GRENFELL TOWER INQUIRY

PHASE 2: MODULE 1

REPORT OF FACADE EXPERT

Jonathan Sakula
MA CEng FIStructE FICE
Sakula Consulting Limited

13 March 2021

Summary

1. The Grenfell Tower Inquiry was set up following the fire at Grenfell Tower on the night of 14 June 2017. Phase 1 focused on the events on the night of the fire and the Phase 1 report was published on 30 October 2019.

2. Phase 2 of the Inquiry examines the causes of these events, including how Grenfell Tower came to be in a condition which allowed the fire to spread in the way identified by Phase 1. Phase 2 of the Inquiry is divided into eight modules, the first two modules being:

   Module 1: The primary refurbishment (overview and cladding)
   Module 2: Cladding products - testing/certification, product marketing/promotion

3. The present report, forming part of Phase 2, Module 1, is in response to instructions given to the facade expert. The full instructions are included in Appendix A of the present report. The following extract from the introduction to those instructions gives an overall view of what the Inquiry requires from the present report:

   "The Inquiry wishes to understand more about the cladding industry in the period January 2012 to June 2017. In asking you about the state of knowledge within the cladding industry during that period, we would like to understand what a specialist cladding contractor exercising reasonable skill and care would have appreciated and understood about certain matters, as set out in the questions below."

4. The questions referred to cover a large number of topics related to the fire performance of the facades of tall buildings. These are all discussed in the report and the following are the main conclusions. They are given in roughly the order in which the issues have been covered in the present report, and not in any order of priority.

5. There is an important distinction to be drawn between product manufacturers and contractors, in that the manufacturers usually make a limited range of products within a specific category, and therefore would be expected to know all the details of legislation and testing in relation to those products, or at least be advised by a local agent or consultant, where supply is to an unfamiliar jurisdiction. On the other hand, a cladding contractor deals with a wide range of products, so would not be expected to be as knowledgeable as the manufacturer, for each product.

6. When considering 'reasonable skill and care', I have considered any differences between the UK-based cladding contractors dealing with overcladding projects such as on Grenfell Tower and the 'top tier' international facade contractors. In considering 'reasonable skill and care' I am considering that which is applicable to UK cladding contractors carrying out overcladding work similar to that on the Grenfell Tower refurbishment. While the level of technical expertise of such contractors may differ from that of their

international counterparts, I consider that the expected level of 'reasonable skill and care' is the same.

7. A reasonably competent cladding contractor would be expected to have a person or people in their technical department who had the expertise necessary to deal with the design and technical matters that were likely to arise. Such people would be expected to recognise where there were gaps in their expertise, and to know how to go about filling those gaps, either through research or by consulting others with the appropriate expertise.

8. Where the cladding contractor sub-contracted design work to another company, I would expect the cladding contractor to review, and take responsibility for, any design or technical information provided by their sub-contractor. The same would apply to matters of compliance with regulations, where that formed part of the sub-contractor's appointment.

9. The advantage of facade consultancy or engineering for the building owner or architect is that the technical advice given is not attached to any commercial interests. The engineers involved are expected to have detailed technical knowledge of the construction industry, and thereby to act as a trusted intermediary between the architect or building owner and the industry.

10. In the case of the Grenfell Tower refurbishment I would expect the appointment of a facade consultant or engineer to have been considered by the Tenant Management Organisation, in dialogue with Studio E, during the pre-novation phase. The dialogue would have needed to address whether Studio E had the required experience and/or technical expertise in overcladding a tall residential building, and whether there were other parties involved who could provide this.

11. The issue of who would pay the fees for facade consultancy or engineering would always be a factor in the discussion. Some building owners consider that they are already paying the architect to design and specify the facade of the building, and they do not see a need to pay another consultant to do this. In cases where the building is large or of a complex nature, the architect may nevertheless convince the building owner that the appointment of a facade engineer is necessary.

12. The main ways in which technical information would have been conveyed to the industry in the period being considered are by notifications of updates to codes and standards, articles in trade journals and magazines, technical training and courses, manufacturers' direct marketing and seminars and conferences. Of these, there were relevant technical publications and courses available and also important seminars on fire safety in facades held in Paris in 2013 and Lund in 2016.

13. The fires during the period being addressed that would, in my opinion, have been more widely known were the fires in the United Arab Emirates (UAE), particularly in Dubai in 2012-2016, because they were well covered in the UK news media and technical press at the time. The fire risks of ACM panels and

of some insulation products should therefore have been known to the UK cladding industry.

14. With reference to Approved Document B to the Building Regulations 2010, Volume 2 (ADB2), I would expect a cladding contractor to have been fully aware of the requirements of section 12 of that document, as the primary business of a cladding contractor concerns the external walls of buildings. The same applies even more so to manufacturers of cladding products.

15. BS 9999 (2008) and BS 9991 (2011) concern fire safety of buildings. As these documents are wide ranging I would expect a cladding contractor to be aware of their existence but not necessarily to be familiar with their contents. However, if the documents were specifically referenced in the cladding contractor's contract or the specification I would expect the cladding contractor to have referred to them, particularly the sections dealing with construction, such as clauses 30-36 in BS 9999 and clauses 27-31 in BS 9991. If the documents were not referred to in the cladding contractor's contract or specification, I would not expect the cladding contractor to have referred to them.

16. BR 135 (2nd edition 2003 and 3rd edition 2013) is a technical publication by the Building Research Establishment (BRE) dealing with fire performance of external insulation in tall buildings. I would expect most specialist cladding contractors in the period being addressed to have been aware of the existence of BR 135, because of its reference in clause 12.5 of ADB2. I would consider, however, that many cladding contractors would not have read it or understood exactly how the tests were classified, nor would I expect them to have read the more general sections of BR 135. Some of the more conscientious and technically aware cladding contractors would probably have studied the document and so would have had a better understanding of the general requirements and how the classifications were made. In the case of manufacturers of cladding products, I would expect them to have been fully aware of the detailed requirements of Appendices A and B of BR 135.

17. The same considerations would have applied to the cladding contractors' and product manufacturers' appreciation of BS 8414-1 and BS 8414-2, the standards relating to fire testing of external walls.

18. The Centre for Window and Cladding Technology (CWCT), based in Bath UK is the main technical umbrella organisation for facade technology in the UK. I would expect all cladding contractors to have been aware of the contents of the 'CWCT Standard for systemised building envelopes' in detail, and to have been aware of the subjects covered by the CWCT Technical Notes, reading specific notes as required. For example Technical Note 73: 'Fire performance of curtain walls and rainscreens' was published in March 2011, and gives an important summary. This applies particularly to those contractors who were members of the CWCT.

19. The Building Control Alliance (BCA) published Technical Guidance Note 18 (Issue 0, June 2014, and Issue 1, June 2015). In my opinion a reasonably

competent cladding contractor working on tall buildings would have been aware of this through conversations with peers, or communications from the CWCT, and would have read it.

20. I would expect the cladding industry to have been familiar with the National House Building Council (NHBC) standards, as NHBC certification was, and remains, quite common for housing projects. I would therefore expect a reasonably competent cladding contractor to have been aware that, to satisfy NHBC standards, any extruded polystyrene insulation should be of the fire retardant grade.

21. With reference to the use of combustible materials in the overcladding of tall buildings, I consider that a cladding contractor would have considered paragraph 12.7 of ADB2 to refer to insulation used as part of the external facade system.

22. The term 'filler material' in clause 12.7 is, in my opinion, unclear. I would consider that it was intended to refer to gap fillers such as expanding foam fillers. I do not think it was intended to refer to the core of an ACM panel, which I have never heard referred to as 'filler'. I also think that a reasonably competent cladding contractor or product manufacturer would have had a similar view.

23. With respect to their understanding of fire test evidence, in my view, most cladding contractor/designers would have regarded the BBA or LABC as an authority, and they would have been content to rely on their certificates, without going back to the source data, provided of course that they (the contractors) were mindful of any caveats included in the certification. I would, however, have expected them to seek further advice if their proposed system did not conform exactly to the system for which any test certificate was issued.

