and/or secondary elements as determined in the standard test for fire resistance, or in accordance with a specific calculation method verified by experimental data from standard fire resistance tests. It comprises three numbers giving the time in minutes for which each of the criteria: a) Structural adequacy (carrying an applied load within defined deflection limits); b) Integrity (preventing the passage of flame or hot gases); and c) Insulation (limiting the transmission of heat) are satisfied and is presented always in that order i.e. 60/-/-. Intumescent coating systems are used on structural steel to satisfy structural adequacy requirements.
Fire Separation	A fire separation is defined in the Building Code as any building element which separates firecells, or firecells and safe paths, and provides a specific fire resistance rating.
Heated Perimeter	See Section Factor.
Inspection (and) Test Plan (ITP)	A checklist of quality control procedures which may include ‘hold points’ to be signed off by stakeholders before the next process of the application may proceed.
Intumescent Coating (Basecoat)	A coating that reacts to heat by swelling in a controlled manner to many times its original dry film thickness to produce a carbonaceous char layer that insulates the underlying substrate from a heat source.
Intumescent Coating System (ICS)	A coating system comprising of all required coatings and surface preparations to meet the requirements and specification. Usually consisting of a primer, intumescent coat, and sealer and/or topcoat.
Limiting Steel Temperature (LST)	The maximum temperature of the critical element of a steel member prior to failure, under fire conditions. See Appendix B.
Loading Schedule	A table specifying the corresponding dry film thickness (DFT) required for the intumescent coating to achieve the fire resistance rating (FRR) required for steel members.
Main Contractor	The company responsible for the execution and completion of the overall project including works carried out by sub-contractors.
Member	An individual item of steelwork, e.g. column, beam, brace, truss etc.

1. Definitions *cont.*

Plans and Specifications	The Building Act defines Plans and Specifications as: a) the drawings, specifications, and other documents according to which a building is proposed to be constructed, altered, demolished, or removed; and b) includes the proposed procedures for inspection during the construction, alteration, demolition, or removal of a building; and c) in the case of the construction or alteration of a building, also includes— i. the intended use of the building; and ii. the specified systems that the applicant for building consent considers will be required to be included in a compliance schedule under section 100 of the Building Act; and iii. the proposed inspection, maintenance, and reporting procedures for the purposes of the compliance schedule for those specified systems.
Primer	A protective coating, usually anti-corrosive, applied to the substrate prior to application of the basecoat. For site-applied intumescent coatings, the primer is the only part of the specification that would normally be applied in-shop.
Producer Statement	A professional opinion that specific building work, designs, or specifications comply with technical requirements that satisfy the provisions of the New Zealand Building Code or a building consent. There are currently four types of producer statements known as: - PS 1 – Design - PS 2 – Design review - PS 3 – Construction (often used by the installers of proprietary systems) - PS 4 – Construction review.
Quality Plan	A document setting out the specific quality practices, standards, and sequence of activities relevant to the contract. This document may be used as an aid to efficient management of the contract, as a 'sign-off' document verifying formal inspection and acceptance of the work, or both.
Realtime	Relating to a system that processes input data within a time frame that is sufficiently short for it to be available virtually immediately as feedback on the process that the data came from. For example, having Quality Assurance (QA) system and Loadings Schedule available on site for inspectors to check in real-time.
Sealer Coat	A coating applied over the basecoat to protect the basecoat from environmental degradation.
Section	One physical piece of steel. It may form an entire member or part of a member.
Section Factor (Hp/A)	The ratio of the heated perimeter (m) of the surface exposed to fire to the area of the cross sections (m2) of the steel. It is also a measure of the rate at which a steel section will heat up in a fire. Section factor is sometimes referred to as Heated Perimeter.

1. Definitions *cont.*

Specification	A document in which the detailed fire protection requirements are defined for all elements of the structure. A Specification may include or be supported by drawings and/or plans. The Specification may allow the use of any certified product, or it may nominate a preferred supplier for the intumescent coating system, depending on the client's wishes. See also Plans and Specifications.
Specifier (Designer)	The person or company, part of the design team, who is suitably competent to issue a specification and/or drawings/plans for fire protection.
Structural Engineer (Designer)	The person(s), part of the design team, typically responsible for identifying what elements are required to be fire protected and their associated LSTs to meet the requirements of the Building Code (B1).
Substrate	A substrate, in the context of corrosion and coatings, is the parent or base material to which a coating is applied or the material upon which a process is conducted.
Territorial Authority	Has the meaning ascribed to it by section 7 of the Building Act 2004 and undertakes the roles described in section 12 of the Act. A territorial authority performs the following statutory functions: › performs the functions of a building consent authority and issues building consents; › issues project information memoranda; › issues certificates of acceptance; › issues and amends compliance schedules; and › administers and enforces annual building warrants of fitness.
Tie Coat	A coat of paint used to bond two otherwise incompatible coats.
Topcoat	Usually an architectural coating either applied over the basecoat to protect it and provide the required finish or applied over the sealer coat for a required finish. A topcoat can also be the sealer coat.
Volatile Organic Compound (VOC)	An organic compound that evaporates or vaporises readily and is harmful to the environment and/or hazardous. Typically, VOCs are released from coatings during curing. Usually measured in g/l.
Wet Film Thickness (WFT)	The measured thickness of an applied wet coating, usually in microns (µm).

2. List of Abbreviations

ACA	Australasian Corrosion Association
ALS	Accidental Limit State
ANARP	As near as reasonably practicable (NZ Building Act terminology)
ASFP	Association for Specialist Fire Protection (UK)
BCA	Building Consent Authority
BWOF	Building Warrant of Fitness
CBIP	(NZ) Certification Board for Inspection Personnel
CCC	Code Compliance Certificate
CIC	(NZ) Construction Industry Council
CM	Construction Monitoring
DFT	Dry Film Thickness
ECI	Early Contractor Involvement
FABIG	Fire and Blast Information Group (UK)
FPANZ	Fire Protection Association New Zealand
FRR	Fire Resistance Rating
Hp/A	Heated Perimeter to Area ratio (also known as Section Factor)
IANZ	International Accreditation New Zealand
ICATS	Industrial Coating Applicator Training Scheme (UK)
ICS	Intumescent Coating System
IPENZ	Institution of Professional Engineers NZ
ITP	Inspection and Test Plan
LTFMM	Life to First Major Maintenance
LST	Limiting Steel Temperature
MBIE	Ministry of Business, Innovation, and Employment
NACE	National Association of Corrosion Engineers (US/international)
NZBC	New Zealand Building Code
PS1	Producer Statement – Design
PS2	Producer Statement – Design Review
PS3	Producer Statement – Construction
PS4	Producer Statement – Construction Review
QA/QC	Quality Assurance/Quality Control
QMS	Quality Management System
SCI	Steel Construction Institute (UK)
SFPE	Society of Fire Protection Engineers
SS	Specified System
SSPC	Society for Protective Coatings (US)
TA	Territorial Authority
TPI	Third-party Inspector
VOC	Volatile Organic Compound
WFT	Wet Film Thickness

 |

3. Introduction

The use of Intumescent (reactive) Coatings Systems (ICSs) for the fire protection of structural steel elements is well established in New Zealand and throughout the world. ICSs are highly technical products where the correct specification and application of each component are fundamental to the overall performance of the system.

3.1 Scope

This Code of Practice is intended to establish good practice technical and process guidelines for the specification, application, and quality control of intumescent coating systems for the fire protection of structural steel. The objective is to achieve consistency across the industry, to describe what industry considers to be good practice, and to support the process needed to ensure that an ICS will perform correctly when required.

The use of ICSs for non-steel building elements is not covered by this document.

This document is primarily intended to prescribe how intumescent coatings should be specified and applied so buildings will satisfy the performance requirements of the NZ Building Code.

To achieve this, it is important that the level of fire resistance rating is adequate for the structure, and that there is objective evidence that intumescent coatings have been applied correctly.

3.2 Roles and Responsibilities of Stakeholders

From concept through to completion and handover, a variety of stakeholders will be involved in the specification, approval, application, and maintenance of ICSs, for both new and existing buildings.

The key stakeholders this document refers to are:

- Designer – which includes Structural Engineer, Architect, Fire Engineer, and Coatings Specifier
- Manufacturer(s)/Supplier(s)
- Local Territorial Authority (Building Consent Authority)
- Client/Building Owner
- Main Contractor
- Applicator(s)

Appendix A summarises the ‘chain of responsibilities’ for each of these key stakeholders, and their expected responsibilities at each stage of a typical project. The definitions of section 1 are also relevant.

When other stakeholders (consultants, third-party inspectors, etc.) are involved, the key stakeholder who has contracted them is generally responsible for defining their roles and responsibilities. These should be clearly defined within the Specification, especially around the need for quality assurance and third-party sign off.

3. Introduction *cont.*

. The Society of Fire Protection Engineers (SFPE) New Zealand Construction Monitoring Guide provides useful clarifications about the roles and responsibilities of those involved in building projects and outlines that it is an industry expectation that the designers are best placed to explain what procedures are appropriate for the monitoring of building work during construction, based on their designs. The guide uses fire proofing of structural steelwork as an example where a specialist designer is required outside of the normal design team (e.g., in addition to the Fire Engineer, Structural Engineer, or Architect). The guide clearly states the primary designer(s) has primary responsibility for the implementation of their designs on the construction site, but indicates that the Fire Engineer, in fulfilling their PS4 for the overall site observation of design features relating to fire engineering, will likely be reliant on a PS4 or Completion Statement from the Specialist Passive Designer.

It is not only good practice, but is highly recommended, to hold a pre-job meeting to ensure responsibilities and outcomes are well-defined, documented, and understood by all parties involved. Such a meeting is referred to in the SFPE New Zealand Construction Monitoring Guide where it is recommended the Fire Engineer leads an on-site meeting with all relevant parties to run through expectations around design comprehension, project communications, programme, quality expectations, commissioning arrangements, and completion documentation etc.

3.3 Intumescent Coating System

An ICS usually has three main component layers: primer, intumescent coating, and sealer/topcoat. In some cases, additional coating types (e.g. for enhanced corrosion protection or aesthetics) are applied in one or more layers.

To perform satisfactorily, an ICS needs to be applied to correctly prepared steel, in the correct environmental conditions, and in accordance with the coating manufacturers' instructions.

3.3.1 WHAT IS AN INTUMESCENT COATING

An intumescent coating is a material that swells when exposed to the heat produced by a fire. The coating has special chemicals suspended within a binder. As the binder is exposed to elevated temperatures it softens allowing the chemicals to react. This reaction forms a thick solid foam-like char that can be over 50 times the original film thickness. This char burns very slowly and provides thermal protection to the underlying substrate by insulating it from heat transfer.

3.3.2 TYPES OF INTUMESCENT COATING

There are two generic types of intumescent coatings: thin film and thick film:

a) **Thin film intumescent coatings** – the most common coatings – are comparatively easy to apply, and often have a good aesthetic finish. They are waterborne or solvent-based and are primarily for internal use, although some are suitable for exterior applications. A sealer coat is often required to protect the intumescent coating from extended weathering during the construction phase unless the coating system

b) **Thick film intumescent coatings** – often (but not exclusively) epoxy-based coatings – are typically used in exterior applications, severe service environments, or when a longer period of fire resistance is required.

3. Introduction *cont.*

In most instances, certified thick or thin film intumescent coatings are used in New Zealand. Certified coatings are formally assessed for the fire protection of structural steel by an accredited laboratory in accordance with either AS 1530.4 or NZS/BS 476 part 21, the standards cited in the NZ Building Code Acceptable Solutions and Verification Methods.

3.3.3 SUITABILITY OF AN INTUMESCENT SOLUTION

An intumescent coating solution may not always be suitable, especially where there is insufficient space available for the coating to fully expand. Examples also include partitioning along the line of a structural steel frame. In such cases, alternative measures should be considered (for example, boarding systems, flexible blanket systems, concrete encasement).

4. Regulatory and Certification Considerations

4.1 NZ Building Act / Code

The New Zealand Building Act and Building Code do not specify how buildings are to meet the functional and performance requirements within the Building Code. Instead, designers preparing 'plans and specifications' for a proposed building have to demonstrate that the building will comply with the Building Code requirements before a building consent is issued.

Designers often follow the guidance in an Acceptable Solution when preparing a building's plans and specifications or follow a Verification Method to check the proposed building design will comply with the Building Code. If the designer complies with these documents, a Building Consent Authority (BCA) must accept that the proposed building will comply with the Building Code and issue a building consent. Those responsible for the construction must demonstrate they have complied with the consented plans and specifications before a Code Compliance Certificate is issued.

Intumescent coating systems (ICSs) provide one way of protecting the structural system from fire so as to avoid collapse during and after a fire. Some of the compliance documents cite standards that can be used to select an appropriate ICS or specify how it is to be applied. In particular, testing standards AS 1530.4 and NZS/BS 476 part 21 can be used to verify that an ICS will provide the required protection. Refer to Appendix F for more information.

Documenting the performance of a specific ICS will therefore typically reference the manufacturer's literature, which in turn will reference a fire test that has been performed to demonstrate the ICS will provide the required fire resistance rating. The manufacturer's documentation and test certificates may need to be included in a consent application. The need for this should be clarified during pre-lodgement discussions with the BCA.

Testing and certification regimes and documents other than AS 1530.4 and NZS/BS 476 part 21 may also be acceptable. However, it is strongly recommended that the acceptability of such less-common compliance paths be established with the BCA during pre-lodgement discussions.

4.2 Regulatory Compliance

It is good practice to ensure that measures that will provide regulatory compliance are built into every contract at the design and specification stages. Where a building design incorporates an ICS as part of the fire engineering design and structural fire protection requirements, the building consent and tender documentation needs to be final and complete.

The application for consent needs to include enough detail to demonstrate how a building constructed to the proposed design complies, and how the building can be constructed to comply with the building consent. This includes providing information such as plans,

4. Regulatory and Certification Considerations *cont.*

specifications, and enough information supporting the design to satisfy the Building Consent Authority that all the relevant Code requirements have been met.

The regulatory requirements can be broken into three sections:

a) Building consent application (Processing);

b) Construction and inspection (Realtime); and

c) Code Compliance Certification.

Further information of each of these sections can be found in Appendix C: Intumescent Coating Systems – Regulatory Documentation Requirements.

4.2.1 IMPORTANCE OF THE COATING SPECIFICATION FOR COMPLIANCE

The project specifications allow all aspects of the passive fire/ fire safety installation to be properly and easily co-ordinated and enables all stakeholders in the contractual chain to understand their legal and contractual responsibilities.

The following contractual requirements for the specification of the ICS should therefore be covered by the project specifications:

- Design Review:
  - Fire Resistance Ratings (periods) required
  - Structural steel drawings detailing members to be protected and to what extent
  - Structural steel section sizes
  - Design LST(s)
  - Nature of any partial protection provided by concrete floors, fire-rated walls, etc.
- Environmental requirements
- Products to be used
- Primer Film Thickness
- Intumescent dry film thickness (loadings)
- Sealer/topcoats (if required)
- Health and safety provisions
- Environmental protection regulations
- Quality Assurance and Quality Control provisions.