24. With respect to British Board of Agrément (BBA) certification relating to aluminium composite panels (ACP), in my opinion, most members of a cladding contractor's staff would have been content to see that a product was covered by a BBA certificate and would probably not have read the details on that certificate. However, those members of the cladding contractor's staff with technical or design responsibility would be expected to be more familiar with the details of the certificate and I would expect them to have read it in greater detail.

25. In my opinion, BBA certificate 08/4510, covering Reynobond Architecture Wall Cladding Panels, is misleadingly drafted, in that it gives the impression on the first page that the product has a 'Class 0' surface, without qualification. However, on turning to Section 6, it is apparent that this contains vital information about the details and limitations of the fire testing carried out. I consider that a reasonably competent cladding contractor would read Section 6 in full. They would thus be alerted to the fact that the tests mentioned in the BBA certificate were for specific core types, paint types and colours. The implication of this is that, at the very least, a cladding contractor should raise

queries with the product manufacturer. It would also mean that they should consider discussing this issue with the architect, the fire consultant and/or the Building Control Officer, to establish whether project-specific system testing was required.

26. With regard to the cladding industry's understanding of 'Class 0', I think that most competent practitioners in the cladding industry understood the meaning of 'Class 0'. However, in my experience that did not apply to all, and some people seemed to confuse the idea of Class 0 with general combustibility.

27. I do not recall having come across the expression 'Class 0 throughout' during the period being addressed. 'Class 0' is based on flame and heat being applied to the surface of the material, and it does not refer to the body of the material being tested. In my opinion, the expression 'Class 0 throughout' would suggest a confusion, or an attempt to mislead, between the idea of combustibility of the material and that of Class 0.

28. Concerning alternative routes to compliance with ADB2, from my experience there was awareness within the cladding industry of these alternatives. However, on considering what cladding contractors in particular would have been aware of, my opinion is that they would have been mostly aware of either the 'linear' route or the 'fire test' or 'desktop study' routes. I do not think they would normally have been aware of the 'fire safety engineering' route, as this would not have been common on the sort of buildings worked on by UK cladding contractors.

29. One factor that would have been behind the decision to use aluminium composite panels (ACP) with a polyethylene (PE) core for buildings with a floor above 18m was that ACPs contain roughly one-third the aluminium of aluminium panels of the same stiffness. As aluminium is relatively more expensive than the PE core, the ACP will therefore be relatively cheaper than a panel of the same stiffness using just aluminium. Also, because PE has lower density than aluminium, an ACP is also lighter in weight, having about two-thirds the weight of an aluminium panel of the same stiffness. This makes the panels easier for operatives to handle on site, which is a useful property, particularly when working at height.

30. When considering the requirements of Section 12 of ADB2, I consider that this section does not disallow the use of ACPs, including those with a PE core. However, the Building Regulations themselves require that external walls should 'adequately resist the spread of fire'. Therefore, despite their weight and cost advantages, I consider that the use of PE-cored ACP for cladding a building with a floor higher than 18m above ground would have been unwise, given the known combustibility. In addition, BCA TGN 18, published in June 2014, advised that, if following the 'linear route' to compliance with ADB2, all elements of the cladding system should be of limited combustibility. In such circumstances, I consider that failure to consider adequately the combustibility of the materials would fall below the standard expected of a reasonably competent practitioner in the cladding industry. This would apply even more so to a situation where such materials

were being proposed as a cost saving measure, where it would be essential to verify whether the cheaper product would perform adequately by comparison with the product for which it was being substituted.

31. Considering any interactions between the cladding contractor and the fire engineer, fire safety and fire strategy reports contain much information relevant to their subject matter. I would expect a cladding contractor to have read these reports and to take note of any matters which affected their work, particularly with regard to materials and design detailing. During the course of a contract I would therefore expect the cladding contractor to raise any fire related questions via the main contractor, but in practice the cladding contractor might address the architect on this, or even the fire consultant directly.

32. Concerning the cladding contractor's understanding of their duties under the CDM Regulations (2007 or 2015), in my experience cladding contractors would have had a good general understanding of their CDM responsibilities. However, that understanding would probably have been focused on how the site work was to be carried out safely, dealing with such matters as handling of heavy loads, falls from height, dropping of components and tools from height, and so on. They would probably not have focused on the as-built safety of the overcladding system, as, for CDM purposes, they would probably have considered that to have been the responsibility of others.

Contents

Abbreviations

The following abbreviations are used in this report:

ACM	Aluminium composite material
ACP	Aluminium composite panel(s)
ADB2	Volume 2 of Approved Document B to the Building Regulations (2006 edition, incorporating 2007, 2010 and 2013 amendments)
BBA	British Board of Agrément
BRE	Building Research Establishment
BS	British Standard
CIBSE	Chartered Institute of Building Services Engineers
CWCT	Centre for Window and Cladding Technology
EN	Euronorm
FR	Fire retardant
ICBEST	International Conference on Building Envelope Systems and Technology
LABC	Local Authority Building Control
LPC	Loss Prevention Council
LPCB	Loss Prevention Certification Board
NHBC	National House Building Council
PE	Polyethylene
PIR	Polyisocyanurate
PVDF	Polyvinylidene Fluoride
RIBA	Royal Institute of British Architects
SFE	Society of Facade Engineering
XPS	Extruded polystyrene

1. Introduction

1.1 The Grenfell Tower Inquiry was set up following the fire at Grenfell Tower on the night of 14 June 2017.

1.2 On the Inquiry's website, the Inquiry's Terms of Reference are stated as:

1. To examine the circumstances surrounding the fire at Grenfell Tower on 14 June 2017, including:

(a) the immediate cause or causes of the fire and the means by which it spread to the whole of the building;

(b) the design and construction of the building and the decisions relating to its modification, refurbishment and management;

(c) the scope and adequacy of building regulations, fire regulations and other legislation, guidance and industry practice relating to the design, construction, equipping and management of high-rise residential buildings;

(d) whether such regulations, legislation, guidance and industry practice were complied with in the case of Grenfell Tower and the fire safety measures adopted in relation to it;

(e) the arrangements made by the local authority or other responsible bodies for receiving and acting upon information either obtained from local residents or available from other sources (including information derived from fires in other buildings) relating to the risk of fire at Grenfell Tower, and the action taken in response to such information;

(f) the fire prevention and fire safety measures in place at Grenfell Tower on 14 June 2017;

(g) the response of the London Fire Brigade to the fire; and

(h) the response of central and local government in the days immediately following the fire;

and

2. To report its findings to the Prime Minister as soon as possible and to make recommendations.

1.3 The Inquiry is investigating a List of Issues that has been separated into two phases. Phase 1 focused on the events on the night of 14 June 2017. Hearings for Phase 1 ran from May to December 2018, with the Phase 1 report being published on 30 October 2019.

1.4 Phase 2 of the Inquiry examines the causes of these events, including how Grenfell Tower came to be in a condition which allowed the fire to spread in the way identified by Phase 1.

1.5 Phase 2 of the Inquiry is divided into eight modules, with the first two modules being:

Module 1:	The primary refurbishment (overview and cladding)
Module 2:	Cladding products - testing/certification, product marketing/promotion

1.6 The present report, forming part of Phase 2, Module 1, is in response to instructions given to the facade expert.

2. Instructions

2.1 Brief

2.1.1 I, Jonathan Sakula, was appointed as an expert to the Inquiry on 26 October 2020 and I received my letter of instruction on 3 November 2020. The Annex to the letter contains the questions that I have been asked to address and is given in full in Appendix A. On 26 January 2021, the Inquiry asked me to address further questions, which are also included in Appendix A. The following extract gives an overall view of what the Inquiry requires from the present report:

"The Inquiry wishes to understand more about the cladding industry in the period January 2012 to June 2017. In asking you about the state of knowledge within the cladding industry during that period, we would like to understand what a specialist cladding contractor exercising reasonable skill and care would have appreciated and understood about certain matters, as set out in the questions below. Except where indicated otherwise, we would ask you to examine the position (i) in England and Wales and (ii) in the rest of the UK, if possible.