Using the information provided above, a project-specific coating specification can be created that includes, but is not limited to:

- Contract information
- Project name and location
- Environment of application
  - Corrosion category
  - Expected weather conditions during construction
  - Special environmental factors

4. Regulatory and Certification Considerations *cont.*

- Substrate material and FRR required
- Who the specification has been produced for
- Surface preparation requirements
- Coatings
  - Intumescent coating system(s) selected/specified
  - Primer and topcoat selected/specified (if applicable)
  - Finish colour (if important)
  - Expected coverage
  - WFT and DFT required to achieve FRRs specified
  - Mix ratio (if applicable)
  - Minimum and maximum time to re-coat, including environmental conditions for drying or limitations for application
  - Loading schedule
  - Manufacturers' specified minimum and maximum allowable thicknesses of primer, intumescent paint, and topcoats (where applicable)
- Specifier information
  - Specifier's name
  - Date specification created
- Product Technical Data Sheets for all coatings being specified
- Safety Data Sheets for all coatings being specified and any on-site exclusion zones during their use or spray application
- Relevant Test or Assessment Reports
- Structural steel references where noted on general drawings
- Excluded fixings – e.g. requirement for no timber blocking ICS expansion
- Order of system installation, where this is important (e.g. before erection of dry wall)
- Any other site-specific requirements for safety or compliance (for example an exclusion zone around the area of application).

The detailed coating specification should ideally be created pre-consent. If it is created post-consent, the final coating specification should be submitted to the BCA as a design/consent amendment.

It is desirable that the necessary completion documentation (e.g. PS3, PS4) is defined in the consent and tender details.

4.2.2 COMPLIANCE SCHEDULE REQUIREMENTS

Buildings that contain certain safety and essential systems ('Specified Systems') require a Compliance Schedule to be issued by the BCA/TA. *The Building (Specified Systems, Change the use, and Earthquake-prone Buildings) Regulations 2005* defines a range of systems as Specified Systems, including Fire Separations under - *SS 15 Other fire safety systems or features.*

4. Regulatory and Certification Considerations *cont.*

SS 15/3 includes fire separations and requires that they be listed on a Compliance Schedule where the fire separation forms part of the means of escape from fire which contains one or more of the Specified Systems 1 to 6, 9, and 13.

Where an ICS forms part of a fire separation, or is included within structural element's design to support a fire separation (such as a fire wall or floor), details of the ICS are required to be included within the building's Compliance Schedule. Other structural elements may be protected with an ICS but are not required to be listed as a Specified System.

However, because all ICSs require ongoing inspection and maintenance to ensure that they continue to perform as required throughout the life of a building, it is considered good practice that all ICSs appear on the Compliance Schedule (see section 8 and 5.1.3).

Once a building has been completed in accordance with the building consent the building's owner will be issued with a Compliance Schedule at the same time as their Code Compliance Certificate. The Compliance Schedule lists the building's Specified Systems, the performance standards, and the inspection, maintenance, and reporting procedures necessary to keep them in good working order.

A Compliance Schedule for ICSs includes:

- a detailed description of each Specified System (member with an ICS)
- location information for each ICS (e.g. as-built drawings, plans)
- performance standards for each ICS
- the inspection and maintenance procedures required to ensure the ICSs continue to function as intended (refer to the supplier and/or AS 1851 for more information).

The building's owner is then responsible for ensuring that all the inspection, maintenance, and reporting procedures for the Specified Systems stated in their building's Compliance Schedule have been carried out, and that those systems are performing, and will continue to perform, to the specified performance standards.

Every year the building owner is required to supply the relevant Territorial Authority with a Building Warrant of Fitness (BWOF), which certifies that the inspection, maintenance, and reporting procedures of the Compliance Schedule have been fully complied with for the previous year.

The design life and Life to First Major Maintenance requirements of an ICS will depend on a range of factors and may be building specific. For further information see 5.1.3.

5. Guidance for Specifying an Intumescent Coating System

The following will typically be conducted by a dedicated specifier, or other skilled and competent person (see definitions) when tendering or specifying for a specific site or project.

Formal training in coating specification is available from recognised organisations (e.g. NACE, SSPC). Training may also be available from ICS product manufacturers or suppliers.

The resulting coating specification will need to be submitted to the Building Consent Authority and should preferably be completed prior to consent submission or project tender.

5.1 Factors affecting performance

5.1.1 ENVIRONMENTAL CONSIDERATIONS

It is vital to ensure that the correct ICS is specified for the environmental conditions each system will be exposed to, both during the application and construction phase, and during its in-service period.

Consideration of the application environment and subsequent timeframes for project completion will also be necessary.

For example, it is necessary to consider the implications for an ICS applied to a steel frame that will be located internally to an office building in a C1-C2 interior zone (see Table 1) but during construction it may be exposed for a period to an environment such as a C3-C4 exterior zones until the building envelope is completed. The ICS manufacturer should be consulted for advice in such situations.

Table 1: AS/NZS 2312.1 Corrosion Categories

AS/NZS 2312.1 Category	Corrosivity Rating	Examples of typical environments	
		Interior	**Exterior**
C1	Very Low	Offices, shops, hotels, controlled internal air-conditioned environments	N/A
C2	Low	Warehouses, sports halls	Arid/Rural/Urban
C3	Medium	Food processing plants, breweries, dairies	Coastal low salinity
C4	High	Swimming pools, livestock buildings, industrial plants	Sea shore (calm)
C5 - I (industrial)	Very High	Plating shops, chemical sites	Within chemical plants
C5 - M (marine)	Very High	N/A	Sea shore (surf)/offshore

Specifiers may wish to consult corrosion experts familiar with the specification of coating systems or corrosion prevention (e.g. ACA, NACE, SSPC, or similar industry qualifications),

5. Guidance for Specifying an Intumescent Coating System *cont.*

protective coating manufacturers, or corrosion engineers. Table 2 gives some general guidance.

The designer (e.g. structural engineer) should define the required corrosion class areas to comply with SNZ TS 3404 which is to be used in conjunction with AS/NZS 2312.1 and AS/NZS 2312.2 within a project during the design phase, in order to have consistency of environmental classification for the coating system selection and performance.

Table 2: General suitability of various intumescent/fire rating coatings per environment

Fireproofing type	Interior, C1-C2	Interior, C3	Exterior, C1-C4	Exterior, C5
Single Pack, Waterborne	Suitable	Not suitable	Not suitable	Not suitable
Single Pack, Solvent-based	Suitable	Suitable	Supplier approval required	Not suitable
Cementitious, Low Density	Suitable	Not suitable	Not suitable	Not suitable
Cementitious, High Density	Suitable	Suitable	Suitable	Suitable
Two Pack, Hybrid Solvent-based	Suitable	Suitable	Suitable	Supplier approval required
Two Pack, Epoxy	Suitable	Suitable	Suitable	Suitable
NOTE: This information has been compiled by coating manufacturers and is generic and indicative only. In all cases the coating manufacturer's specific product technical data sheets take precedence.				

5.1.1.1 Awareness of weathering resistance during the construction phase

The final built environment can be quite different to the construction phase environment. Special attention needs to be given to this. Steelwork that will be interior enclosed C1 once the building is completed may well be exterior exposed C3-C5 and fully open to the weather, humidity, and other environmental influences (e.g. seaside, chemicals) for an extended period during construction. Site-specific consideration needs to be given to the ICS's ability to withstand such exposure (see also Table 3).

For example, most single pack intumescent coatings have a limited tolerance to contact with moisture (condensation) or water (rain/pooling) without an appropriate sealer. Even short-term contact can result in permanent damage to some unsealed intumescent coatings. Each product has its own limitations and guidance should be sought from the supplier.

The use of appropriate seal coats and/or topcoats can help with enhancing the weather protection of the ICS. Where continuous exposure to the elements is likely during the construction phase, sealing and/or top coating will be necessary, unless otherwise proven. Refer to the ICS manufacturer for guidance.

5. Guidance for Specifying an Intumescent Coating System *cont.*

Table 3: Typical short-term durability for rain/moisture exposure of different Intumescent Coatings

Type of Topcoat	Waterborne single pack intumescent	Solvent-based single pack intumescent	Hybrid intumescent	Epoxy Intumescent
No Topcoat	Not suitable	Up to 6 months*	Up to 6 months	No limitations
Waterborne Acrylic	Up to 3 months	Not recommended	Not compatible	No limitations**
50µm of Polyurethane	Up to 6 months	Up to 12 months	Up to 12 months	No limitations
150µm of Polyurethane	Up to 6 months	Up to 10 years	Up to 10 years	No limitations

** 6 months is not feasible with all solvent-based products, but only those specifically formulated to give that durability. Standard product durability will be about 3 months. Actual weather conditions will vary these estimated figures.*

*** A waterborne acrylic topcoat is not expected to improve durability on exposure, so the durability will be similar to that without a topcoat.*

NOTES:

1. *The durability periods above all rely on the intumescent coating being fully dry before it is exposed to any weathering. It is also essential that any single pack materials do not have prolonged contact with water/ moisture, e.g. ponding or running water, even with a polyurethane topcoat applied.*
2. *This information is generic and indicative only. In all cases the coating manufacturer's specific product technical data sheets take precedence.*

5.1.2 ENVIRONMENTAL SPECIAL CASES

Special case environments and environmental factors that will influence the assignment of a corrosion category include:

- Exterior zones exposed to weather/salt spray
- Industrial corrosive atmospheres
- Humid/damp environments
- Extreme temperatures
- Frequent washing and/or cleaning
- Splash zones
- Abrasion/impact/vibrations
- Hard to clean/inspect zones
- Ease of maintenance

5.1.3 DESIGN LIFE AND LIFE TO FIRST MAJOR MAINTENANCE

For a Building Code acceptable solution approach, the applied ICS must comply with Building Code clauses C6 (Structural Stability) and B2 (Durability). Clause B2 and Acceptable Solution B2/AS1 set the minimum durability periods for building elements that have normal maintenance as not less than 50, 15, or 5 years depending on the ease of access and remediation.

However, any need to substantially remove and reinstate the intumescent coating at any stage in the life of a building will involve considerable cost and disruption. Therefore,

5. Guidance for Specifying an Intumescent Coating System *cont.*

serious consideration should be given to specifying an ICS that will last for the design life of the building (typically 50 years), allowing for the normal maintenance generally recognised as necessary to achieve the expected durability.

Advice should be sought from manufacturers and suppliers as to the appropriate ICS to be specified, including the expected design life and Life to First Major Maintenance (LTFMM) for the ICS. This will consider factors such as:

a) Environmental classification (see Table 1);
b) Interior vs exterior systems;
c) Type of intumescent coating;
d) Whether a protective topcoat is required or not; and
e) Durability (B2/AS1) requirements – 5, 15, or 50 years.

For example, a thin film acrylic intumescent coating designed for installation in C1 interior environments may not have an LTFMM specified, as they are typically installed in areas free from human impact and damage and are intended to last the design life of the building.

For C3 or C4 exterior environments, however, where a thin film acrylic ICS typically has a protective topcoat installed, the LTFMM is generally limited to the life span of the sealer/topcoat applied over the intumescent coating in line with AS/NZS 2312.

In this situation, the LTFMM is critical; if the sealer/topcoat is compromised, the underlying thin film acrylic intumescent coating is exposed to the environment. This can lead to loss of adhesion or complete failure of the intumescent coating.

The ICS manufacturer should provide a maintenance guide to ensure the continued effectiveness and compliance of an ICS. An appropriate schedule of inspection should also be specified.

The above information should allow the whole-of-life costs to be adequately considered for the project, especially where there is a choice of ICS.

The inspection and maintenance requirements for each ICS need to be documented in the building's Compliance Schedule (see 4.2.2). AS 1581:2012 (specifically Table 14.4.2) provides detailed guidance around inspection of active and passive systems with recommendation for an annual visual inspection of structural steel fire protection for those elements that are accessible.

For more information, consult the ICS supplier. For additional guidance on building refurbishment or changes of required FRR, see 6.4.11.

As a guide the following should be the minimum:

5.1.3.1 Inspection

The frequency of inspection will depend on a number of factors relating to the coatings:

- Whether they are internal or external
- Whether they are exposed internally or hidden behind partitions, suspended ceilings, etc.

5. Guidance for Specifying an Intumescent Coating System *cont.*

- The location of the coated steel in relation to sources of potential physical damage e.g. factory floor, warehouse, supermarket, loading bay, etc.
- The final stable environment of the building will also have an effect. Coated steel in a building with high humidity levels or extremes of temperature would need to be inspected more frequently and maintained accordingly.

5.1.3.1.1 External steel

External steel should be inspected annually. If this is not possible, then engagement of the ICS supplier and design team should be considered in order to ensure long-term suitability of the product for the environment.

5.1.3.1.2 Internal exposed steel

Internal steelwork that is accessible should be inspected during the maintenance cycle of the building, usually every 3-5 years.

Small scratches or dents in the surface of the seal/topcoat are not serious and can be left until the next maintenance period if desired. If the coated steelwork is located in an area where it is more likely to be subjected to localised damage or chemical attack such as a supermarket, factory floor etc, inspection should be carried out on a yearly basis, and repairs carried out as necessary.

5.1.3.1.3 Internal hidden steel

Internal steelwork which is hidden behind partitioning/suspended ceilings is difficult to inspect on a regular basis. In an office-type environment, where the steel is concealed behind ceiling panels or partitions, the likelihood of physical or environmental damage to the coatings is low. Damage to the coatings caused by unusual circumstances, such as electrical fires or burst pipes, should be apparent and must be addressed and repaired as soon as possible after the event.

5.1.4 REPAIR PROCEDURE

A copy of the repair procedure/specification (which is typically straightforward) should be included in the project operations and maintenance manual. Where possible, it is recommended that the original supplier be consulted before carrying out any repairs in case the recommended repair procedures have changed since installation.

5.1.5 REQUIRED FIRE RESISTANCE RATING

Responsibility for determining the fire resistance ratings necessary for structural elements to meet Building Code requirements typically lies with the project's fire engineer. This needs to be determined before specification of the intumescent coating.

A structural engineer is typically responsible for providing the structural steel section sizes and identifying what items require fire protection based on the fire engineer's report. The specifier is typically responsible for the determination of how these elements are to be protected by either an ICS or other suitable fire protection system.

Typical fire resistance rating periods required for structural adequacy (X/-/-) are 30, 60, 90, or 120 minutes.

5. Guidance for Specifying an Intumescent Coating System *cont.*

5.1.6 LIMITING STEEL TEMPERATURE

The designer (typically a structural engineer) is required to determine the LST as part of the structural design package. Temperature values can also be determined from performance-based approaches which consider the structural utilisations from appropriate analyses carried out by a structural or fire engineer. It is important that the correct LST is used because assuming an elevated LST, without a proper analysis, could leave the structure under-protected in the event of a fire (see ASFP Advisory Note 19).

Consideration should be given to the relevant guidelines and safety factors of the overarching structural design standard used for the project (which for an installation to the NZ Building Code will normally be NZS 3404 and AS/NZS 1170 part 0) as modified by the Acceptable Solutions and Verification Methods for NZBC clause B1.

Attention should also be given to weld and bolt connections. There is no specific method for calculating such junctions within NZS 3404. However, these members will have differing yield performance and should be given consideration by the designer(s).

For more information on the effect of LST, see Appendix B.

5.1.7 DESIGN

The following sections are a summary of the design considerations for projects where an Intumescent Coating System will be used. Further information can be found in a variety of resources including the ASFP Yellow Book or ASFP Technical Guidance Document 11: Annex D.

5.1.7.1 Junctions between different passive fire protection systems

In addition to ensuring that all aspects of intumescent coating applications are compatible, considerable design focus should be exercised at, and around, the junctions between different passive fire protection systems and different construction methodologies/products.

Where an intumescent coating system meets a spray system, the spray system should overlap the intumescent system by 100mm. Similarly, where an intumescent coating system meets a boarded system then the board system should overlap the intumescent system by 100mm and be capped off using the same board system as shown in Figure 1.

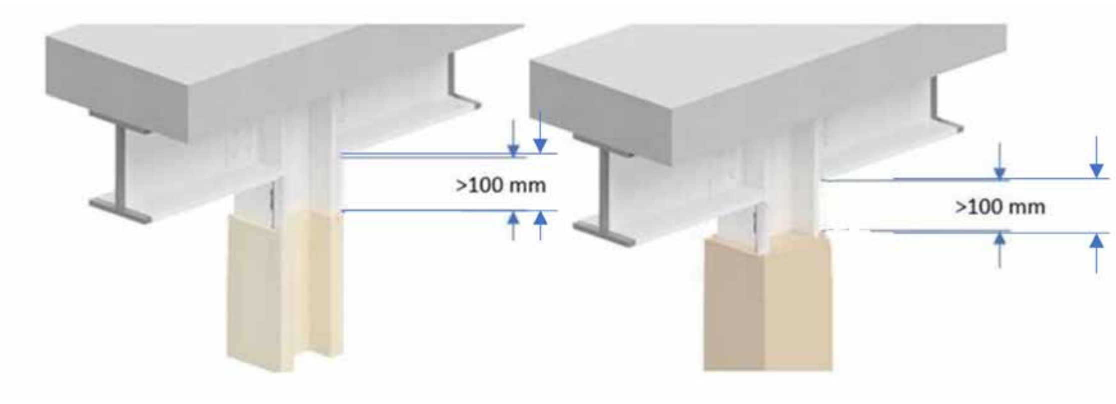

Figure 1: Left - Junction between cementitious (column) and intumescent coating (beam). Right - Junction between boarding system (column) and intumescent coating (beam).

5. Guidance for Specifying an Intumescent Coating System *cont.*

The construction advice of manufacturers of all passive fire protection systems involved should be sought regarding any proposed arrangement, as their product may have specific requirements or exclusions.

See ASFP Technical Guidance Document 8 for additional details and suggestions.

5.1.7.2 Standoff distances

Timber noggins/joists, battens and wall framing are often used in conjunction with structural steel. If timber is fixed directly to and over intumescent coated steelwork, the coating underneath the timber will not be able to intumesce to achieve the required fire resistance rating.

Where wall systems, cladding systems or timber framing are to be used in conjunction with an intumescent coating for protecting steel members from fire, and no supporting test evidence proves otherwise, a gap of 50 times the DFT of the intumescent coating will generally need to be provided (for thin film intumescent coatings) to allow for full expansion of the intumescent coating during a fire. Gap sizes may be reduced to 10 times the DFT where an epoxy or MMA (Methyl Methacrylate) intumescent is used, or where the intumescent coating manufacturer has specific test evidence to justify a reduction for the specified period of fire resistance. This guidance also applies to the gap required between the cladding/framing and the flat surfaces of the protected steel section, as well as to flange tips.

This standoff distance may be achieved by various means, including:

a) 'Z' clips or equal angles attached to the main steel member itself to offset the framing from the fire-rated member. These are considered fixings (see 5.1.7.6); or

b) Achieving the required FRR by boarding with fire-rated materials; or

c) Tested and concept-proven methodology conducted by intumescent coatings supplier/manufacturer.

Where cladding systems/timber framing and intumescent coatings are to be used together a proving test needs to be documented, or a formal assessment obtained, from an accredited laboratory in accordance with AS 1530.4 or NZS/BS 476 part 21.

For more information consult the intumescent coating supplier.

5.1.7.3 Web openings (Cellular and castellated beams)

Long-span beams with multiple web openings, commonly known as 'cellular beams' or (historically) 'castellated beams', have numerous openings in the web to accommodate services such as pipes and ducts through ceiling voids. The openings can be any shape, however circular openings are most common.

The introduction of openings in the web of the steel beam means the structural capability of the beam differs from that of a solid beam. Cellular beams can display complex failure mechanisms in a fire compared to a solid beam. It has become clear that the limiting temperature of such beams is not the same as for unperforated sections. Instead, the geometry of the beam defines the limiting temperature, so every cellular beam needs to be assessed on its own merits.

5. Guidance for Specifying an Intumescent Coating System *cont.*

Some cellular beam manufacturers will supply limiting temperatures for their products. Generalised (or universal) solutions are not appropriate.

Alternative calculation of Area/Volume can be used in lieu of Hp/A for Cellular beams whereby the Area/Volume is calculated to account for openings.

It is good practice to obtain advice from a specialist structural fire engineer.

Cellular beams are most commonly protected using thin film intumescent coatings. The Association for Specialist Fire Protection (ASFP) and the Steel Construction Institute (SCI) have developed structural models for beams with circular and rectangular web openings which enable the calculation of the limiting temperature as a function of beam geometry and load. As an alternative solution under the NZBC compliance regime, these models might be used to determine the correct intumescent coating thickness for the required fire resistance rating period.

Further information on determining product thickness, and fire test and assessment procedures for cellular beams protected with intumescent coatings can be obtained from the ASFP Yellow Book, online resources, or from the supplier.

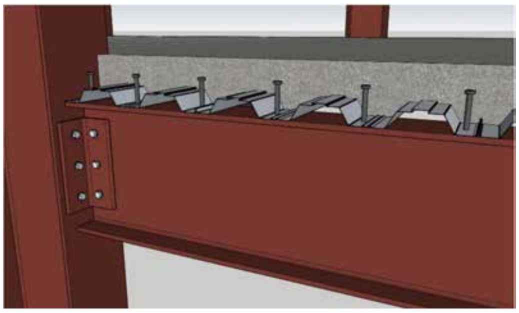

Figure 2: Trapezoidal decking

5.1.7.4 Deck voids

Trapezoidal profiled flooring systems, as shown in Figure 2, create voids between the slab soffit and the (unprotected) top surface of the beam, which provides a direct heat path into the steel member in a fire scenario. Such decking sheets are typically fixed to the top flange of the beam by a series of shear studs involving an electric arc welding procedure that relies on electrical conduction being maintained through the connection between the stud, decking sheet and top flange, preventing the beams being protected with intumescent material prior to the sheets being fitted.

To cater for the additional heat transfer to the exposed top flange of the steel beam two approaches are typically employed. These can be either:

a) Fill the void between the top flange of the beam and the deck with a certified fire stopping product, as shown in Figure 3; or
b) Leave the void unfilled but increase the thickness of the fire protection coating on the rest of the beam, see Table 4.

Either approach can be used successfully but will have an effect on cost of materials, labour, and time.

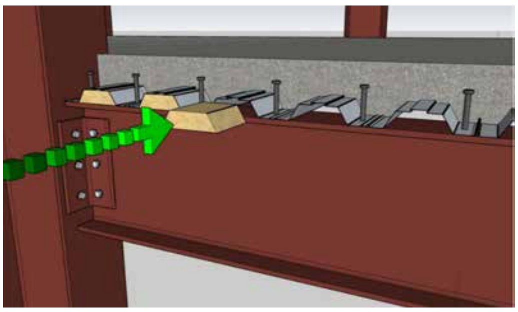

Figure 3: Filling voids in trapezoidal profiled decking

When using the default LST of Appendix B, Table 4 provides conservative guidance on filling the voids from trapezoidal decking. A more detailed analysis may be able

5. Guidance for Specifying an Intumescent Coating System *cont.*

to rationalise the design with the aim of reducing the required thickness of coating to achieve the required performance outcome.

Table 4: Recommendations for dry film thickness adjustment for trapezoidal decking when using default LST of Appendix B (from ASFP Yellow Book 5th Edition)

Beam Type	**Fire Resistance Required**		
Composite	30-60min	90min	Over 90min
	Increase DFT by 20% or Increase Hp/A by 30% and assess DFT	Increase DFT by 30% or Increase Hp/A by 50% and assess DFT	Fill voids
Non-composite	Fill voids		

If the LSTs are to be calculated individually for each steel beam, rather than using default LSTs of Appendix B, the beams with exposed voids will need to account for this by reducing the calculated LST. Table 5 shows the adjustments that typically need to be made to the LST.

Table 5: Typical trapezoidal decking temperature modifications for beams with specified limiting temperatures (ASFP Yellow Book 5th Edition)

Beam Type	**Temperature reductions to calculated LST required for fire resistance**			
	30min	60min	90min	Over 90min
Composite	50°C	70°C	90°C	Fill voids
Non-composite	Fill voids			

It should be noted that the use of re-entrant or 'dovetail' profiled decking sheets as shown in Figure 4 requires no additional considerations in the use of intumescent coating as the top flange can be regarded as being fully protected by the floor system.

It is likely to be necessary to consult either a fire engineer, structural engineer, and/or supplier for further clarification when using trapezoidal decking systems. More information can be found in the ASFP Yellow Book Annex 3.5.

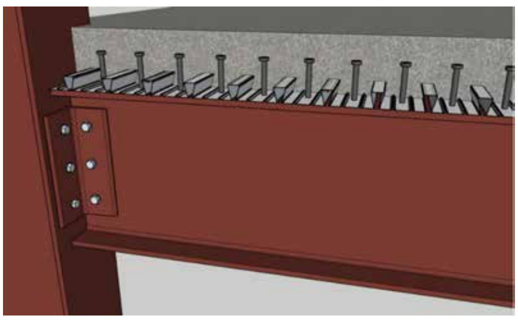

Figure 4: Re-entrant or 'dovetail' profiled decking

5.1.7.5 Junctions between protected and unprotected steel

The potential for heat transfer from unprotected structural steel into protected structural steel also needs to be considered. Unless specified otherwise by a competent person, it is necessary to protect the adjoining 'unprotected' structural

5. Guidance for Specifying an Intumescent Coating System *cont.*

steel with an intumescent coating to limit unwanted heat transfer. The application of the intumescent coating onto adjoining steel is known as a coatback. The coatback shall be 500mm or the lesser length of the member. Such coatbacks should be specified in the tender information supplied for the project. The design team needs to confirm at the design stage whether coatbacks are required, or not, and this should be thoroughly documented.

See ASFP Technical Guidance Document 8, section 3 and ASFP Advisory Note 21 for further detail.

5.1.7.6 Fixings

Where it may be necessary to make attachments to steel members (e.g. suspended ceilings, light fittings, services, angles, brackets, seismic bracing), consideration of direct heat transfer into the steel member is required. In such occurrences, the question arises as to how big the attachments can be, and also the frequency/ spacing at which they are attached, before the steel member and ICS may become compromised in a fire scenario.
Where fixings cannot be eliminated then contact the supplier for further information.

5.1.7.7 Fire Separations and Fire Walls

Intumescent coated steel beams often form part of a fire wall or fire separation, however an ICS is typically certified only for structural adequacy (X/-/-) and not integrity (-/X/-) or insulation (-/-/X). The fire separation factors need to be considered separately.

An integrated system may be necessary, and it is recommended that the designer considers this.

Particular caution should be exercised with intumescent coated beams in conjunction with fire walls where the beams have service penetrations. Unless tested and certified as a combination in accordance with AS 1530.4 or NZS/BS 476 part 21 by a suitably accredited laboratory, this arrangement is not advisable because both systems are certified to different criteria. In such situations, it is recommended that the stand-off distances of 5.1.7.2 be observed, and a suitable fire rated board system be used along with an AS 1530.4 / AS 4072.1 certified passive fire system.

Because of the uncertainty about the most robust method of installing partitioning to the underside of structural steel beams coated with an ICS, and the possible impact this may have on any performance, it is recommended that the beam or column is treated for fire protection and acoustic separation as if there were no other treatment to the steel to replace the level of protection designed to be provided by the ICS, and also meet the performance requirements of the partitioning.

Boxing out the beam or column with an independently tested framed or unframed system that will provide the required level of fire protection to the beam/column ensures that the beams/columns are protected and that the performance requirements of the compartmentation are maintained.

For further information see ASFP Advisory Note 18 and consult the intumescent coating supplier.

5. Guidance for Specifying an Intumescent Coating System *cont.*

Steel beams do not provide any fire rating for integrity (-/X/-) or insulation (-/-/X) by default and are therefore not able to be considered an Acceptable Solution.

5.1.8 ACCESS

For the correct application of an ICS, access to the structural steel must be allowed for, especially in the case of on-site application. When applying coatings via spray gun, good practice requires the application operator to be within arm's-length of the item being painted and at such a height they do not need to raise the spray gun above their head. An allowance for the erection and maintenance of appropriate scaffolding or access machinery should be considered, as well as interference by/to other trades that may be working in the vicinity.

Environmental protection and health and safety requirements for the project, and any of these particular to the ICSs specified, should also be considered at this point.

5.1.9 SURFACE PREPARATION

Generally, the surface preparation and priming of the structural steel will be carried out by the steel manufacturer ,or an off-site coating facility, and then transported to site. It is recommended that after transportation, site storage and erection, further measures are specified to ensure cleanliness and remaining within the recoat window of the primer prior to application of the intumescent coating.

The intumescent coating system specification needs to cover the minimum level of surface preparation, including its cleanliness standard and profile requirements, and the criteria for the primer application.

a) Pre clean. (e.g. Solvent clean SSPC-SP 1);

b) Surface preparation (e.g. Abrasive blast SSPC-SP 10 or AS 1627.4 Class Sa 2 ½ with a uniform jagged profile of 35-75µm);

c) Clean/de-dust the substrate; then

d) Primer application (Application window before surface deteriorates and environmental conditions).

For more information on surface preparation standards refer to NACE/SSPC, ISO 8501.1, AS 1627.4, or AS/NZS 2312.1.

With product development and improvement, some ICS are able to be applied directly to black steel. In such cases it will be necessary to obtain the manufacturer's input and supporting test evidence before commencing application.

5.1.10 PRODUCT SELECTION

To be used in New Zealand, intumescent coatings should have test certification or a formal assessment from an accredited independent laboratory in accordance with AS 1530.4 or NZS/BS 476 part 21. Evidence of such compliance should be provided by the ICS manufacturer or supplier.

An ICS can include a primer, intumescent coating, and topcoat. Occasionally, build and sealer coats will also be required. It is essential that all proposed components are carefully evaluated for performance and compatibility (see 5.1.10.2) before being specified. Particular attention should be paid to any limitations stated in the manufacturers' technical data sheets.

5. Guidance for Specifying an Intumescent Coating System *cont.*

5.1.10.1 Primer Selection

Primer selection depends on the corrosion protection level required for the environment, whether the primer is to be applied on-site or in-shop, and the time interval between primer application and intumescent application.

The primer needs to be compatible within the intumescent coating system. Confirmation should be sought from the manufacturer of the proposed intumescent coating as to suitability and compatibility.

Primers may have specific requirements such as DFT or recoat windows. These specific requirements need to be obtained from the manufacturer(s) and included within the coating specification.