In providing an opinion on these matters we are particularly interested to know whether you can point to any industry conferences, journals and other publications, circulars or guidance available during the relevant period which provide objective evidence of the information that was available about these matters within the industry. To the extent that the position changed between 2012 and June 2017, please describe those changes when answering the questions and explain why they occurred. Please also explain any differences of opinion, understanding and practice within the industry during that period."

2.1.2 In addition to the above, the Inquiry wishes to find out more about the role of the specialist facade engineer or facade consultant and the factors that might have played a part in why one was not appointed for the Grenfell Tower refurbishment.

2.2 'The cladding industry'

2.2.1 I note that the phrase 'the cladding industry' is quite broad. For the purposes of the present report, I shall take this to mean cladding contractors, cladding consultants and relevant manufacturers. However, the emphasis will be on cladding contractors, as manufacturers are addressed mainly in Module 2. Also, there was no cladding consultant on the Grenfell Tower refurbishment, so their state of knowledge is not as relevant to the Inquiry as that of cladding contractors.

2.2.2 An important distinction to be drawn between product manufacturers and contractors is that the manufacturers usually make a limited range of products within a specific category, and therefore would be expected to know all the

details of legislation and testing in relation to those products. Where a manufacturer is supplying materials to an unfamiliar region or country, they would reasonably be expected to have a local branch or agent, or there would be a local consultant involved, and one of those parties would be expected to advise the manufacturer of the local regulatory environment.

2.2.3 On the other hand, a cladding contractor deals with a wide range of products, so would not be expected to be as knowledgeable as the manufacturer, for each product. The cladding contractor would therefore rely, to a large extent, on the information and certification provided by the manufacturer.

2.3 'Reasonable skill and care'

2.3.1 The phrase 'specialist cladding contractor exercising reasonable skill and care' requires further clarification.

2.3.2 In section 5, I give a summary of the nature of the UK cladding industry, differentiating between the UK-based cladding contractors dealing with overcladding projects such as on Grenfell Tower and the 'top tier' international facade contractors. In considering 'reasonable skill and care' I am considering that which is applicable to UK cladding contractors carrying out overcladding work similar to that on the Grenfell Tower refurbishment. While the level of technical expertise of such contractors may be slightly less than that of their international counterparts, I consider that the expected level of 'reasonable skill and care' is the same.

2.4 Methodology

2.4.1 In addressing the questions about the state of knowledge within the cladding industry, I recognise that, to assess this issue thoroughly, a survey or interview process would strictly be needed. However, in the context of this Inquiry I understand that such an approach would not be feasible. I shall therefore give my own view of the state of knowledge in the cladding industry, based on my experience, while noting that I shall not in general be able to provide statistical evidence to back up my opinions.

2.4.2 In the following report, I have repeated the questions from the Annex to my letter of instruction, in ***bold italics*** in each section, for ease of reference.

2.5 Chronology

2.5.1 Although the applicable period of time is defined in my brief as January 2012 to June 2017, it is relevant to be aware of the following dates relating to the installation of overcladding on Grenfell Tower:

July 2014	Design started by specialist cladding contractor
October 2014	Site start for overcladding works
March 2016	Overcladding work substantially completed

2.5.2 The 'lead-in' period before site start was therefore three months and the period on site was 18 months.

2.5.3 These dates were of course preceded by the design work by the architect, and by the tender process.

3. Background and experience

3.1 I have worked in the construction industry for over 45 years and in the facade industry for almost 30 years. Having left full time employment in 2017, I have been practising since 2019 as a facade expert though Sakula Consulting Limited. I am a Chartered Engineer, a Fellow of the Institution of Structural Engineers and a Fellow of the Institution of Civil Engineers. My CV is enclosed as Appendix B, and the following gives a summary.

3.2 After studying engineering at Cambridge University I started my career as a structural engineer with Arup. Following an initial period in London and three months on site in Qatar, I worked in Africa for eight years, firstly, as a volunteer, developing rural small-scale cement projects in Tanzania, and then as the director of Arup's office in Lusaka, Zambia.

3.3 I returned to London in 1987 and led large multi-disciplinary design projects and also spent time as a Research Manager for the Construction Industry Research and Information Association (CIRIA), before becoming a founder member of Arup Facade Engineering in 1992. One of the projects that I led was the overcladding of a tall residential tower block in Hackney, East London. I also led the teams for assessing buildings for blast damage following the Bishopsgate bombing in 1993, and I subsequently led the design team for the facade of Portcullis House in Westminster.

3.4 I then worked as facade team leader, consecutively for Dewhurst Macfarlane, Yolles and Halcrow, before spending the last seven years of my full time career as the Technical Director for Buro Happold Facade Engineering in London. Although primarily working with the London team I was also responsible for technical coordination with Buro Happold's USA, Middle Eastern and East Asian facade teams. I spent 2016/17 as a Principal in Buro Happold's New York office, leading their facade team.

3.5 During the course of my career I have worked on many projects, ranging from structural engineering for whole buildings and parts of buildings, to facade engineering and also research and development work. For the facade consultancy projects since 1992 I have worked at all stages of the construction process, for building owners, architects, main contractors and facade subcontractors. I have worked in the office as a designer/specifier and also on site inspecting new work and carrying out investigations where there were facade-related problems on existing buildings.

3.6 The following table gives an approximate breakdown of the types of projects in which I have been involved (165 in total):

Structural	43
Facade consultancy for building owner	23
Diagnostic, expert or forensic facade work for building owner	25
Facade consultancy for architect	27
Facade consultancy for main contractor	5
Facade engineering for specialist subcontractor	35
Research and development on facades	7

4. Disclosure of interests

4.1 As mentioned in the preceding section I have worked on a large number of projects over the course of my career, and have consequently met many people in the construction industry. I have searched my memory for recollections of the firms or people involved in the Grenfell Tower Inquiry, and can advise as follows.

4.2 Studio E was the architect for Haileybury College, for which the structural engineer was Dewhurst Macfarlane and Partners, my employer from 1997 to 2001. I do not recall having any involvement in that project, nor any other project with Studio E.

4.3 I recall corresponding with Exova on one or more previous projects.

4.4 I have worked with Max Fordham LLP on one or more previous projects.

4.5 I have corresponded with the Building Research Establishment (BRE) on previous projects, and I have visited their facility.

4.6 During the course of my career I have attended a number of presentations by product manufacturers. It is possible that I have attended product presentations by Celotex, Kingspan or Siderise, but I cannot recall this with any certainty, nor any details of such presentations.

4.7 I cannot recall having met or interacted with any other companies or people listed as the Core Participants (dated 21.09.2020), nor in the list of witnesses for Modules 1 and 2 of the Inquiry (dated 20.02.2020).

5. The UK cladding industry

5.1 The nature of the UK cladding industry

5.1.1 In addressing the state of knowledge within the cladding industry during the period referred to in my brief, it may be useful to clarify some terms.

5.1.2 The term 'facade' is used generally in the industry to refer to the building enclosure or 'skin' of the building - that which separates the inside from the outside of the building. A 'curtain wall' is a non-loadbearing part of this enclosure, typically spanning between floors. 'Cladding' is also usually non-loadbearing and is a building skin normally used to cover an opaque surface.

5.1.3 It may be helpful to explain briefly the nature and evolution of the UK cladding industry over the last 50 years.

5.1.4 During the 1970s and 1980s there was an increase in the penetration of the UK (and UK-related overseas) facade markets by facade contractors from countries in mainland Europe, for example from Italy, Germany, Switzerland, France and Holland. Design and technical staff from those countries had a relatively high level of technical education. In more recent years, since 2000, the UK and international market place has also included facade contractors from China. Tender lists for large or complex buildings would therefore have comprised mainly such companies.

5.1.5 By contrast, the UK facade contractors would have carried out the more routine facade work. In particular, overcladding work, of the kind used for Grenfell Tower, would normally have had mainly UK companies on the tender lists.

5.1.6 In considering the state of knowledge within the cladding industry therefore, I shall consider only the typical UK-based contractors, and not the international players referred to above.