Particular care needs to be taken with zinc-rich primers where weathering exposure can lead to the formation of zinc salts, which may affect inter-coat adhesion. This may be mitigated by washing, applying a tie coat, or other manufacturer-specified procedures.

5.1.10.2 Compatibility between coats

To ensure that an intumescent coating will perform its intended function in a fire, it is imperative that all the elements that make up the ICS are compatible and have been tested in actual fire conditions by an accredited laboratory in accordance with AS 1530.4 or NZS/BS 476.21, and for durability. Before specifying an intumescent coating that has elements sourced from multiple suppliers, evidence of compatibility needs to be obtained.

5.1.11 UPGRADING EXISTING NON FIRE-RATED STEELWORK TO AN ICS

Where existing steelwork requires refurbishment or upgrading, good practice is often to completely remove the existing coating system and replace it with a new ICS. This is because there is often no definitive way to ensure that any existing non fire-rated coating system will perform adequately in a fire, the adequacy of the surface preparation beneath the existing coating, or whether it will be compatible with any new fire-rated coating system being installed.

It is recommended to consult with the ICS manufacturer prior to specification and deciding on a course of remediation. It is possible some existing coatings might not have to be completely removed if they can be assessed or tested on site.

5.1.12 STANDARD OF ARCHITECTURAL FINISH

The aesthetics of the finished ICS can vary depending on the application method and ease of access. The standard of finish required by the client should be included in the coating specification and agreed upon before commencing application. Refer to AS/NZS 5131, particularly for architecturally exposed steelwork. To ensure everyone agrees on the visual standard, the use of samples or test patches is recommended. Typically, the type of finishes that can be required are:

a) **Basic finish** – The coating system itself achieves the required performance for fire and corrosion protection. No requirements for aesthetics;

b) **Decorative finish** – As for a basic finish, however a satisfactory level of aesthetics is required when viewed from 5m. It will be smooth and even with minor 'orange peel'/ brush marks. No visible runs or sags; or

5. Guidance for Specifying an Intumescent Coating System *cont.*

c) **Architectural finish** – The coating is to have a very high level of aesthetics (even, smooth, gloss level) when viewed from 2m. This finish level should apply to visible steel only.

The applicator will typically provide a basic finish, unless otherwise specified in the contractual documents.

5.1.12.1 Selection of topcoat colours

For single pack intumescent coatings, coated surface temperatures above 40°C should be avoided at any time during its service life (e.g. solar heat via windows, atrium areas, or similar). These types of coatings start to plasticise with any entrapped solvents mobilised, giving rise to blistering and coating failure. Chemical reactions also start initiating within the coating above 60-70°C and overall fire performance may be compromised past this point. Dark-coloured topcoats exposed directly to sunlight should also be avoided, as this will exacerbate this effect.

Two pack intumescent systems have much higher temperature stability properties and can mitigate or eliminate this issue, so topcoat colours are not as important.

Seek advice from the manufacturer for individual product capabilities.

5.1.13 VERIFICATION AND SPECIFICATION OF DRY FILM THICKNESSES (LOADINGS)

Intumescent coatings typically undergo a series of type tests to ensure that they behave appropriately for each steel section shape in the event of a fire. These tests confirm the required loadings and are summarised into a table for the steel section shape, FRR, Section Factor (Hp/A), and LST. Proven test certification, or a formal assessment from an accredited laboratory in accordance with AS 1530.4 or NZS/BS 476 part 21 needs to be provided for the intumescent coating chosen.

The specification of the necessary DFT should be provided by the intumescent coating's manufacturer/supplier, after they have received the following information:

- Fire Resistance Rating required
- Structural steel drawings identifying the elements to be protected
- Structural steelwork section sizes, weights, and lengths
- Nature of partial fire protection if any, provided by concrete floor slabs, fire-resistant walls etc.
- LSTs, if they fall outside of the accepted defaults (see Appendix B).

5.2 Considerations for management of the coating application

An ICS can be installed on-site, off-site, or a combination of both. There are advantages and disadvantages for each. When deciding on the most appropriate intumescent coating system and its method of application, consideration should be given to the potential for disruption to and from other on-site trades and activities, health and safety/environmental implications (e.g. VOCs, overspray, spray drift, work at heights), cartage to site, storage and erection on site, and repairs required after installation.

The responsibilities for all aspects of the ICS project (including design, specification, scheduling, application, repair, and quality assurance) should be clearly defined and agreed between the stakeholders involved. See Appendix A for recommendations.

6. Guidance for the Application of Intumescent Coatings

Intumescent coating systems (ICS) are a highly critical and specialised building component, designed to protect the structural adequacy of the building's load-bearing elements during a fire event. They need to be installed by specialist applicators who know and understand not only the practicalities of coatings and application, but who will also provide the necessary attention to detail in the application and be underpinned by a robust quality management system.

The following sections cover application requirements. They describe the practical procedures and measures that will be needed for compliance.

6.1 Choice of applicator

A protective and/or intumescent coating is a critical factor in ensuring the design of a building or structure meets the minimum requirements for compliance. All stages of the ICS (Primer/Intumescent/Seal Coats/Topcoats) preparation and application should be carried out only by skilled professionals who can demonstrate the following as a minimum:

a) The applicator (company) holds a formal Quality Management System accreditation (various schemes and levels are available, up to AS/NZS ISO 9001); and

b) The applicator (company) is a member of a relevant professional body with a code of ethical conduct (for example, FPANZ); and

c) The applicator (or application supervisor) holds an accredited coating inspection certification (such as NACE Level 1 or CBIP); and

d) The applicator (coatings sprayer/operator) holds an accredited coatings application certificate (such as SSPC Train the Painter: white paper - thin film intumescent coating application module, or ICATS Industrial Coatings Applicator).

NOTE: it is recognised that it will take some time for the industry to fully achieve the above.

Where one or more of the above criteria has not been met, an accredited third-party coatings inspector should be engaged to oversee the project.

In the absence of the above, it may prove difficult to obtain a PS4 or Certificate of Code Compliance.

Some ICS suppliers require specialised product training to be undertaken in order to become a certified applicator of specific coatings. It is advisable to seek guidance from the supplier on this, and any other specific requirements they may have.

6.2 Preparation of the substrate and primer

This section outlines the factors that need to be considered to ensure that the substrate and primer meet all the requirements for intumescent coatings.

6. Guidance for the Application of Intumescent Coatings *cont.*

Generally, structural steel will require solvent cleaning (degreasing) and abrasive blast cleaning before being primed, which will usually be done off-site at a dedicated blast and paint company. This allows the steel to arrive to site complete with the correct blast profile and primer ready for the intumescent coating to be applied after any necessary remedials are carried out (see 5.1.9). It is important if the steel is to be prepared and primed off site that the off-site applicator has reviewed and adhered to both the ICS specification and project-specific ITP.

The applicator who has applied the primer needs to supply documentation for the steelwork including the type of primer, date of application, conformance to the specification, and average dry film thickness of the primer in accordance with AS/NZS 2312.1 or SSPC-PA 2 methodology. It is important that the primer DFT falls within the acceptable range for the ICS to be applied over it. The specification should clearly state the minimum and maximum DFT allowable for the primer coat. The level and percentage of readings to be taken should be nominated in the contractual documents.

In a case where the primer dry film thickness is found to be outside the specification, the on-site contractor should consult the specifier and coating supplier/manufacturer before proceeding.

In the unusual circumstance that the steel arrives to site as black steel, the specified method will need to be followed to ensure the level of cleanliness and profile is achieved before applying the primer. This is often a higher cost method than off-site preparation and primer application.

Note: Some intumescent coatings can, in limited situations, be applied directly to un-primed steel.

6.2.1 HANDLING, TRANSPORTATION, AND STORAGE OF SHOP-PRIMED STEELWORK

Generally, steelwork that is primed only will be more resistant to damage during transport and storage than steelwork that has had the full intumescent coating system applied. Either way, the contractor is required to implement protective measures and appropriate care during the transport, storage, and erection of the steelwork. Further information can be found in SNZ TS 3404:2018 section 4.3 or ASFP Technical Guidance Document 11 section 3.2.

To protect the primer from early onset failure, where steelwork is stored for a prolonged period and exposed to the weather it is advisable to stack and cover it to eliminate ponding of water and to periodically wash it down to remove any surface contamination.

6.2.2 REMEDIAL WORKS OF PRIMED STEEL ON SITE

6.2.2.1 Repair of transportation or erection damage

A pre-inspection of the steelwork is necessary to assess the extent of damage from transportation, storage, erection, and site modifications including on-site welding and fabrication. The repair of any damaged steelwork is typically straightforward, most often consisting of either spot power tool cleaning to a minimum of SSPC-SP 3 or spot abrasive blasting to a minimum of SSPC-SP 6, before applying a remedial spot prime to the damaged area.

6. Guidance for the Application of Intumescent Coatings *cont.*

In all cases the applicator should seek clarification from the intumescent coating supplier before commencing works.

6.2.2.2 Contaminated and/or corroded primer

Primed steel that has foreign contamination, such as concrete splatter, dust, dirt, salt deposits etc., from either transportation, construction, or delays will need to be thoroughly cleaned to remove all foreign contamination. Refer to the specification and/or contact the supplier for further information.

In the case of a primer showing early-onset corrosion, it will be necessary to clarify and confirm the repair procedure with the primer and/or intumescent coating supplier.

6.2.2.3 Primer compatibility

The compatibility of the ICS with the primer should have been established prior to any works being started. No further application should be carried out until such compatibility has been confirmed in writing by the primer and/or intumescent coating supplier.

Where the primer is incompatible, either a tie coat or removal and re-application of a compatible primer will be required. The new primer or tie coat needs to be confirmed or specified by the intumescent coating supplier.

The applicator needs to satisfy themselves, and document, that the underlying substrate and coatings are all compatible, within the latest specification, clean, and correctly applied or remediated before commencing the application of subsequent coatings.

6.2.2.4 Primer dry film thickness confirmation

The coating inspection methodology, percentage of steelwork, and level of traceability should be defined clearly in the pre-job conference and requirements documented in the ITP. This should be agreed before any primer is applied.

For steel primed off-site, documentation provided for the steelwork should include, at a minimum, a summary of the average dry film thickness of the primer. Nevertheless, the on-site coating applicator should take their own readings to confirm the dry film thickness of the primer for traceability, and as a duty of care.

Any discrepancies identified in the dry film thickness of the primer need to be clarified, and an average dry film thickness needs to be confirmed and agreed upon by the relevant parties before starting with the intumescent coating application. By proceeding with the intumescent coating application, the applicator is implicitly accepting the condition and DFT of the primer.

6.2.2.5 Sealing of inaccessible areas

Where an ICS is applied to an area that will be inaccessible, it is recommended to seal the ICS to ensure any risk of moisture ingress is mitigated. For further information refer to 5.1 and section 8 of this document and seek advice from the intumescent coating supplier.

6. Guidance for the Application of Intumescent Coatings *cont.*

6.2.3 PREPARATION OF GALVANISED STEELWORK AND BOLTED CONNECTIONS

Preparation for galvanised steelwork and/or bolted connections should be clearly described in the coating specification. If not, or if further clarification is required, the applicator should consult the primer and/or intumescent coatings supplier.

6.2.4 THERMAL METAL SPRAY COATINGS

It is not advisable to use thermal metal spray coatings on steelwork that is to have intumescent coatings applied over it. There is an increased risk of delamination associated with coatings over 300µm DFT applied onto thermal metal sprayed substrates. In situations where this cannot be avoided, the intumescent coatings supplier needs to be consulted for advice.

6.3 Preparation for the Application of the Intumescent Coating

This section sets out the factors that need to be considered before commencing application of intumescent coatings. It is primarily aimed at on-site application, however the considerations for off-site application will be similar.

6.3.1 ALLOCATION OF RESPONSIBILITY

For any application contract it is critical that responsibility for every stage is clearly defined and identified for administration tasks, progress updates, compliance, and quality assurance. Responsibilities need to be allocated to the correct stakeholder to ensure that all work is carried out correctly and safely.

Key responsibilities that need to be assigned are:

- Coating Specification - system durability and fire protection performance, product, and procedural standards
- Choice of supplier and product and/or ensuring compatibility between coats
- Preparation of method statements, schedules, procedures, and programme
- Health and safety and environmental compliance
- Compliance with all relevant legislation
- Quality Assurance and Quality Control – Inspections, corrective actions, documentation, and records.

It is the overall responsibility of the intumescent coating applicator to ensure that the intumescent coating system is applied to meet the required specifications.

6.3.2 INTERACTION WITH OTHER SERVICES

Whenever possible, it is advisable to have a clean and sufficient area free of other trades and services made available for the applicator to ensure the least amount of disruption to other contractors on site. During application of any coating by spray it is recommended a generous exclusion zone be established.

6.3.3 HEALTH AND SAFETY

The applicator has a legal responsibility to act in full compliance with all relevant health and safety and environmental legislation throughout the application process.

6. Guidance for the Application of Intumescent Coatings *cont.*

Many coatings contain chemicals and VOCs that carry health and environmental risks. It is imperative that the latest Safety Data Sheets for any products used are obtained from the supplier, consulted, followed, and made readily available on-site.

6.3.4 MATERIAL SUPPLY

It is advisable to confirm with the material supplier before commencing application that sufficient stock is available on hand, or within a lead time that meets the requirements of the construction programme. If product becomes unavailable at any stage of the application programme, it is crucial that any alternative product proposed is confirmed as compatible with the system. In such cases, details of the alternative coating specification should be submitted to the BCA as a design/consent amendment.

All materials supplied must be within their shelf life and clearly marked with the manufacture date and batch number for traceability.

6.3.5 STORAGE

Any product storage on site needs to be done in accordance with the manufacturer's technical data sheet and any requirements of the Health and Safety at Work (Hazardous Substances) Regulations. As a general guide the following should be observed:

a) All materials stored between 5°C and 30°C;

b) Material containers should remain unopened until required and used in date order;

c) Material should be stored off the ground and protected from the elements; and

d) All materials should be stored in a suitably bunded and/or flammable goods containment area.

Note: Any waterborne product that is, or has been, frozen will not be fit for purpose and will need to be discarded.

6.3.6 EQUIPMENT

The applicator should ensure that all equipment required for surface preparation, application, and quality control of all elements of the ICS are available, in good working order, and that current test and/or calibration certificates are available. The applicator needs to ensure that all equipment operators have relevant training and are familiar with current technical data sheets and method statements. This should all be verified and signed off by the supervisor before commencing work.

6.3.7 ENVIRONMENTAL CONDITIONS

No application should take place while environmental conditions are outside the environmental limits specified by the coating manufacturer for the particular product. The minimum environmental conditions that need to be monitored are:

a) Air temperature;
b) Steel temperature;
c) Dew point; and
d) Relative humidity.

6. Guidance for the Application of Intumescent Coatings *cont.*

Steel temperatures should be at least 3°C above the dew point to ensure that no moisture is present on the surface during application. Working outside of the stipulated environmental conditions can have detrimental effects on both the film formation and the integrity of the coating, as well as on long-term performance.

It is particularly important, where application is to be carried out in a partially clad building, that the applicator and/or main contractor ensures the building is watertight, or that other measures are taken to ensure that any areas where coatings are to be applied are not directly exposed to external weather conditions that the coating is not able to tolerate during its curing time.

For further clarification or information on the required environmental conditions consult the coating supplier.

6.4 Application

This section sets out the factors that need to be considered during application of intumescent coatings. It is primarily aimed at on-site application, however the considerations for off-site application will be similar.

6.4.1 PRE-INSPECTION

It is necessary for a pre-inspection to be carried out by the applicator to confirm the following:

- Substrate preparation as per coating specification
- Correct primer has been applied and is compatible
- Primer condition
- Primer within its recoat window
- Primer dry film thickness
- Primed surface is clean and dry
- Each steel section is adequately identified and marked up for traceability and different intumescent coating thicknesses.

If any of the above is found to be unsatisfactory, refer to 6.2 and 6.3 for guidance on remediation.

6.4.2 MIXING

Intumescent coatings are highly structured products. Use of the correct mixing technique is essential to achieve a uniform consistency allowing the product to be applied correctly and easily. It is best to consult with the coatings supplier to confirm any specific mixing requirements.

6.4.3 THINNING

Most intumescent coating systems cannot be thinned. In some circumstances, the intumescent material may require partial thinning. Over-thinning can be detrimental to not only the coating application but also the long-term performance of the coating, typically leaving the DFT short of what is necessary for compliance. Consult the coatings supplier before thinning the product and stay within the parameters they advise. Only thinners permitted by the coating manufacturer should be used.

6. Guidance for the Application of Intumescent Coatings *cont.*

6.4.4 ENVIRONMENTAL MONITORING

The environmental conditions listed in 6.3.7 should be monitored and recorded before, during, and after application. It is necessary that these be recorded at a maximum of 4 hr intervals and form part of the installation's QA documentation.

6.4.5 MASKING AND OVERSPRAY

The application contractor should ensure that areas of steel not requiring fire protection are adequately masked off. Any other sensitive or critical areas (car parks, hospitals, air vents, etc.) which may be subject to overspray or airborne VOCs should also be appropriately protected.

6.4.6 APPLICATION OF THE INTUMESCENT COATING

The application of all coatings should be carried out fully in accordance with manufacturers' technical data sheet requirements and the applicator's method statement. These in turn need to reflect the fire rating schedule's DFT requirements.

6.4.6.1 Equipment

While airless spray is generally the preferred and most economic method of application for most coatings, the use of this method on site may be limited, in which case the coating specification may need to either include provision for sheeting-in to protect adjacent buildings and the surrounding environment from overspray or concede to the more costly use of brush or roller application instead.

Where spray is not possible, a larger number of coats by brush or roller will normally be required. The manufacturer's specified minimum and maximum overcoating times must be observed. The surface finish quality from brush or roller application may be unacceptable, particularly for visible steelwork. It is suggested a sample be provided in advance to the specifier for confirmation before proceeding.

Application operators need to be fully trained and proficient in the use of the equipment.

6.4.6.2 Wet Film Thickness applied

Recommended thicknesses are typically provided on manufacturer's technical data sheets, along with the maximum achievable thickness per coat by the different methods of application.

6.4.6.3 Solvent entrapment with excessive film build

Each individual intumescent coating product will have its own limitations recommended by the product manufacturer with regards to maximum WFT per application per day under standard application conditions. For single pack solvent borne intumescent systems, if these limitations are exceeded, solvent entrapment risk becomes much higher and may lead to blistering and coating failure. Repeated coats of the same intumescent before the coating has reached the required level of cure and solvent loss, cold weather, and poor ventilation around the coated steelwork will exacerbate this effect. Sufficient time for cure for the coatings at hand must be allowed to avoid this.

6. Guidance for the Application of Intumescent Coatings *cont.*

For single pack water borne intumescent systems, excessive film build/lack of cure results in cracking of the film and eventual delamination of the intumescent away from the priming system. Just like their solvent borne counterparts, repeated coats of the same intumescent before the coating has reached the required level of cure and solvent loss, cold weather, and poor ventilation around the coated steelwork will exacerbate this effect.

Two pack intumescent systems have a much higher film build tolerance and a very different curing mechanism to the single pack intumescent systems. These products are used to mitigate or eliminate the negative effects of solvent entrapment as described above for single pack products.

6.4.6.4 Recoat times

Recoat times (minimum and maximum) between all coats utilised within an ICS must be followed to ensure inter-coat adhesion. Whether this be between primers and intumescent, between coats of intumescent itself, or intumescents and seal and/or topcoats, care must be taken to adjust these recoat times according to the project environment and conditions. The applicator needs to adhere to the data provided in the product data sheets. Failure to comply with recoat times will lead to a compromised ICS and early failure, or reduced performance in the event of a fire, or both.

If a coating is found to be outside of its recoat window then contact the supplier for advice.

6.4.7 FILM THICKNESS DETERMINATION

Whatever the method of application employed; it is essential to ensure that the correct DFT of each coat of the coating specification is achieved. This is particularly important in the case of a site-applied intumescent coating because this is the part of the ICS that confers the necessary fire protection for the structure.

6.4.7.1 Wet Film Gauges

Wet Film Gauge readings should be taken throughout application of the ICS. Although these measurements are not particularly accurate and are only useful for the coating that is being applied, they provide assurance that the applicator has applied enough coating to minimise any film deficiencies.

6.4.7.2 Dry Film Gauges

To confirm the thickness of the intumescent coating it is necessary to know the average thickness of the primer. This should either have been supplied by the primer applicator or determined by additional baseline readings. After application of the intumescent coating, the average primer DFT should be subtracted from the measurements taken on the intumescent coating, to determine the true intumescent DFT.

Alternatively, adding the measured average primer DFT to the required DFT of intumescent coating will give the required DFT for the combined primer plus any site-applied intumescent coating.

6. Guidance for the Application of Intumescent Coatings *cont.*

The DFT measurement and acceptance should be carried out in accordance with 6.5.5.

It is important to confirm that the correct DFT of the intumescent coating has been applied before proceeding with application of the sealer/topcoat, as any deficiency in intumescent coating DFT is best corrected at this stage.

6.4.8 REPAIR OF INTUMESCENT DRY FILM THICKNESS DEFICIENCIES

If the DFT of the intumescent coating does not achieve the nominal thickness stated in the Loading Schedule, further application of the coating will be needed. If this is carried out within the recoat window of the intumescent coating then, after ensuring the surface is clean and free of any contamination, additional coating can be applied as per 6.4.6.

6.4.9 APPLICATION OF SEALER AND/OR TOPCOATS

Some ICSs require a sealer/topcoat to be applied, depending on the final environmental exposure conditions. Where a sealer/topcoat is specified, it should be applied in accordance with the manufacturer's technical data sheet.

Sealer/topcoats are usually very thin; however, it is important to apply the correct DFT because this is a key factor in the durability of the system. The application should be carefully monitored to ensure the correct DFT is applied, and to ensure full sealing of the intumescent coat.

It is common for the sealer/topcoat alone to provide the decorative finish. Occasionally, additional coats will be required for either a specific finish or extra protection for the intumescent coating. The sealer coat or decorative topcoats should meet the specified finish requirements as outlined in 5.1.12. Sealer/topcoats applied incorrectly and/or outside of the coating specification may compromise the intumescent coating's performance.

6.4.10 REPAIR OF THE COMPLETE INTUMESCENT COATING SYSTEM

Damage to an ICS can typically occur during building fit-out post-application. Remedial work on a complete ICS will depend on the extent of the damage. Recommendations are as follows.

6.4.10.1 Minor damage

Small chips and scrapes will not significantly affect the system's performance unless the service environment is wet or exposed to the weather. It is recommended that repairs are carried out at the earliest opportunity and as per the original coating specification.

Where the ICS is damaged down to the substrate, with rust showing, the substrate is typically cleaned to a minimum of SSPC-SP 3 and the surrounding (intact) coatings are lightly abraded. The coatings are then reinstalled as spot coatings to the damaged area as per the coating specification.

If only the intumescent coating is damaged, a fresh coating of the specified intumescent material is applied, or a suitable repair coating, before reapplying the sealer and/or topcoats to reinstate the originally specified system.

If only the sealer coat or topcoat is damaged, these can be abraded and spot recoated.

6. Guidance for the Application of Intumescent Coatings *cont.*

6.4.10.2 Major damage

In the unlikely event that major repairs are required (i.e. due to water or chemical attack), the intumescent coating manufacturer should be consulted for specialist advice.

6.4.10.3 Deck stud and welding damage repair

Two generic types of stud welding are typically used in construction: mechanical shot fired, and arc welded studs. Where intumescent coatings are yet to be applied or are already in place on any surface of the steel section, the use of shot fire studs is recommended.

Where post installation of arc welded studs is unavoidable, it is preferable to undertake the intumescent painting on site after completion of the welding. Any heat-damaged areas (to the primer) and any areas to be intumescent coated that have weld splatter need to be re-prepared by suitable mechanical means to a standard agreed with the intumescent manufacturer. Typical means include spot power tool cleaning to SSPC SP3 or spot abrasive blasting to SSPC SP-10 prior to reinstatement of the primer.

Where welding is carried out after application of the intumescent basecoat, any heat-damaged coating should be cut back to a sound coating (and at least 50mm away from the existing visual damage line) prior to re-preparation and reinstatement of all coats in the area of repair. Further guidance on off-site applied intumescent paint and the undertaking of welds is covered in Section 3.5 of ASFP Technical Guidance Document 16, which states that in some instances the blistering caused by the heat of the weld may not necessarily be repaired and that the likelihood of blistering and other detrimental effects to intumescent paint can be reduced or eliminated by:

- Consideration of the arc welding equipment set-up with the correct amperage, earth contact, lift and time settings which suit the shear stud size and weld orientation;
- Using single lines of studs, with these being positioned above the flange web junction, and ensuring flanges are greater than 12 mm thick; and
- Ensuring that where double lines of shear studs are required, the beam flanges are at least 15 mm thick.

It is recommended to conduct remedial works in any of the following situations:

a) Where aesthetics is a prime consideration;

b) Where the construction is to remain exposed to the weather for a significant period of time;

c) Where the construction is still open to the weather and blisters have cracked;

d) Where the end use situation will fall into categories C2-C5 as per ISO 12944-2:2007 i.e. external exposure or internal environments where condensation and/or high humidity may occur; or

e) Where blisters have formed.

6. Guidance for the Application of Intumescent Coatings *cont.*

6.4.11 CHANGE IN FIRE RATING REQUIREMENTS OR EXTENDING LIFE OF INTUMESCENT COATING

Over the life of a building, it is likely that the applied ICS may need to be reviewed. Typical reasons are: building upgrade, refurbishment, change of use, change in required fire rating, structural alterations, or simply extending the life of an applied ICS.

Where this occurs, the works would be subject to a building consent and so would involve the full design process of this Code of Practice.

When reviewing existing ICSs in these circumstances, the following should be considered:

Initial Steps:

a) Establish the fire resistance requirement of the structural steel members. This should be provided by the design team as outlined elsewhere in this document;

b) Identify the existing fire protection system. This may involve destructive testing and/or laboratory samples to verify;

c) Consult the manufacturer and assess the likely contribution of the existing ICS to the required fire resistance, including the suitability of the existing system for continued use;

d) Check corrosion and durability of the existing steel and any applied ICS or primer; and

e) Depending on the outcomes of the above assessment, all areas and parts of the system which fail to meet the new design requirements for fire resistance should be repaired, over-clad, or removed and replaced with a system capable of fulfilling the new requirements in accordance with manufacturer's instructions and a certified solution.

Possible outcomes may include:

f) Manufacturers (and applicator, if applicable) re-certifying the existing ICS as compliant with all the new requirements;

g) As near as reasonably practicable consideration (ANARP) – the design team may choose to evaluate any existing ICS on an ANARP basis, in accordance with Building Act;

h) Removal and full replacement with a new ICS;

i) Additional ICS applied over the existing ICS, subject to manufacturer's instructions and a compatibility assessment;

j) Partial replacement of existing ICS – a combination of h) and i); or

k) Existing ICS is over-clad with a fire rated board system or other system type to avoid compatibility issues.

6.5 Quality Assurance

This section identifies, but is not limited to, all of the standards, requirements, and factors that need to be considered to ensure that the application of the ICS is completed in accordance with the specification and meets with the specified levels of quality.

6. Guidance for the Application of Intumescent Coatings *cont.*

6.5.1 QUALITY MANAGEMENT SYSTEM

A Quality Management System (QMS) is the overall management system (documented) which provides adequate and appropriate control over an organisation's activities to ensure outcomes meet the desired and quantified levels of quality. An example of a typical QMS structural overview is shown in Figure 5 below.

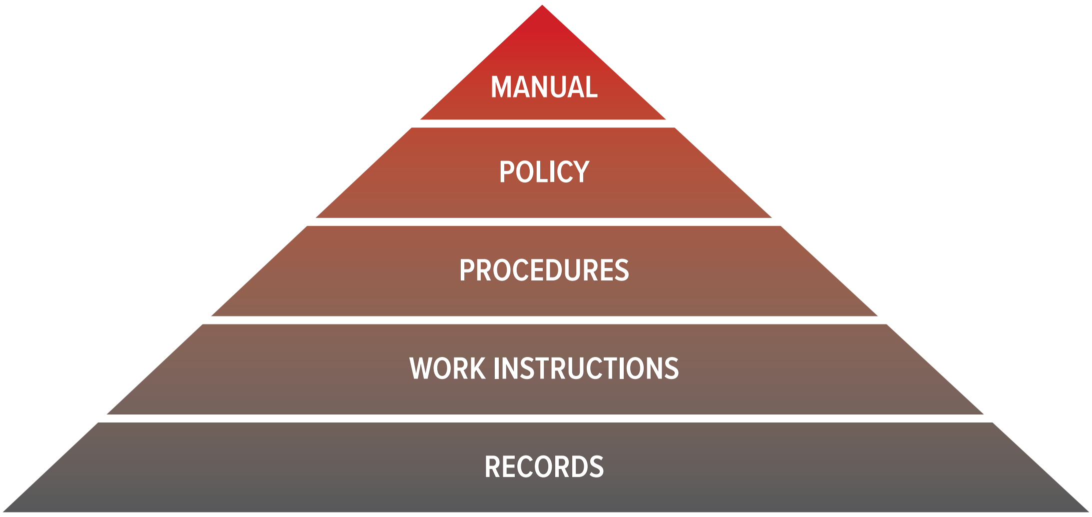

Figure 5: Overview of a quality management system.

- **MANUAL** – The organisation's roadmap of the overall QMS. The quality manual contains such information as organisation structure, departmental structure, responsibilities, and accountabilities.
- **POLICY** – An overarching plan (direction) for achieving an organisation's goals. A statement of intent.
- **PROCEDURES** – The documented steps in a process and how these steps are to be performed to ensure effective implementation and compliant outcomes.
- **WORK INSTRUCTIONS** – Very detailed instruction as to how to perform a task.
- **RECORD** – A document or form which, once completed and signed, provides evidence of an activity or signatory approval. For example, a quality plan (see 6.5.4).

6.5.2 QUALITY CONTROL CONSIDERATIONS AND EQUIPMENT

Quality control measures need to be adequate to provide assurance that each stage of a process is being completed as stipulated in the specification, and in accordance with the manufacturers' technical data sheets.