5.2 The location of technical knowledge within a cladding contractor's organisation

5.2.1 I have also considered *where* technical knowledge by the cladding contractor resides. Not all departments within the contractor's organisation would be expected to have a high level of technical knowledge, but this would be expected of those departments dealing with design and technical matters. If other departments, for example those dealing with contracts, estimating or site operations, needed to understand technical information, in my experience they would have sought advice from their technical and design departments.

5.2.2 It therefore follows that a reasonably competent cladding contractor would be expected to have a person or people in their technical department who had the expertise necessary to deal with the design and technical matters that were likely to arise. Such people would be expected to recognise where there were gaps in their expertise, and to know how to go about filling those gaps, either through research or by consulting others with the appropriate expertise.

5.2.3 As a further point, where the cladding contractor sub-contracted design work to another company, I would expect the cladding contractor to review, and take responsibility for, any design or technical information provided by their sub-contractor. The same would apply to matters of compliance with regulations, although that would depend on whether checking compliance with regulations formed part of the sub-contractor's appointment.

6. Role of facade engineer or facade consultant

I have been asked to address five questions, which will be taken in turn.

6.1 Role of specialist facade engineer or consultant

Q1.a What was the role of a specialist façade engineer or consultant?

6.1.1 During the 1970s and 1980s people with experience in the facade industry began to offer services as consultants, typically to building owners and architects. Initially these were individual consultants, but by the early 1990s the larger multi-disciplinary consultancies in the UK began to recognise the value of providing facade consultancy as a new specialised service.

6.1.2 The terms 'facade consultant', 'curtain wall consultant', 'cladding consultant' and 'building envelope consultant' were used more or less interchangeably, although they do in fact have slightly different meanings. In addition, the term 'facade engineer' became more widespread. Like other kinds of engineering, this service implied a more 'hands-on' approach, involving for example structural and thermal calculations and detailed design and specification. This is distinct from a pure consultancy role, involving for example the review of architect's drawings.

6.1.3 I shall use the single term 'facade engineer' for brevity, but this should be taken for the purpose of the following discussion to include the terms 'facade consultant', 'curtain wall consultant', 'cladding consultant' and 'building envelope consultant'.

6.1.4 To understand the role of the facade engineer it is useful to recognise how the architectural profession has evolved over the last hundred years or so. Up to about the end of the 19th century, architects would have been the only professional involved in the building design, although some design was carried out by specialist contractors, for example steelwork frame contractors. Around the start of the 20th century the independent profession of consulting structural engineers evolved, separately from contractors. Similarly, around the middle of the 20th century the profession of building services engineers evolved, carrying out for the building owner or architect design and specification services that were previously done by specialist mechanical and electrical contractors.

6.1.5 The advantage of these new types of consultancy for the building owner or architect was that the technical advice given was not attached to any commercial interests. The engineers involved were expected to have detailed technical knowledge of the construction industry, and thereby to act as a trusted intermediary between the architect or building owner and the industry.

6.1.6 Similarly, the growth of facade engineering during the last quarter of the 20th century was driven by the need for building owners and architects to receive sound technical facade advice independent of any commercial interests. The people coming into facade engineering were from a variety of backgrounds:

from the design and technical departments of facade contractors themselves; from architects with a technical bent; from product and industrial designers; from building physics specialists; and from structural engineers.

6.1.7 It should be noted that, before the growth of the profession of facade engineers, structural engineers often found themselves in a difficult position because their appointments usually covered the main frame of the building, but excluded the structural issues in connection with the facade. They were often asked to advise on facade matters, even if their appointment did not cover those.

6.1.8 The range of skills of people coming into facade engineering represented the multi-disciplinary nature of the facade, and of facade engineering. Typically facade engineers would deal with design, structural and building physics matters in-house, while obtaining advice from other specialists as needed, for example from acousticians, blast specialists, fire specialists and materials specialists.

6.1.9 The advice given reflected the increasingly complex technical nature of facades in the second half of the 20th century, and generally both building owners and architects welcomed this advice at the pre-contract stages of the project. However, as well as providing services to building owners and architects, facade engineers could also work for main contractors, assisting the contractor in reviewing drawings and technical submissions from their specialist facade contractors. In addition, sometimes facade engineers worked directly for the specialist facade contractors themselves, supplying design and technical services, for example in detailed structural design of brackets and fixings.

6.1.10 The new service was generally welcomed by other professionals in the field, as it was recognised that the facade of the building was the part that had historically given rise to the largest proportion of building problems, such as rainwater penetration, condensation, breakages and so on. Most architects in particular saw the role of a facade engineer as helpful to them in minimising potential future liabilities with regard to the facade.

6.2 Membership of professional organisations

Q.1b Would you expect such a person to have been a member of any professional organisation?

6.2.1 There was initially no professional body regulating facade engineers, and the various practitioners would have been regulated instead by being members of the professional body of their own specialisation.

6.2.2 In the UK, the Centre for Window and Cladding Technology (CWCT), founded at the University of Bath in 1989, acted as an umbrella technical organisation, but had no professional regulatory role.

6.2.3 In 2004 the Society of Facade Engineering (SFE) was founded jointly by the Royal Institute of British Architects (RIBA), the Institution of Structural Engineers and the Chartered Institution of Building Services Engineers (CIBSE). It was located as a Society within CIBSE. The SFE is a growing professional society, and acts as a 'qualifying' body for facade engineers. However, there is currently no requirement in the UK for a facade engineer to be a member of the SFE in order to practise.

6.2.4 A full description of how the SFE describes facade engineering is available on their website, and an excerpt from this is included in Appendix C.

6.2.5 The code of conduct expected of SFE members is set out in paragraph 8 of the SFE Rulebook, Issue 01, 21 July 2008[1], and states:

"A member of SFE of whatever class shall comply with the code of professional conduct laid down at the time in the Rules of CIBSE as if it were the code of professional conduct of SFE, insofar as it may be appropriate to the profession of the member. A member, who is also governed by the code of professional conduct of another professional body, shall also comply with that code of professional conduct."

6.2.6 The code of professional conduct for CIBSE, referred to by the SFE, is included as Appendix D. This code contains typical duties of engineering professionals, including, for example, the requirement to:

'Exercise professional skill, care and diligence to the best of their ability and discharge their duties and responsibilities with fidelity, and with proper regard for professional standards.'

6.3 Alternatives to facade engineer or consultant

Q2. If a façade engineer or consultant was not instructed on a project, who would you expect to undertake that role or perform the duties ordinarily carried out by such a person?

6.3.1 In addressing this question it is important to know which party the facade engineer would have had as its client.

6.3.2 If the client would have been the building owner or architect 'pre-contract' the person who would have had to carry out the work that would otherwise have been carried out by the facade engineer would be the architect.

6.3.3 If, however, the facade engineer would have been appointed by the main contractor, and they were not so appointed, their role would have to be carried out by the main contractor's own design office or by an architect appointed by the main contractor as a sub-consultant. If none of these sources of expertise

[1] {INQ00014577}

were available, the specialist facade contractor would have to be relied upon to provide the necessary design and technical expertise.

6.4 Responsibility for designing the facade

Q3. How would that person's role relate to the role of the architect? If both were appointed, which of them would normally take primary responsibility for designing the façade?

6.4.1 The answer to this depends on what role the facade engineer would have been carrying out, whether for the building owner or architect 'pre-contract' or whether for the main contractor 'post-contract'.

6.4.2 It also depends on how the contract is written, in terms of responsibilities. For example, in the case of the Grenfell Tower refurbishment the contract between Rydon, the main contractor, and Harley, the specialist subcontractor, was based on a letter of intent, which simply referred to 'design of facade works', without any further clarification. There were hardly any references to design in the enclosures and appendices to the letter of intent. The document 'Part 2A- Preliminaries[2]' notes on page 2A/3 that the contractor is responsible for design beyond RIBA Stage E. This is a general obligation on the main contractor, which they passed on to Harley in relation to the facade works. Appendix D to the contract, which comprises the minutes of a pre-contract meeting held on 16/6/2014, includes the following note at the end of paragraph 4.2:

'*All drawings and specifications received by us will be commented upon and approved in principle only. The subcontractor remains fully responsible for the design, including relevant compliances, design and dimensional integration.'*

6.4.3 By contrast, Rydon's contract with Studio E was much more specific and referred among many other things to dealing with planning issues, co-ordination of building regulations approvals and provision of external wall details. It goes beyond my brief to comment on this further, but it does mirror my own experience that there is sometimes lack of clarity between the responsibilities where both an architect and a cladding subcontractor are appointed by a main contractor.