6. Guidance for the Application of Intumescent Coatings *cont.*

Some of the equipment and devices that would be expected to be part of a quality control process include:

6.5.2.1 Surface preparation

- Electronic profile gauge
- Pictorial standards
- Comparator plates
- Replica tape (e.g. Testex)
- Micrometers

6.5.2.2 Coatings

- Wet film thickness gauges
- Dry film thickness gauges

6.5.2.3 Environmental conditions

- Thermometers (dry/wet, steel substrate)
- Whirling hygrometer or electronic equivalent

6.5.3 INTUMESCENT COATING QUALITY ASSURANCE

The manufacturer should provide evidence and verification of the intumescent coating for product quality, performance, and fitness for purpose.

More information can be found in the ASFP Technical Guidance Document 11 Annex C.

6.5.4 QUALITY PLAN

Contractors and applicators need to have a well-established system to ensure that the correct procedures are carried out for quality workmanship and compliance. A Quality Plan is a verification document that can be used to confirm that every stage in the process is performed correctly, and that the required documentation has been completed.

The quality plan is a comprehensive authentication process which can be completely tailored to a project, and the needs of the contractor. The quality plan can also be included with the project records as evidence of compliance.

This section outlines the minimum information the applicator needs to provide. It can be produced as a simple table and is helpful because it:

- Summarises quality requirements in the specification and suppliers' technical data sheets
- Often includes referenced standards/methods to be used, and requirements
- Records conformance
- Can be used as an inspection checklist and/or summary verification document

A sample site quality plan/checklist is shown in Appendix D.

6. Guidance for the Application of Intumescent Coatings *cont.*

6.5.4.1 Inspection Test Plan

Conformance of an applied ICS is influenced by a variety of factors, not only the dry film thickness. The fire engineer's report, structural engineering specification, architectural specification, coating supplier's performance specification, and material loading schedule all contribute to some extent to the requirements of an ICS and the requirements may vary from one project to the next.

For example, minimum surface cleanliness and blast profile are applicable to certified ICS, which should be reflected in the supplier's performance specification. A maximum primer thickness under intumescent is applicable as well as a maximum over-coating period. In addition, solvent and water based acrylic intumescent coatings in certain construction and harsh operating conditions will require a seal coat application to mitigate the impact of water exposure. The architectural specification may also require a specific surface finish and topcoat colour.

All the specified requirements, in conjunction with the dry film thickness required by the material loading schedule, need to be considered in an ICS. The detailed inspection and test plan (ITP), based on the combined requirements of the various specification contributors, is to be developed and discussed at a pre-job meeting attended by key stakeholders, such as designer, supplier, client, main contractor, applicator, and third-party inspectors. The applicator should demonstrate thorough inspection, testing, and record keeping conformance to the specification and ITP of all specified requirements.

A sample on-site application inspection and test plan is shown in Appendix E.

6.5.5 DRY FILM THICKNESS MEASUREMENT

It should be clearly stated whether the final DFT reading achieved refers individually to the primer, intumescent coating, and/or topcoat, or to the ICS as a whole. Clear confirmation needs to be provided that the DFT readings have been carried out to an approved standard (e.g. AS 3894.3) and are in accordance with the required specifications.

A suitable gauge should be used for taking DFT readings. The gauge needs to have a range appropriate for the specified DFT of the entire ICS, and all readings taken should be recorded. Most modern electronic gauges have the capability to directly link to software, making this process straightforward. The gauge needs to be calibrated prior to use following the equipment manufacturer's instructions. Current calibration certificates should be included in the documentation package.

DFT readings should be taken only when the coating is sufficiently hard to prevent the probe indenting the surface, but before any additional coatings are applied.

6.5.5.1 Frequency and location of readings

Readings should be taken on every steel section with the minimum as follows and as shown in Figure 6:

- I-Sections, T-Sections, Channels, Angles, and Square or Rectangle Hollow Sections:
    - **Webs:** One reading per metre length on each face

6. Guidance for the Application of Intumescent Coatings *cont.*

- **Outer Flanges:** One reading per metre length on each face
- **Inner Flanges:** One reading per metre length on each face
- **Square/Rectangle Hollow Sections:** One reading per metre length on each face

Note: Readings should not be taken within 25mm of any edge or web/flange junction.

- **Circular Hollow Sections:** Four readings per metre length spread evenly around the section

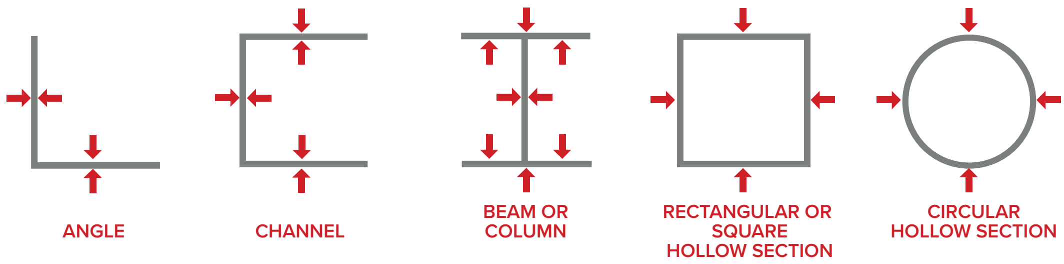

Figure 6: Pictorial guide for locations of DFT readings

6.5.5.2 Dry Film Thickness survey

Every project carries a level of risk for ongoing maintenance and traceability. During the pre-job conference a detailed ITP should be agreed to that covers the expected level of inspection, frequency, and documentation along with all other required inspections. The documentation submitted by the applicator must conform to this.

On some projects, it may be possible to approach this with a reduction to the frequency of individual documented items once continual conformance has been demonstrated and evidentially observed. For example, 1 out of X members or reduced measurements on areas that continually conform and a tighter focus on documentation for higher risk areas. This needs to be carefully considered because although economically appealing, the long-term benefits might not be delivered. Refer to ISO 2859.1 for more information.

6.5.5.3 Dry Film Thickness acceptance criteria

Good practice coating thickness acceptance criteria are as follows, assuming that the specified thickness is a nominal value:

a) The average dry film thickness applied to each element shall be greater than or equal to the specified nominal value.
b) The average measured dry film thickness on any face of any member shall not be less than 80% of the specified nominal value.

Where any single thickness reading is found to be less than 80% of the specified nominal value, additional readings shall be taken, radiating from the single low reading in 150mm intervals. If one or more of the additional readings is less than 80% of the specified nominal value, further readings shall be made to determine

6. Guidance for the Application of Intumescent Coatings *cont.*

the extent of the area of low thickness. In such cases, low thickness areas identified should be brought up to the required thickness by the applicator.

The initial reading may be considered isolated if all the additional readings are at least 80% of the specified nominal value. Refer to the manufacturer's technical guidelines for more information on this scenario.

Note: The dry film thickness testing must be conducted prior to the application of a seal coat or topcoat.

The average measured dry film thickness of any face of any member should not exceed the manufacturer's recommended maximum thickness for the member shape and orientation. Refer to the manufacturer for further information.

6.5.5.4 Dry Film Thickness correction procedure

a) Where the DFT of the intumescent coating is found to be less than what is acceptable, refer to 6.4.8; and
b) Where the DFT of the intumescent coating is found to exceed the manufacturer's maximum specified DFT, guidance should be sought from the intumescent coating manufacturer.

In either of these situations, remedial work will be required by the contractor/applicator, and a corrective action or non-conformance, as applicable, should be raised in their QMS.

6.5.5.5 Quality Assurance auditing by a third-party inspector

Involvement of a third-party auditor or inspector should be confirmed at the start of a project, not part way through or at completion. The third-party auditor/inspector should consider all Specification requirements in the Inspection and Test Plan in planning an audit or inspection; PS3 of Specification Conformance should reflect the complete scope.

Independent third-party inspections should be carried out only by skilled professionals who can demonstrate the following as a minimum:

- Certified Coating Inspector (Minimum NACE CIP Level 2, CBIP or equivalent)
- Certified Intumescent Coating Inspection (SSPC Fireproofing Inspector or equivalent)

It is not practicable for 100% of intumescent coated structural steelwork to have its DFT measured and recorded during an audit by a surveyor or a third-party inspector. The recommended minimum percentage of steel to be surveyed is 10% of all intumescent coated steel members selected at random, in a mix of section sizes, including a representative sample of difficult-to-access through to easy-to-access locations.

The non-conformance acceptance of a 10% survey lot size is zero, i.e. if one item tested does not conform to the requirements of all acceptance criteria in 6.5.5.1, the survey size should statistically be increased to include an additional 10% lot size until conformance can be established.

6. Guidance for the Application of Intumescent Coatings *cont.*

After the identification of non-conformance in the initial 10%, the applicator or contractor can elect to re-test, remediate non-conforming areas, and request a follow-up survey. This approach minimises inspection cost.

It is recommended to confirm during the pre-job conference the project audit requirements, if any, for a third-party coating inspector. A coatings inspector may wish to conduct baseline testing of the primer prior to the application of the intumescent coating.

7. Records

Detailed and accurate records are important for any coating contract, but for fire protection projects they are essential. Because the work can extend over a long period of time, may be undertaken in several locations, and may involve more than one product supplier and/or sub-contractor, evidence of compliance with the specification will often rely on the existence of a detailed and accurate dossier of information and records.

Such records are also necessary to demonstrate compliance with regulatory requirements. However, the mere existence of records (of lower level of detail as described in this document) may not be sufficient to provide complete confidence that the work has been carried out to the required standards. Therefore, wherever possible, key stages in the application process should be witnessed by a QA representative or independent third party.

Validation may be through recognised third-party certification schemes or through first-hand inspection and acceptance (using a sign-off procedure, for example as suggested in Appendix D). Alternatively, a combination of both may be used.

Copies of these records should be given to the building owner or facilities manager as part of the commissioning documents. The main contractor should also be provided with these records and a copy lodged with the Building Consent Authority as part of the final approvals process.

Where appropriate, site records should contain, but not be limited to, the following:

- Basic contract information
- Verification of specification and products
- Record of materials and batch numbers
- Substrate inspection records
- Environmental conditions – daily logs of temperatures, dew points, and humidity
- Dry film thickness per coat and for the full intumescent coating system. Measurements should include:
    - Member identification
    - Number of readings
    - Maximum/minimum and average recorded
    - Any supplementary readings or information
- Variations, corrective actions, and concessions

Records should typically include date, time, stage in process, site location, and the name and contact details of the person who made the record.

Record keeping should occur throughout the project and be reviewed/updated at regular intervals. These records shall be held for a minimum of 10yrs for long-term traceability.

8. Post-Project Completion

In most cases, correctly applied intumescent coating systems exposed internally in corrosivity category C1 should not require any maintenance over the design life of the building, other than for decorative purposes, or where mechanical damage has occurred.

For all other corrosion categories (C2-C5), the building owner should establish periodic inspection and maintenance contracts in accordance with the requirements of the Compliance Schedule (see 4.2.2). The advice of the intumescent coating manufacturer on the LTFMM should always be sought.

8.1 Maintenance and Inspection

8.1.1 INTERNAL COATINGS

Typically, internal coatings are designed for the life of the building provided that they are used in no more than a dry C1 environment. However, it is recommended to have access points provided throughout the building to allow periodic BWOF inspection of the coatings (see 5.1.3 for further discussion).

8.1.2 EXTERIOR COATINGS

Exterior coatings should have an appropriate washing schedule that will vary according to the microenvironment. Irrespective of the coating system life, all exterior areas sheltered from rain-washing should be washed down with fresh water on a quarterly basis, and on a yearly cycle all painted surfaces should be washed with a suitable cleaning agent followed by rinsing with fresh water. This will remove salt, dirt, and contamination build-up on painted areas.

8.1.2.1 Example maintenance schedule

- • Year 1: Thoroughly inspect all painted areas and repair areas of damage/coating breakdown according to the original paint specification or approved equivalent.
- Year 4/5: Repeat full inspection and repair areas of damage/coating breakdown as per year 1.
- Year 6/7: Repeat condition survey and repair as necessary to maintain integrity of painted areas.
- Year 9/10: A full inspection by a qualified Coatings Inspector or Coatings Technician to be undertaken to arrive at a condition status. This survey should address future maintenance requirements beyond the initial system lifetime, and at this point decisions on touch-ups/repair of areas or full recoating can be made.

Further specific information on maintenance and repairs should be obtained from the coating manufacturer or a qualified Coatings Inspector/Technician.

Appropriate maintenance details should be prepared by the installation contractor and included in the Compliance Schedule.

9. References

New Zealand Standards

- NZS/BS 476.21:1987 – Fire tests on building materials and structures - Methods for determination of the fire resistance of loadbearing elements of construction
- NZS 3404 Parts 1 and 2:1997 – Steel Structures Standard (NOTE: the 2009 revision of NZS 3404 was withdrawn)
- NZS ISO/IEC 17025:2018 – General requirements for the competence of testing and calibration laboratories
- SNZ TS 3404:2018 – Durability requirements for steel structures and components

Joint Australian/New Zealand Standards

- AS/NZS 1170:2002 – Part 0 – Structural Design Actions – General Principles
- AS/NZS 2312.1:2014 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Part 1: Paint coatings
- AS/NZS 2312.2:2014 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Part 2: Hot dip galvanizing
- AS/NZS 3750.0:2008 (R2019) – Paints for steel structures - Introduction and list of Standards
- AS/NZS 5131:2016 – Structural steelwork – Fabrication and erection
- AS/NZS ISO 9001:2016 – Quality management systems – requirements

Australian Standards

- AS 1530.4:2014 Methods for fire tests on building materials, components and structures – Fire-resistance tests for elements of construction (Latest version, not yet referenced in the NZBC Acceptable Solutions and Verification Methods – see below)
- AS 1530.4:2005 Methods for fire tests on building materials, components and structures – Fire-resistance tests for elements of construction (Superseded version currently referenced in the NZBC Acceptable Solutions and Verification Methods)
- AS 1627.1:2003 (R2017) – Metal finishing - Preparation and pre-treatment of surfaces - Removal of oil, grease and related contamination
- AS 1627.4:2005 (R2017) – Metal finishing - Preparation and pre-treatment of surfaces - Abrasive blast cleaning of steel
- AS 1627.9:2002 (R2017) – Metal finishing - Preparation and pre-treatment of surfaces - Pictorial surface preparation standards for painting steel surface
- AS 1851:2012 – Routine service of fire protection systems and equipment

9. References *cont.*

- AS 3894.3:2002 (R2013) – Site testing of protective coatings - Determination of dry film thickness
- AS 4072.1:2005 (R2016) – Components for the protection of openings in fire-resistant separating elements. Part 1: Service penetrations and control joints