6.4.4 In practice, in the absence of a facade engineer, the expertise would be covered by a *combination* of the expertise of the architect and the cladding contractor.

[2] {TMO10004647}

6.5 Frequency of instructing a specialist façade engineer or consultant on a high-rise residential overcladding project

Q4. How common was it to instruct a specialist façade engineer or façade consultant on a project involving the addition to a high-rise residential building of an overcladding system comprising thermal insulation protected by rainscreen panels?

6.5.1 Going back to the early 1990s it would not have been common for a facade consultant to be appointed for an overcladding project of this type. However, it was not unheard of, and I give in paragraph 6.6 below an example. However, by 2012 in my experience it would have been normal for a facade engineer to be appointed for any large or complex project. The overcladding of a high-rise residential tower is a large project, but it may not be complex. The situation in which a facade engineer would not be appointed for this kind of project would be where the architect had enough technical knowledge and relevant experience not to require the additional expertise, or where the building owner did not wish to pay for an additional consultant.

6.6 Consideration of appointment of facade engineer or consultant on a Local Authority high-rise overcladding project

Q5. Would you expect consideration to have been given to the appointment of a façade engineer or consultant to advise a Local Authority on a project such as the refurbishment of Grenfell Tower? If so, by whom would you expect such an appointment to have been considered?

6.6.1 I have had personal experience of the company for which I worked being appointed as a facade consultant by a Local Authority, in 1993, for a project involving the overcladding of a residential tower in Hackney, London. At the time, this was unusual, and was driven by two factors: the architect freely admitted that they were not experienced in overcladding high rise buildings; and the client had an enlightened procurement approach, whereby they were open to the appointment of whichever consultants were considered necessary.

6.6.2 In the case of the Grenfell Tower refurbishment I would expect such an appointment to have been considered by the Tenant Management Organisation, in dialogue with Studio E, during the pre-novation phase. The dialogue would have needed to address whether Studio E had the required experience and/or technical expertise in overcladding a tall residential building.

6.6.3 I note, however, that the appointed structural engineer, Curtins Consulting, wrote a specification entitled 'Structural Performance Specification for the Design, Supply and Application of Overcladding Systems to Grenfell Tower'[3], dated March 2013. Section 7.0 of this document is called 'Overcladding' and addresses more than just structural considerations. For example, weather

[3] {CCL00001449}

performance and fire matters are also covered. Although not covered by my present brief, I note the following extracts:

7.1.13 The system should comply fully with the recommendations of the BRE document "Fire Performance of External Thermal Insulation for Walls of Multi Storey Buildings", second edition, 2003.

7.1.14 The system shall not be a fire risk at any stage of installation, nor shall it constitute a fire hazard after completion if for any reason the insulant becomes exposed.

6.6.4 I mention the above because it appears that Curtins Consulting covered both structural and non-structural issues in connection with the overcladding, and that fact may have contributed to the TMO's decision not to appoint a facade engineer.

6.6.5 The issue of who would pay the fees for a facade engineer would always be a factor in the discussion. Some building owners consider that they are already paying the architect to design and specify the facade of the building, and they do not see a need to pay another consultant to do this. In cases where the building is large or of a complex nature, the architect may nevertheless convince the building owner that the appointment of a facade engineer is necessary.

6.6.6 Sometimes, even if the building owner is unwilling to appoint a facade engineer, an architect may consider that they do nevertheless need some technical help, and pay for some limited facade consultancy advice out of their own fee. This advice might cover, for example, services selected from: a review of the architect's drawings; the preparation of a technical specification or review of the architect's specification; assistance with tender evaluation; assistance with reviewing contractor's drawings and other technical submissions.

7. Means of dissemination of knowledge within the cladding industry

7.1 Introduction to knowledge dissemination

7.1.1 In the following I shall concentrate on what was available in the years which would have had a bearing on people working on the Grenfell Tower refurbishment. Although the dates applicable to my brief are January 2012 to June 2017, I consider that, for the purpose of addressing this issue, it would be appropriate to start at the year 2010, as information available from that date onwards would be relevant to the people involved.

7.1.2 The main ways in which technical information would have been conveyed to the industry in the period being considered are:

- Updates to codes and standards
- Articles in trade journals and magazines
- Technical training and courses
- Manufacturers' direct marketing and seminars
- Conferences

7.1.3 I shall address these in turn.

7.2 Updates to codes and standards

7.2.1 Most companies in the construction industry subscribe to some sort of library service, whereby they have online access to codes, standards and other technical information. Such services would require at least one named individual within the company who would be the main correspondent. The service would usually provide regular notifications when new documents are published. On receipt of such a notification the correspondent would be expected to inform those within their organisation who would need to know about the new publication or update to an existing publication.

7.3 Trade journals

7.3.1 Notification of the publication of new documents would often appear in the technical press, for example in architectural or trade magazines.

7.3.2 I am not aware of a specific trade magazine addressed to the UK facade industry as a whole, operating during the period in question. There were, however, magazines dealing with glass specifically and there are other magazines dealing with cladding and related matters, for example the Roofing, Cladding and Insulation (RCI) magazine, the online version of which was available on rcimag.co.uk. The RCI also organised annual trade exhibitions of relevant products.

7.4 Centre for Window and Cladding Technology

7.4.1 MSc in Facade Engineering

7.4.1.1 The MSc in Facade Engineering was developed by the CWCT and was offered by the University of Bath (Faculty of Engineering Design, Department of Architecture and Civil Engineering) from about 1990. In about 2017 the MSc course moved from the University of Bath to the University of West England in Bristol.

7.4.1.2 According to the document file 'MSc Facade Engineering - summary'[4], the Bath MSc was either a full time course taking one year or a part time course over 2-4 years. According to the Programme Handbooks 2014/15[5], 2015/16[6] and 2016/17[7], to achieve the MSc candidates had to:

- Take 8 core units
- Take 2 out of 6 optional units
- Submit a dissertation

7.4.1.3 With regard to fire matters, the document 'MSc Facade Engineering - summary' mentions two relevant units:

- Core unit AR50374 'Facade construction' included a lecture entitled 'Cladding interfaces and fire', given, I understand, in about February of each year.

- Optional unit AR50380, 'Acoustics and Fire' included six lectures on fire topics, including one entitled 'Fire performance of built up walls'. These lectures were, I understand, given during one week in about March of each year.

7.4.1.4 The lecture included in the core unit 'Facade construction' should have been attended by all MSc students. The one lecture on fire included would have given the students a general introduction to the issues. The 'Acoustics and Fire' unit was one of the optional units, so not all students took it. Those that did take it would have had six lectures on fire topics in relation to facades, so would have gained a good understanding of the subject.

7.4.2 Courses

7.4.2.1 These courses included short courses (between one and four days) offered at the CWCT in Bath and also Cladding Training On-Line (CTOL) courses.

---

[4] {CWCT0000097}
[5] {CWCT0000098}
[6] {CWCT0000099}
[7] {CWCT0000096}

7.4.2.2 Some of the short courses made reference to fire matters, but the main courses wherein fire matters were covered in more detail were:

- Course C101 'Standard for systemised building envelopes - principles and specification[8]'. This 2-day course was given from 2007 to 2010 and included a lecture entitled 'Fire'.

- Course CWDC 'Curtain wall design and construction [for building professionals]'[9]. This 4-day course was given from 2007 onwards and included a lecture entitled 'Fire performance of facades'.

7.4.2.3 The CWDC course would have been available to members of the CWCT during the period in question.

7.4.2.4 I also note that the AGM of the CWCT held in 2014 included the topic 'Built up walls/fire' as a special technical topic that year[10]. This AGM would normally be attended by a range of CWCT members, including cladding contractors.