Other International Standards and Design Guides

- ASFP Technical Guidance Document TGD 8:2010 – Code of practice for junctions between different fire protection systems when applied to load bearing structural steel elements
- ASFP Technical Guidance Document TGD 10:2008 – Code of practice for the refurbishment and upgrading of fire protection of Structural steelwork
- ASFP Technical Guidance Document TGD 11:2014 – Code of practice for the specification and on-site installation of intumescent coatings for fire protection of structural steelwork
- ASFP Technical Guidance Document TGD 13:2010 – Code of practice for the over-cladding of reactive coatings when used as fire protection to steel structural sections
- ASFP Technical Guidance Document TGD 16:2010 – Code of Practice for off-site applied thin film intumescent coatings
- ASFP Yellow Book 2014 – Fire protection for structural steel in buildings, 5th edition
- BS 5950-8:1990 Structural use of steelwork in building - Part 8: Code of practice for fire resistant design (Note: this is a withdrawn standard)
- IPENZ Practice Note (PN) 22 (2011) – Guidelines for documenting fire safety designs
- ISO 2859.1:1999 – Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
- ISO 8501.1:2007 – Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
- ISO 12944 series – Paints and varnishes - Corrosion protection of steel structures by protective paint systems
- SSPC-PA 2:2022 – Paint application standard No. 2 – Procedure for Determining Conformance to Dry Coatings Thickness
- SSPC-SP 1: 2016 Surface Preparation Standard No. 1 – Solvent Cleaning
- SSPC-SP 3: 2018 Surface Preparation Standard No. 3 – Power Tool Cleaning
- SSPC-SP 6/NACE No. 3: 2007 Surface Preparation Standard No. 6 – Commercial Blast Cleaning
- SSPC-SP 10/NACE No.2: 2006 – Joint Surface Preparation Standard – Near White Metal Blast Cleaning

9. References *cont.*

New Zealand Legislation and Associated Documents

- New Zealand Building Act 2004
- New Zealand Building Regulations 1992 (The New Zealand Building Code)
- New Zealand Building Code Acceptable Solutions and Verification Methods (formerly 'Compliance Documents')
- Building (Specified Systems, Change the use, and Earthquake-prone Buildings) Regulations 2005
- Health and Safety at Work (Hazardous Substances) Regulations 2017

Other Useful Documents

- ASFP Advisory Note 12: ASFP - BCF Best practice guide for specifying reactive coating fire protection for steel structures
- ASFP Advisory Note 18: ASFP Position on Installing Partitioning to the Underside of Structural Steel Sections Coated with a Reactive Fire Protection System
- Advisory Note 19: ASFP Position on the Use of Critical Steel – Temperatures above 650°C
- ASFP Advisory Note 20: ASFP Position on Portal Frame Buildings
- ASFP Advisory Note 21: ASFP Position on Coatback with Respect to Unprotected Secondary Beams Fixed to Protected Primary Beams
- BRANZ SR288:2013 – Update of New Zealand's atmospheric corrosivity map
- CEPE/EAIPC/EAPFP 2015 Applicator Best Practice Guide – European industry best practice guide on the application of intumescent coatings to constructional steel
- FABIG Technical Note 13: 2014 – Design Guidance for Hydrocarbon Fires
- FPA Australia Good Practice Guide GPG-01:2012 – Specification and application of intumescent coating systems (ICS) for the fire protection of structural steel
- HERA Report R4-133:2011 – New Zealand steelwork corrosion and coatings guide
- ICorr/CED/CT06:2017 – On-site and off-site application of intumescent fire and corrosion protection coatings for steel structures: Guidance on selection, specifications and use.
- New Zealand Construction Industry Council (CIC) Design Guidelines 2016
- SFPE (New Zealand Chapter) – Construction Monitoring Guide – A guide to monitoring construction of building design features relating to Fire Engineering (August 2021) available at https://www.sfpe.org.nz/resources

Appendix A: Key Stakeholder ‘Chain of Responsibilities’ during a typical Project

Project Stage: Stakeholder:	Building Design	Specification	Pre-Application	Application	Quality Control / Construction Monitoring	Remediation	Quality Assurance	Handover & Maintenance
Fire Engineer	State the fire performance rating required for the fire separations and elements of structure.	If required (e.g., IPENZ PN 22) check the design documentation by others and include provisions to satisfy the requirements of the Fire Report. If required to undertake a PS4 (May request at prestart stage if third-party monitoring required).	Make sure any design changes are transmitted to relevant parties. Update drawings and/or specification as necessary.		If required, undertake site observation to meet the required CM Level and to monitor that the installation aligns with the performance-based fire engineering design.		May receive and review QA documentation	Acknowledgement that C6 of NZBC has been satisfied in accordance with their design. If required to, provide a PS4.
Structural Engineer	Identify the specific structural elements which require Post Fire protection to meet the fire engineer’s fire rating requirements.	Produce structural drawings. Confirm LSTs. Coatings for steel (typically around durability, and sometimes includes ICS) to be specified in the Structural Specification, outlining the performance to be achieved and the design standards and/or codes of practices to be followed, and quality control and assurance requirements, and the need (or otherwise) for third- party inspection. Ensure corrosion protection specifications align with Intumescent paint specification	Make sure any design changes are transmitted to relevant parties. Update drawings and/or specification as necessary.		If required, monitor reporting being undertaken by independent coatings inspector, or if no independent inspector monitor applicator’s QA reporting and to monitor that the installation aligns with the structural design.		May receive and review QA documentation	If required to, provide a PS4.
Structural Fire Specialist (or Engineer) *(If engaged for the project)*	Works with the structural engineer to provide specific details to show how the Fire and Structural Engineer’s fire rating requirements are to be met. This may be a design optimization or innovation role.	Identify what quality procedures are necessary to support their design.			If required, undertake site observation to meet the required CM Level and to monitor that the installation aligns with the structural Fire design.		May receive and review QA documentation	If required to, provide a PS4.

Appendix A *cont.*

Project Stage: Stakeholder:	Building Design	Specification	Pre-Application	Application	Quality Control / Construction Monitoring	Remediation	Quality Assurance	Handover & Maintenance
Architect	Coordinates the other discipline's designs and provides overall building design, specifying the materials the various elements are to be constructed from. Interprets requirements of Fire and Structural Engineers for Steel Fire protection and decides which protection systems are appropriate for each area. Likely done in consultation with full design team.	Produce detailed drawings that document what fire proofing systems are to be used and in what locations. Ensure construction detailing for interfacing elements have consideration for ICS. Coatings for steel (typically inclusive of ICS) may be specified in the Architectural Specification, outlining the performance to be achieved and the design standards and/or codes of practices to be followed, and quality control and assurance requirements, and the need (or otherwise) for third-party inspection.	Make sure any design changes are transmitted to relevant parties. Update drawings and/or specification as necessary.		Likely will monitor site for quality of install and finishes.			If required to, provide Statement of Completion.
Intumescent Coating Manufacturers / Suppliers	Works collaboratively with the design team (especially the architect) to provide specific construction details (drawings and specifications) to show how the fire rating requirements are to be met.	Contribute to the coatings specification for both fire-rated and non-fire-rated systems. Confirm compatibility of ICS. Define life to first maintenance expectations.	Produce Loading Schedules from quantum take-off provided by clients or applicators. Info to include # of sides, "Comflor" or flat slab, LST, and FRR. Ensure applicator meets competence requirements (duty of care). Pre-start meeting on selected projects.	Be available to troubleshoot any issues with products. Advise on remedial works to damaged areas.	No responsibility for suppliers. Limited spot checks may be conducted to reinforce applicator's records.	Supply of specification for remedial works.		Supplying suggested maintenance and inspection regimes. Verification of supply documentation, if required. Confirmation of any warranty/life to first maintenance statements by suppliers.
Building Consent Authority		"Issue building consent on reasonable grounds" Typically involves: Receive, review, and approve sufficient documentation ("plans and specifications") to demonstrate compliance with the proposed fire engineering design. Evidence includes steel specifications and fire-rated element drawings, information on the intumescent coating supplier, product details, and applicator's Quality Management System.	Pre-start meeting on selected projects to set out BCA expectations including level of design information and level of Construction Monitoring required.				Receive and review QA documentation (if requested).	Code of Compliance issued on receipt of adequate QA/QC documentation. Issue of Compliance Schedule. See Appendix C

Appendix A *cont.*

Project Stage: Stakeholder:	Building Design	Specification	Pre-Application	Application	Quality Control / Construction Monitoring	Remediation	Quality Assurance	Handover & Maintenance
Client/Building Owner		Provide detailed set of requirements to design team, including any specific requests over and above NZBC requirements or performance outcomes.	As per Main Contractor (if project self-managed).	As per Main Contractor (if project self-managed).				Implement a robust and documented maintenance plan as per Compliance Schedule and suppliers' recommendations.
Main Contractor	Potentially Design and Build Contractor or Early Contractor Involvement (ECI), and therefore will have Design responsibilities in accordance with their engagement.	Consultation during development of deliverables (assuming Early Contractor Involvement or Design and Build).	Ensure a pre-job conference occurs to iron out any questions/ irregularities in the system, products, work environment, buildability etc. If applicator does not meet minimum qualifications specify that third-party inspection is required. Ensure other trades' design and engagements align with Intumescent paint requirements, Including Blast and Primer Specification and QA requirements.	Regular monitoring of QA documentation as it is being produced. Ensure product and methodology used is suitable for temporary exposure conditions anticipated during the construction phase. Ensure Blast and Primer QA data is provided prior to application of Intumescent Paint and meets specification.	Gather and collate reports issued by applicators. Coordinate and oversee third-party inspections (if required). Manage any non-conformances for Primer and Intumescent application through contract.	Temporary protection to ICS during build and weather methodology.	Compile all QA/ QC documentation for all trades and submit to design team and client for review and approval.	Provide all contract documentation to client, including maintenance plans.
Steel Primer Applicator			Ensure specification for project has been read and interpreted, including identification of all members requiring ICS and the necessary Blast and Primer requirements.	Detailed on-site checklists. Calibrated equipment. Trained/Certified applicators. Correct products on site. Ambient conditions checked and recorded (4x daily). WFT checks recorded. Blast profile is correct. Primer DFT is correct. Arris edges to steel and the like.	Suitably trained supervisors. Well-defined QC frequency – DFT check etc. Blast profile Calibrated equipment. Loading Schedule to be cross referenced to drawings. Project Spec available on site. Photographic record of defects (incl. primer).	Clearly recorded defect list. Photographic recording of remediation process. Clearly defined repair spec available on site.	Clearly defined audit regime. Clear and concise QA reports to be prepared. Prepare as-built records. Utilise qualified Inspectors. Hand all QA evidence over to the Main Contractor/ ICS applicator to ensure QA is carried through to succeeding trade.	Issue QA reports to client for maintenance records. Issue as-built records. Issue PS3 (to be issued with all relevant supporting evidence).

Appendix A *cont.*

Project Stage: Stakeholder:	Building Design	Specification	Pre-Application	Application	Quality Control / Construction Monitoring	Remediation	Quality Assurance	Handover & Maintenance
ICS Applicators	Potentially Design and Build Contractor or Early Contractor Involvement (ECI), and therefore will have Design responsibilities in accordance with their engagement.		Pre-Inspection of steel and acceptance of primer/ surface. Produce Detailed: • Methodology • Quality plan • Work breakdown Structure • Applicator's warranty • Personnel training records.	Detailed on-site checklists. Calibrated equipment. Trained/Certified applicators. Correct products on site. Ambient conditions checked and recorded (4x daily). WFT checks recorded.	Suitably trained supervisors. Well-defined QC frequency – DFT check etc. Calibrated equipment. Loading Schedule to be cross referenced to drawings. Project Spec available on site. Photographic record of defects (incl. primer).	Clearly recorded defect list. Photographic recording of remediation process. Clearly defined repair spec available on site. Close-out process for defects.	Clearly defined audit regime. Clear and concise QA reports to be prepared. Prepare as-built records. Utilise qualified Inspectors.	Issue QA reports to client for maintenance records. Issue as-built records. Issue PS3 (to be issued with all relevant supporting evidence).
Third Party Inspector *(if engaged)*		Potentially involved to peer review specifications.	Decision made whether third-party monitoring is a requirement or not for the project. Loading schedules and specifications provided to third party agent and reviewed.		Regular QA inspections and DFT testing throughout the build at various stages of the build and application, in accordance with the specification requirements	Reinspection of any remedial works, if required.		Provide statement on Compliance with specification and design.

Readers are also advised to reference and become familiar with the SFPE (NZ) *Construction Monitoring Guide* for CM requirements for Fire.

Appendix B: LSTs

LST: The maximum temperature of the critical element of a steel member prior to failure, under fire conditions.

LST calculation methods are defined by NZS 3404.

Typically, to allow for the correct specification of the fire protection, the following minimum information is required for steelwork:

- Fire test standard (e.g. AS 1530.4 or NZS/BS 476 part 21)
- Fire resistance period (e.g. 90 minutes)
- Structural member type (e.g. I-column)
- Degree of exposure (e.g. 4-sided)
- LST (e.g. xxx°C)

The LST may be used to assess the structural adequacy of steel members, including columns and beams, during a fire. The LST, which should not be exceeded during the required fire resistance period, depends upon several factors, including the structural utilisation at the Accidental Limit State (ALS) in fire, the temperature gradient within the member, the dimensions of the section, and the yield strength of the steel.

Typically, the default tested and certified LSTs according to test standards referenced by the Acceptable Solutions are:

- 550°C for typical columns in compression
- 620°C for non-composite beams supporting concrete slabs or composite slabs
- 520°C for hollow sections

It is generally acknowledged that the temperatures of 550°C and 620°C are suitable for most circumstances, but not always. Anything outside of these default LSTs must be clearly stated for the steelwork in question and calculated by the Structural Engineer in accordance with NZS 3404.

Table 6 illustrates how the required Intumescent Coating thickness for an example product varies relative to LST.

The LST should be calculated by the Structural Engineer. When following the NZBC Acceptable Solutions and Verification Methods this will be as per NZS 3404 and AS/NZS 1170: 2002 – part 0 C4.2.4.

It is in the interest of structural engineers concerned with defining LSTs to coordinate closely with passive fire protection suppliers to ensure that the potential benefits and potentially unsafe implications are understood.

Appendix B *cont.*

Table 6: Effect of LST on the required DFT of an example intumescent coating

Degrees (°C) LST		**350**	**400**	**450**	**500**	**550**	**600**	**650**	**700**	**750**
Required Dry Film Thickness (µm)	1 hour (60/-/-) I-section column Hp/A* 150	X	1080	880	710	550	400	270	250	250
	2 hours (120/-/-) I-section column Hp/A* 150	X	6000	4740	3900	3300	2890	2370	1850	1510

** The rate of increase in temperature of a steel cross-section is determined by the ratio of the heated surface area (A) to the volume (V). This ratio, A/V, (also known as Hp/A), has units of m^{-1} and is known as the 'Section Factor'. Members with a lower Section Factor will heat up more slowly and vice versa.*

Appendix C: Intumescent Coating Systems – Regulatory Documentation Requirements

Where a building design incorporates an Intumescent Coating System (ICS) as part of the fire engineering design and structural fire protection requirements, the application for consent needs to include sufficient details to demonstrate how the proposed design complies, and also how it will be constructed to comply. This includes providing information such as plans, specifications, and sufficient information to support the design and to satisfy to the Building Consent Authority (BCA) that the relevant New Zealand Building Code requirements have been met.

The following table sets out the typical minimum requirements a BCA might expect to be provided at each stage of the consenting and approvals process to support an efficient approvals process. It is necessary to ensure that sufficient documentation is provided at all stages to support the design, application, testing, inspection, and ongoing maintenance stages of the ICS over the life of the building.