7.5 Manufacturers

7.5.1 Manufacturers usually maintain databases of key industry contacts and would have sent them emails and postal information about new products. On occasion they would also have telephoned. In addition, manufacturers often gave seminars and lunchtime talks to interested parties, for example to architects, facade engineers and contractors.

7.6 Conferences

I am not aware of any specific conferences covering the cladding industry *per se* in the period being addressed. However, there were some relevant conferences dealing with facade matters as a whole.

7.6.1 International Conferences on Building Envelope Systems and Technology

7.6.1.1 The International Conference on Building Envelope Systems and Technology (ICBEST) takes place every 3-4 years. Of relevance to the period being addressed were the ones held in 2010 in Vancouver, Canada, and in 2014 in Aachen, Germany.

7.6.1.2 I have not been able to obtain the list of attendees for the 2010 Vancouver conference, but the breakdown is likely to have been roughly similar to that in the 2014 conference below.

---

[8] Course Overview{CWCT0000077}, Lecture material from fire session {CWCT0000079}

[9] Course Overview{CWCT0000082}, Lecture material from curtain walling session {CWCT0000083}

[10] {CWCT0000044}

7.6.1.3 I have reviewed the programme for the 2010 conference, which gives a list of papers and speakers. None of the paper titles suggests that fire was a theme of the paper.

7.6.1.4 The 2014 Aachen conference was attended by about 90 people, broken down roughly as follows:

Educational institutions and test houses	43%
Architects and consultants	27%
Manufacturers	11%
Others	19%

7.6.1.5 It appears from this that contractors in general, and facade contractors in particular, were not in attendance at this conference. It is also of note that none of the papers presented at the conference appeared to be on the subject of fire matters.

7.6.2 International Seminars for Fire Safety of Facades

7.6.2.1 The 1st International Seminar for Fire Safety of Facades was held in Paris, France, in November 2013. In my opinion, it is significant that this conference was held that year, as it reflects a growing awareness of the fire safety of facades at that time, possibly as a result of the fires in France in 2010 and 2012, and the spate of fires in the United Arab Emirates in 2012 (see section 9 of the present report).

7.6.2.2 There were 38 papers presented, and a list of these is given in Appendix E. Many of these were relevant to fire risk in high-rise buildings.

7.6.2.3 One paper of particular relevance was 'Fire hazards of exterior wall assemblies containing combustible components', by White, Delichatsios, Ahrens and Kimball[11].

7.6.2.4 This paper gives, among other things, statistics for fires in the USA in the years 2007 - 2011, originating in or near the exterior wall of a building. It cites more than 5,000 fires in this category. However, of these only about 1% were in buildings taller than 11 storeys.

7.6.2.5 The paper highlights fires involving ACM panels, particularly those which had recently occurred in the United Arab Emirates. It notes that about 70% of the tall buildings in the UAE were clad in ACM panels, and that the UAE Building Code was being revised to address this problem.

7.6.2.6 The 2nd International Seminar on this subject was held in Lund, Sweden, in May 2016.

[11] {IMA00000930}

7.6.2.7 There were 32 papers presented and a list of these is given in Appendix F. Many of these were relevant to fire risk in high-rise buildings.

7.6.2.8 I have not been able to obtain the specific attendance lists for these seminars, but the Research Institute of Sweden has provided a contact list[12] in connection with the 2013 and 2016 seminars, and the attendees were apparently drawn from this list. The list contains a wide range of international organisations, including quasi-government bodies, universities and test houses, manufacturers and consultants. There do not appear to be any main contractors or cladding contractors on the contact list which indicates to me that contractors generally would have relied on manufacturers to be involved in such seminars and to have fed back information as necessary.

[12] {RIS00000001}

8. State of knowledge within the cladding industry

Q: Between January 2012 and June 2017, what was the state of knowledge within the cladding industry of:

a. The fire risks posed by Aluminium Composite Panels (ACP) with a polyethylene (PE) core;
b. The fire risks posed by polyisocyanurate insulation boards;
c. The fire risks posed by phenolic insulation boards;
d. The fire risks posed by cladding panels containing extruded polystyrene ('XPS').

8.1 Aluminium composite panels

8.1.1 The combustibility of these panels was, in my opinion, well known in the industry, particularly since the UAE fires in 2012 to 2016. See Section 9 of the present report.

8.1.2 This combustibility was also specifically mentioned at the 1st International Seminar for Fire Safety of Facades, which was held in Paris, France, in November 2013, referred to in Section 7.6.2 of the present report.

8.2 Insulation boards

8.2.1 The insulation boards to be considered are set out in the following table:

Type of board	Reference standard	Notes
Extruded polystyrene (XPS) foam	BS EN 13164 (2012, with Amendment 1 - 2015)[13]	
Polyisocyanurate (PIR) foam	BS EN 13165 (2012)[14]	This BS EN is for polyurethane (PU) but covers both polyurethane (PUR) and polyisocyanurate (PIR)
Phenolic foam (PF)	BS EN 13166 (2012)[15]	

8.2.2 All of these products are combustible to a greater or lesser degree. While fire specialists would probably have been able to rank these in terms of fire propagation and smoke generation, in my experience the reasonably competent cladding contractor would have known that they were combustible but would not have been able to rank their combustibility.

[13] {BSI00001739}
[14] {CEL00001204}
[15] {BSI00001710}

9. Knowledge of fires involving cladding

Q: Between January 2012 and June 2017, what was the state of knowledge within the cladding industry of cladding fires, both in different parts of the UK and overseas, which involved external fire spread, including those which involved, or were suspected to have involved, Aluminium Composite Panels (ACP) with a polyethylene (PE) core?

9.1 During the period being considered, and in the years preceding this, there were a number of important fires involving external fire spread. The following table, derived from press and web information and related papers, summarises some of these:

Date	Location	Notes
June 1999	Garnock Court, Irvine, Scotland	Started on 5th floor of 14 storeys. Reached 12th floor. One died. Cladding was some sort of plastic material and PVC window frames. Scottish Select Committee Report January 2000 led to change of Building (Scotland) Regulations in 2003, requiring external walls to be constructed to inhibit fire spread.
April 2005	Berlin, Germany	2nd floor flat. Two died. Expanded polystyrene insulation involved.
February 2009	Television Cultural Centre, Beijing, China	34 storey building. One death. Extruded polystyrene insulation suspected and insufficient cavity barriers
July 2009	Lakanal House, Camberwell, London	Built 1959. Six died. Fire started on 9th floor of 14 storeys, after refurbishment. Inquest concluded that firestopping had been removed. External cladding panels were combustible.
November 2010	Dijon, France	Seven died. Combustible insulation.
November 2010	Jiaozhou Road, Shanghai, China	Fire started on 9th floor of 28 storey building. 58 died. Polyurethane foam insulation suspected.
February 2011	Wanxin Complex, Shenyang, China	ACM panels involved, and both extruded and expanded polystyrene insulation.
April 2012	Al Tayer Tower, Sharjah	Fire started on 8th floor of 40 storeys. ACM panels.
May 2012	Mermoz Tower, Roubaix, France	Fire broke out on 2nd storey of 18 storeys. One died. ACM cladding.
July 2012	Polat Tower, Istanbul, Turkey	42 storeys. Combustible insulation suspected.

October 2012	Saif Belhasa Building, Tecom Area, Dubai	Fire started on 4th floor of 13 storeys.
November 2012	Tamweel Tower, Dubai	34 storeys completed 2008. Fire started on floor near top. ACM cladding.
April 2013	Olympus Tower, Grozny, Chechnya	40 storeys - tallest in Chechnya. Combustible insulation suspected.
April 2013	Al Hafeet Tower 2, Al Taawun area, Sharjah	20 storeys. Reports of 'burnt cladding'.
September 2014	Novaya Vysota, Krasnogarsk, Russia	25 storeys. 'Plastic cladding' suspected.
February 2015	Marina Torch, Dubai	When built in 2011 was world's tallest residential tower, at 79 storeys. ACM cladding. Fire started at mid-height.
December 2015	The Address Hotel, Dubai	Fire started on 20th floor of 63 storeys. ACM cladding.
March 2016	Ajman Tower, Dubai	Fire started on 20th floor of 50 storeys. ACM cladding suspected.
April 2016	Shepherd's Court, Shepherd's Bush, London	Fire started on 7th floor of an 18-storey tower. Reached 11th floor before being extinguished. No deaths. Polystyrene foam boards suspected.
June 2016	Ramat Gan, Israel	ACM panels involved.