Building Consent Application - Processing	Check
1. Fire Safety Report completed in accordance with the Acceptable Solutions or Verification Methods clearly identifying the required fire rating for Structural adequacy for the various areas of the building.	
2. Structural drawings clearly identifying each element to be rated, and the Fire Resistance Ratings required to be achieved. This should be cross-referenced with the Fire Safety Report to confirm the fire protection Structural adequacy ratings are correct. These drawings need to identify the limiting steel temperature or this needs to be noted elsewhere from the structural engineer.	
3. Architectural drawings clearly identify the Steel fire protection strategy throughout the building including plans, cross sections, and details showing boarding, ICS, or other requirements. Plans and details co-ordinated with Structural and Fire Engineers' requirements.	
4. Manufacturer's technical specification confirming all of the following as it applies to the approved intumescent coating system (ICS): a. Limiting coating thickness (where applicable) b. That the coating complies with the requirements of the approved fire engineering design specification and the current NZ Building Code, including the durability requirements of NZBC Acceptable Solution B2 c. Compatibility of the ICS components if products from different suppliers are to be used. *Note: The provision of technical information applies equally to all primers, undercoats, and finish coatings.*	
5. Statement confirming the date and drawing set that the Loading Schedule is based upon, and project-specific Steel Schedule submitted for consent.	
6. Supplier's Loading Schedule confirming/identifying all of the following: a. Intumescent Coating to be applied b. Limiting Hp/A (heated perimeter-to-area ratio) c. Limiting steel temperature d. Structural steel members to be coated e. DFT (Dry Film Thickness) to be achieved for each member f. Fire-resistance rating to be achieved for each member.	
7. Details of the Intumescent Coating(s) to be applied should include the associated Quality Assurance (QA) system specific to the method of application and site conditions	

Appendix C *cont.*

Building Consent Application - Processing	Check
8. Relevant design standards necessary for application, i.e. ASFP, AS/NZS standards.	
9. Exposure time for coatings prior to closing in, details on manufacturers application requirements etc.	
10. Design co-ordination statements.	
11. Quality Assurance including construction inspection expectations, roles, responsibilities.	
12. Producer Statement – Design (PS1/PS2) if applicable and required by BCA.	
Note: Steel Schedules and Loading Schedules are to include and specifically identify all cellular beams and custom-welded sections. Loading Schedules are to be additionally supported by a statement from the intumescent coating supplier on their company letterhead confirming that the dry film thicknesses specified for cellular beams and custom-welded sections include appropriate adjustments to those applying to base sections. *Technical data and test certification for intumescent coatings is to confirm product suitability where applied for the protection of cellular beams and custom-welded sections, together with all limitations as may apply to such use.*	

Construction and Inspection (Realtime)	Check
Realtime definition: Relating to a system, in which input data is processed within a reasonable time frame so that it is available virtually immediately as feedback on the process from which it is coming e.g. QA system and Loadings Schedule available on site for inspectors to check in real-time. During Inspections, the following must be available on site during the construction process:	
1. Preconstruction meeting prior to application of the ICS to ensure responsibilities are well-defined, documented, and understood by all parties involved.	
2. All documentation relating to the specific coatings to be used, QA system, Monitoring, who and when, frequency of inspections, contractor's competency/experience (approved for application of the coatings), WFT and DFT readings, etc.	
3. Up to date/real-time documentation available on site, (target: not less than 24h prior to inspection).	
4. Site notes from architect, structural engineer, fire engineer, or the specifier of the ICS.	
5. Details of any remedial process and work to be identified, actions and close out.	

Code Compliance Certificate (CCC) Documentation	Check
To enable issue of the Code Compliance Certificate, and to support ongoing maintenance, the documentation to be submitted with application for CCC is to include:	
1. Specifications and plans identifying each member that has been coated.	
2. A copy of the QA System report included as part of PS3 or as part of the third-party independent certification and/or PS4 documentation.	
3. Supplier's Loading Schedule.	
4. Manufacturers' test certification.	
5. Typical Producer Statement Requirements – Construction (PS3) from the approved applicator confirming that all coatings were applied in accordance with the approved supplier's Material Schedule, manufacturer's instructions, and the approved consent documentation.	
6. Third party inspection certification. In lieu of third-party certification, provide a Construction Review (PS4) from a suitably qualified engineer confirming that all building elements identified in the approved Steel Schedule and related structural drawings have been protected with the approved ICS.	
7. Associated warranties.	
8. Recommended inspection regime for monitoring after applications and any relevant requirements including Life to First Major Maintenance	
Note: Where a PS4 from a structural engineer is provided but does not confirm or include reference to an ICS then it would be expected that third party certification be provided.	

Appendix D: Sample Site Quality Plan

SITE QUALITY PLAN	
Project Details:	
Contractor Details:	

1. DESIGN AND SPECIFICATION					
Ref No.	Activity	Auth.	Process	Complete/Received	Notes
1.1	Design Criteria		Environmental Considerations		
			Building considerations		
			Drawings		
			Steel Sections		
			Fire Rating Required		
			Steel Limiting Temperatures		
			Maintenance/repair considerations		
1.2	Specification		Method Statements		
			Surface preparation		
			Coating System		
			Compatibility statements		
			Product Certification		
			Design drawings		
1.3	Assessment		Applicator		
			Third Party Inspector		
			Report		

2. SURFACE PREPARATION					
Ref No.	Activity	Auth.	Process	Complete/Received	Notes
2.1	Pre-Blast		Visual		
			DFT readings		
			Acceptance report		
			Rust Grade		
			Part ID		
			Solvent Cleaning		
2.2	Blast		Blast media		
			Surface Profile		
			De-dust		

Appendix D *cont.*

3. PRIMER APPLICATION					
Ref No.	Activity	Auth.	Process	Complete/Received	Notes
3.1	Pre-checks		Air Temperature		
			Steel Temperature		
			Relative Humidity		
			Dew Point		
3.2	Application		Stripe coat (if required)		
			Wet film		
3.3	Post-checks		Dry film measurements		
			Visual appearance		

4. INTUMESCENT APPLICATION					
Ref No.	Activity	Auth.	Process	Complete/Received	Notes
4.1	Pre-checks		Primer condition, DFT, compatibility		
			Air Temperature		
			Steel Temperature		
			Relative Humidity		
			Dew Point		
4.2	Application		Stripe coat (if required)		
			Wet film		
4.3	Post-checks		Dry film measurements		
			Visual appearance		

5. SEALER/TOPCOAT APPLICATION					
Ref No.	Activity	Auth.	Process	Complete/Received	Notes
5.1	Pre-checks		Air Temperature		
			Steel Temperature		
			Relative Humidity		
			Dew Point		
5.2	Application		Stripe coat (if required)		
			Wet film		
5.3	Post-checks		Dry film measurements		
			Visual appearance		

6. REMEDIATION
Remediation:

7. FINAL CHECK
Final Check:

Appendix E: Sample onsite application Inspection and Test Plan

LEGEND: P = Perform, W = Witness, H = Hold Point, S = Surveillance, R = Review

	Activity	Test method/ Specification reference	Conformance Criteria	Comments	Test Frequency	Applicator	Third Party Inspector	Main Contractor	Designer
SURFACE PREPARATION PRIOR TO APPLICATION OF INTUMESCENT COATING									
1	Environmental conditions checked								
2	Degrease primed surface prior to application of intumescent coating								
3	Power tool clean								
4	Application of spot prime								
APPLICATION OF INTUMESCENT COATING IN ACCORDANCE WITH THE PRODUCT LOADING SCHEDULE PER ITEM									
5	Calibration of equipment								
6	DFT testing of primer/baseline								
7	Environmental conditions checked								
8	Application of spot prime								
9	DFT testing of intumescent								
COATING REPAIRS									
10	Defective areas remediated								
REVIEW OF QC RECORDS (TPI AUDIT IF REQUIRED)									
11	Review of QC records against the specification								
DOCUMENTATION SUBMITTED									
12	Documents submitted								

Appendix F: Example of Fire testing requirements to gain conformance to standards for intumescent coatings

1.1 General requirements

Primary elements and secondary elements, closures, and fire stops shall be assigned a fire resistance rating (FRR) when tested with current Building Code requirements.

The tests must be carried out by the third-party test laboratory:

a) Having valid accreditation to NZS ISO/IEC 17025 by IANZ or recognized by IANZ through formal agreements, for example NATA accreditation in Australia, and

b) The scope of accreditation must include the testing of the relevant structural element, for example, the accreditation scope shall include AS 1530.4:2014 Section 5 (Columns) and Section 6 (Beams, girders. trusses).

Testing conducted to other testing standards such as European Norms (EN) or ISO may be acceptable, but a formal opinion from a recognised testing laboratory shall be presented.

1.2 Expression of the results

Fire resistance rating for the structural steel elements is normally expressed as (X/-/-), where X is structural adequacy in minutes.

Failure in relation to structural adequacy shall be deemed to have occurred upon collapse, or when the following occurs:

1. The criteria for axially loaded elements have been exceeded:
   Limiting axial contraction, C = h/100, and
   Limiting rate of axial contraction, dC/dt = 3h/1000, mm/min

Where: h - initial height

2. When the following criteria for laterally loaded elements has been exceeded:

Deflection of L2/400d, mm

Where the rate of deflection (in millimetres per minute) as calculated over 1 min intervals, starting at 1 min from the commencement of the heating period, exceeds the limit set by:

Rate of deflection = L2/9000d, mm/min

Where: L - clear span of the specimen, in millimetres
  d - distance from the top of the structural section to the bottom of the design tension zone, in mm

Since relatively rapidly deflections can occur before stable conditions are reached, the rate of deflection limit shall not apply before a deflection of L/30 is exceeded.

Appendix F: *cont.*

1.3 Test specimen size

that which can be accommodated by the test equipment, the testing laboratory shall test a representative portion of the full-sized element of length not less than 2800 mm.

Beams, girders, and trusses - The specimen shall be full size. Where the length of the full-sized element exceeds that which can be accommodated by the test equipment, the testing laboratory shall test a representative portion of the full-sized element in which the curtailed length is not less than 3000 mm.

Where a beam(s) is to be incorporated in a concrete floor or roof system for which the design details are not available to the testing laboratory, the test specimen shall comprise:

a) the beam(s) and its fire-protective material, if any; and

b) a symmetrically located concrete deck or slab in intimate contact with the beam, which is:
   (i) not less than 1000 mm wide; and
   (ii) 100 mm thick.

NOTE: It has been established that certain types of lightweight concrete offer less of a heat sink than other concrete, and this results in appreciably higher temperatures in supporting steel members. Consequently, a test carried out using lightweight aggregate concrete will produce a result that may be applied conservatively if dense aggregate concrete is used in practice.

In addition to a full-scale specimen, a series of particular elements of minimum length 1000 mm may be tested to determine the effectiveness of different thicknesses of protective materials on the structurally critical temperatures for assessment purposes. This specimen shall include insulation on the ends to prevent conduction.

Where temperature-measurement procedures are adopted, the loading may be waived and specimens of minimum length of 1000 mm may be used, subject to the following conditions:

a) It shall be demonstrated by means of tests conducted in accordance with relevant test method that the applied fire insulation system will remain substantially in place throughout the test period.

b) Where a series of columns or beams is tested to determine the effectiveness of different thicknesses of protective materials, testing shall be applied to those specimens having the thickest and the thinnest protection in the range.

NOTE: Insulation system includes materials, fixings, joints, and application techniques.

1.4 Permissible variations to the tested prototype

The results of the fire test contained in the test report are directly applicable without reference to the testing laboratory to similar constructions where a change has been made in the reduction of the height of a column without an increase in the load.

NOTE: Reference should be made to the relevant structural design Standards for other permissible variations.

Appendix F: *cont.*

1.5 Test report

A test report shall be prepared and shall include the description of the test specimen and the drawings. As far as practicable, the description and the drawings shall be based on information provided by the applicant and verified by a survey of the test specimen. When full and detailed drawings are not produced by the testing laboratory for inclusion in the report, the applicant's drawing(s) of the test specimen shall be authenticated by the testing laboratory and at least one copy of the authenticated drawing(s) shall be included in the report. The report shall state that the drawings are those provided by the applicant.

The test report shall include at least the following information:

a) The name and address of the testing laboratory;
b) The name and address of the applicant;
c) The date of the test;
d) The unique reference number of the test;
e) The name of the manufacturer (if known) of the test specimen and of the products and components used in the construction, together with identification marks and trade names;
f) The construction details of the test specimen, including product name or product identifier, description and drawings and principal details of the components;
g) The relevant properties of materials or components that have a bearing on the fire performance of the test specimen. Where it is impracticable to measure some of these properties, this shall be reported;
h) The method of assembly and installation of the test specimen;
i) Details of pre-test conditioning of the test specimen;
j) A statement concerning the testing laboratory's involvement in the selection of the test specimen;
k) For loadbearing elements, the load applied to the test specimen, the basis for its calculation as provided by the applicant, and the method of loading;
l) The measured exposed surface area and cross-section area of steel sections tested;
m) Thickness of all components of applied protection system and basis of measurement;
n) The support and restraint conditions employed, and the rationale for their selection;
o) For asymmetrical separating elements, the direction in which the specimen was tested and the reason for this choice;
p) Information concerning the location of all thermocouples, pressure measurement and deflection measurement devices, including drawings that clearly illustrate the positions of the various devices and identify them relative to the data provided;
q) The ambient temperature of the laboratory at the commencement of the test;
r) The location of the pressure sensor;
s) Temperature curves of the furnace heating conditions;
t) The reasons for validating the test in the event of the tolerances on the temperature/time curve, pressure conditions, or ambient laboratory conditions being inadvertently exceeded;
u) The result stated in terms of time, in elapsed whole minutes, between the commencement of heating and the time of failure with respect to the relevant criteria, including-

Appendix F: *cont.*

(i) the rate of deflection when this is the criterion used to assess loadbearing capacity, including the value of used in calculating the limiting rate of deflection for flexural members;
(ii) the maximum deflection and the time and position at which it occurred, supported by adequate graphical data;
(iii) the mode of failure with respect to all integrity criteria;
(iv) the position(s) at which the maximum temperature rise was measured should this be the case of insulation failure; and
(v) any alternative and additional tests (e.g. plate thermometers).

v) Tabulation or graphical depiction of the output from all pressure-measuring devices, deflection-measuring devices, heat flux meters, unexposed face thermocouples and, where applicable, internal thermocouples;

w) A description of any significant behaviour of the test specimen;
x) The field of direct application of the results for the specimen; and
y) The FRL (FRR) assigned to the test specimen.

1.6 Assessment report

specimens to a full-scale fire resistance test. Where an element requires the variation to the tested prototype subject to formal opinion/assessment a full justification for the assessment shall be included in a report or formal opinion obtained from a registered testing laboratory.

The formal opinion shall be derived directly from the full-scale fire resistance test results, by means of a technical analysis of the effects of the proposed variations in relation to the failure criteria of the fire resistance test.

The formal opinion shall include at least the following:

a) Reference to the full-scale test including a general description of the tested item and the specific results achieved relevant to the opinion;
b) Reference to other supporting information;
c) A detailed statement of the proposed variation(s) to the tested prototype, including the element type and description, Hp/A or W/D, rating in minutes, proposed coating thickness, etc.;
d) A summary of the critical issues leading to the opinion, including the main points of the argument and any assumption made;
e) A statement of the formal opinion, including the number and date of the Standard against which the fire resistance has been assessed;
f) The name of the person and the organization accepting responsibility for the opinion;
g) The name of the individual(s) preparing and reviewing the opinion together with their signatures and the date; and
h) A period of validity for the report, which shall not exceed 5 years.