9.2 I have listed the above, but I would not expect all practitioners in the cladding industry to have been aware of all of these at the time. Nevertheless, the ones that would, in my opinion, have been more widely known were the fires in the United Arab Emirates (UAE), particularly in Dubai in 2012-2016, because they were well covered in the news media and technical press at the time.

9.3 For example, the UAE fires were well covered by the local and international online media. They were also reported online on bbc.com, and on itv.com, and within the technical online feeds, such as architectsjournal.com, building.com and constructionweek.com. Although I cannot provide specific contemporaneous evidence, it is in my opinion highly likely that news of these fires would also have been covered by the relevant broadcast TV news programmes and in the print editions of the above magazines. Finally, I would expect local agents dealing with importation of cladding and insulation materials to the UAE to have been aware of these fires from their local media, and to have informed their relevant suppliers accordingly.

9.4 The UAE fires were reported at the time as being specifically exacerbated by the ACM cladding. One relevant article among many is in Building magazine[16]. Those involved in the cladding industry would, or at least should, have been aware of the dangers inherent in using this type of cladding on tall buildings.

9.5 As a general observation I would expect the manufacturers of relevant materials (cladding and insulation) to have been aware of these fires, and their implications, to a greater degree than cladding contractors. I would expect such manufacturers to draw to the attention of their customers the relevant risks.

[16] https://www.building.co.uk/comment/torch-tower-burning-questions/5074224.article

10. Awareness by cladding contractors of key documents relating to fire

Q: Between January 2012 and June 2017, would you have expected a competent cladding contractor working on projects in England and exercising reasonable skill and care to be:

a. Aware of the guidance on fire safety contained in Volume 2 of Approved Document B (2006 edition incorporating 2007, 2010 & 2013 amendments) at Section 12 "Construction of external walls[17]";

b. Aware of the guidance contained in BS 9999:2008[18] and BS 9991:2011[19];

c. Aware of the guidance contained in BR 135 Fire Performance of external thermal insulation for walls of multi-storey buildings (Second Edition), 2003[20];

d. Aware of the guidance in BR 135 Fire Performance of external thermal insulation for walls of multi-storey buildings (Third Edition), 2013[21];

e. Members of the Centre for Window and Cladding Technology ('CWCT');

f. Aware of the following CWCT guidance: i. Standard for Systemised Building Envelopes, Part 6, Fire Performance dated September 2008[22]; ii..Technical Note 73 Fire performance of curtain walls and rainscreens dated March 2011[23];

g. Aware of the guidance in the Building Control Alliance (BCA): i. Technical Guidance Note 18, Issue 0 dated June 2014[24]; ii. Technical Guidance Note 18, Issue 1 dated June 2015[25];

h. Aware of any other guidance relevant to the fire performance of external walls?

---

17 {CLG00000224}
18 {BSI00000064}
19 {BSI00000059}
20 {BRE00005554}
21 {BRE00005555}
22 {CWCT0000046}
23 {CWCT0000019}
24 {BCA00000001}
25 {BCA00000002}

10.1 Building Regulations

England and Wales

10.1.1 Document B of the Approved Documents to the Building Regulations relates to fire safety in England and Wales. The document relevant to the Grenfell Tower refurbishment relates to the Building Regulations 2010 and is divided into Volume 1[26], dealing with 'dwellinghouses', and Volume 2[27], dealing with other buildings. With reference to the definitions given in Appendix E of Volume 1, a 'dwellinghouse' does not include blocks of flats, therefore, for a block such as Grenfell Tower, Volume 2 applies. In the present report this will be called 'ADB2'.

10.1.2 The version of ADB2 that I have been asked to consider is the 2006 edition, incorporating 2007, 2010 and 2013 amendments.

10.1.3 Section 12 of ADB2 deals with the construction of external walls.

10.1.4 As the primary business of a cladding contractor concerns the external walls of buildings I would expect a cladding contractor to have been fully aware of the requirements of this section. The same applies even more so to manufacturers of cladding products.

Northern Ireland

10.1.5 The equivalent to ADB2 in Northern Ireland is Building Regulations (Northern Ireland) Guidance, Technical Booklet E, Fire Safety, October 2012. This document has similar guidance to that given in ADB2.

Scotland

10.1.6 The equivalent to ADB2 in Scotland is Section 2 of the Building Regulations (Scotland) Technical Handbook[28], which covers domestic buildings, including flats.

10.1.7 It is useful to follow through the requirements of the Handbook, starting with the 2005 version, as some of the information changes with the different versions. The 2005 edition states:

2.7.1 External wall cladding (including any insulation core) not more than 1m from a boundary should be constructed of non-combustible material.

10.1.8 In Annex 2.C of the 2005 edition, 'non-combustible' is described as being assessed through testing to BS 476-4 or BS 476-11. The latter is used in England as a test of 'limited combustibility', so the Scottish Technical Handbook effectively does not have a category for 'limited combustibility' and

[26] {CLG00000158}
[27] {CLG00000224}
[28] 2005 Edition {INQ00013979}, 2010 Edition {INQ00013977}, 2013 Edition {INQ00013978}

regards such materials as 'non-combustible'. Also, what is described as 'Class 0' in ADB2 is categorised as 'low risk' in the Scottish Technical Handbook.

10.1.9 The 2005 edition contains an Annex 2.A, which defines 'high rise' buildings as those with a storey 'at a height of more than 18m'. For such buildings, the Annex requires:

2.A.4 Material situated or exposed within a cavity formed by external wall cladding, including thermal insulation material, should be constructed of non-combustible materials.

2.A.7 External wall cladding should be constructed of non-combustible materials.

10.1.10 Alternative routes to compliance, through testing or fire engineering, are also allowed.

10.1.11 The 2010 version of the Scottish Technical Handbook is similar to the 2005 version, except that it introduces fire testing to BS 8414-2[29], which was not published at the time of the 2005 version. Another important difference is that Annex 2.A (dealing with 'high rise' buildings) in the 2005 version is not present in the 2010 version, as the relevant material has been incorporated into the main body of the document. However, the term 'high rise' does not appear to be explicitly defined in the 2010 version.

10.1.12 There is also a 2013 version of the Scottish Technical Handbook, and this is very similar to the 2010 version.

10.2 BS 9991 and BS 9999

10.2.1 BS 9999 (2008)[30] is a code of practice for fire safety in relation to buildings in general.

10.2.2 BS 9991 (2011)[31] deals with the same matters, with particular application to residential buildings. It complements BS 9999.

10.2.3 These codes of practice contain information covering a range of topics relating to fire. Taking BS 9991 as an example, there are 10 sections. For the purposes of a cladding contractor, the important part in my opinion is Section 6, covering 'Design for construction'. This section repeats much information from ADB2, but is not identical. For example, clause 29.2 is headed 'External fire spread over the external faces of buildings'. Among other things it states:

*"This [control of flame spread] is particularly important where a stay put strategy (see **E.1**) is in place. Combustible materials should not be used in*

[29] {BSI00000097}
[30] {BSI00000064}
[31] {BSI00000059}

cladding systems and extensive cavities."

10.2.4 It should be noted that this statement that combustible materials should not be used is slightly different from that stated in clause 12.7 of ADB2, which says that materials of limited combustibility can be used. Furthermore, the equivalent clause 36.6 in BS 9999 does not include the above italicised statement at all.

10.2.5 As these documents are wide ranging I would expect a cladding contractor to be aware of their existence but not to be familiar with their contents. However, if the documents were specifically referenced in the cladding contractor's contract or the specification I would expect the cladding contractor to have referred to them, and in particular to have read clauses 30-36 in BS 9999 and clauses 27-31 in BS 9991. If the documents were not referred to in the cladding contractor's contract or specification, I would not expect the cladding contractor to have referred to them.

10.3 BR 135

10.3.1 BR 135 is a report by the Building Research Establishment (BRE) entitled 'Fire performance of external thermal insulation for walls of multi-storey buildings'. Following the 1st edition dated 1988[32], there was a 2nd edition[33] dated 2003 and a 3rd edition[34] dated 2013.

10.3.2 BR 135 (3rd edition) contains two Annexes, A and B, setting out in detail the method by which fire performance results of testing to BS 8414-1[35] and BS 8414-2[36] may be classified. (The 2nd edition had contained only Annex A, dealing with masonry backing walls, since at the time of publication BS 8414-2 had not been published.) It is these performance criteria which are specifically referenced in ADB2[37] clause 12.5, and that gives BR 135 great importance in assessing the question of compliance with ADB2.

10.3.3 I would expect most specialist cladding contractors in the period January 2012 - June 2017 to have been aware of the existence of BR 135 (2nd or 3rd edition), because of its reference in clause 12.5 of ADB2. I would imagine, however, that most of them would not have read it or understood exactly how the tests were classified. Some of the more conscientious and technically aware specialists would probably have studied BR 135 and so would have had a better understanding of how the classifications were made.

10.3.4 In the case of manufacturers of cladding products I would expect them to have been fully aware of the detailed requirements of Appendices A and B of BR

[32] {BRE00001077}
[33] {BRE00005554}
[34] {BRE00005555}
[35] {BSI00000163}
[36] {BSI00000097}
[37] {CLG00000224}

135. Each of these appendices is only 4 pages, and contains vital information about the criteria for BS 8414 (Parts 1 or 2) test success or failure.

10.4 Guidance from the CWCT

10.4.1 The Centre for Window and Cladding Technology (CWCT) is the main UK centre serving the curtain walling and cladding industry overall. It acts as a technical resource and training centre for the facade industry, primarily in the UK.

10.4.2 The CWCT has in 2020 more than 350 members, comprising mainly architects, consultants, main contractors, specialist contractors, suppliers and manufacturers. Of these, specialist contractors represent about 40% of the membership, which is a significant proportion.

10.4.3 The way in which the CWCT disseminated information was that each member organisation had one or more designated contacts, and that person or those people would be the regular recipients of emails from the CWCT. Such emails would have contained information about new technical notes, or updates published, and about forthcoming courses and conferences.

10.4.4 The most important document produced by the CWCT was the 'Standard for systemised building envelopes', originally published in 1996 as the 'Standard and guide to good practice for curtain walling'. An updated version of this was published in 2005, of which Part 6: Fire performance was published in December 2005[38].

10.4.5 The overall standard, known for short as 'The CWCT Standard' was very well known to practitioners in the cladding industry. In the absence of a BS or EN dealing with facades as a whole, the CWCT Standard became the *de facto* standard for the UK facade industry, which is evident from the fact that it was often referenced in specifications. I would expect all cladding contractors to have been aware of its contents in detail, particularly those who were members of the CWCT. This expectation would have included Part 6, dealing with fire performance.

10.4.6 The CWCT also publishes a series of Technical Notes, numbering more than a hundred by 2020. These are well-researched and well-respected technical documents, and are available without charge to all members of the CWCT.

10.4.7 Technical Note 73: 'Fire performance of curtain walls and rainscreens'[39] was published in March 2011, and gives an important summary. I would expect all cladding contractors to have been aware of its contents, particularly those who were members of the CWCT. One important paragraph from TN 73 states:

---

[38] {CWCT0000046}
[39] {CWCT0000019}

'The only commonly used insulation material that will satisfy the definition of limited combustibility is mineral wool. It is sometimes argued that thermoset insulation materials with non combustible facings may be regarded as satisfying the requirement, noting that their decomposition in fire will release smoke.'

10.4.8 TN73 also contains the following paragraph:

'Where testing is carried out in accordance with BS 8414, the test applies to the complete cladding system including insulation, rainscreen, flashings and cavity barriers. Changing any of these components may affect the ability of the wall to resist the spread of fire.'

10.4.9 The CWCT also published TN 98[40] in April 2017, which updated TN 73. Because of its date, the cladding contractor for the Grenfell Tower refurbishment would not have been expected to be aware of TN 98 during the project. However, TN 98 was more specific than TN 73 in its statements about combustibility, in particular:

'Limits on combustibility of materials are given in Clause 12.7 of ADB. Clause 12.7 specifically refers to insulation materials and filler materials but is now being interpreted more generally (see BCA Guidance note 18). Therefore where a building has a storey 18m or more above ground level ***all significant materials*** [bold in original] *should be of limited combustibility (Class A2 in accordance with EN 13501-1).'*

This is discussed further in Section 17 of the present report.

10.5 Building Control Alliance

10.5.1 The Building Control Alliance (BCA) has the following terms of reference[41] (downloaded from its website buildingcontrolalliance.org/terms-of-reference 28/11/20):

- Act as an informed adviser, providing a single, coordinated information resource on the value of building control to society, including analysing and publishing data on the performance of the building control system in England and Wales
- Help set and maintain high standards in building control, including promoting best practice via its building control publications
- Liaise effectively with other industry organisations, providing the voice of building control on all critical working groups
- Respond in a coordinated fashion to Government and other policy proposals and initiatives where they concern pan-industry issues, in order to improve efficiency and minimise duplication in consultation

[40] {CWCT0000024}

[41] http://buildingcontrolalliance.org/terms-of-reference/

- Help its member organisations with generic information and support for their own lobbying activities
- Provide an information resource and support for campaigns to recruit and retention of the best talent within the building control profession
- Collaborate on research projects where there is mutual benefit and to ensure better dissemination of research findings
- Communicate its work, data and policy decisions effectively to all member organisations for wider dissemination among the building control industry.

10.5.2 In the light of perceived uncertainty about fire requirements for facades of buildings with a floor above 18m within the facade industry during the period being assessed, the BCA published the following documents:

- Technical Guidance Note 18, Issue 0, June 2014[42]
- Technical Guidance Note 18, Issue 1, June 2015[43]

These documents are very similar, except that in Issue 1 the 18m height is clarified as being to the highest floor, rather than the height of the building. Also, in Issue 1, the option of holistic fire engineering is introduced as a fourth option for showing compliance with ADB2.

10.5.3 It is of note that both versions of TGN 18 give a broader interpretation of the applicability of 'limited combustibility' materials than that stated in ADB2. While 'limited combustibility' is stated in paragraph 12.7 of ADB2 to apply only to insulation materials, TGN 18 states that the term applies for 'all elements of the cladding system', if the 'linear route' to compliance with ADB 2 is being followed (see section 15 of the present report). This is discussed further in Section 16 of the present report.

10.5.4 These documents provided guidance to Building Control Officers and others on how the requirement of ADB2 should be interpreted. In addition to the first three routes to compliance outlined in Section 15 of the present report, the BCA evidently considered that it would be unreasonable to require a fire test for every new situation, so proposed that a desktop study could be provided in lieu of a fire test, provided that the study was carried out by a competent fire engineer and was extrapolated from actual fire tests.

10.5.5 The TGN documents were available for download from BCA's website. TGN18 would have been of great interest to cladding contractors, as it offered them the possibility of additional ways of satisfying the requirements of ADB2, through 'desktop studies'. However, I am unclear exactly how cladding contractors would have been alerted to their existence, except by word of mouth among peers and through the relevant technical press.

[42] {BCA00000001}
[43] {BCA00000002}

10.6 National House Building Council

10.6.1 The National House Building Council (NHBC) acts as a certifying body and provides technical guidance on house building. It issues technical standards and, if these requirements are met, the NHBC issues a warranty. Mortgage companies sometimes require this as a condition of the mortgage for new houses.

10.6.2 One relevant clause of the curtain walling and cladding section of the NHBC Standards, Chapter 6.9, Clause M6, 2014 version[44], states the following to be acceptable:

- Extruded polystyrene insulation is grade FR (fire retardant) to BS EN 13164
- Polyisocyanurate or polyurethane insulation is to BS EN 13165
- Phenolic insulation is to BS EN 13166

10.6.3 Although the Grenfell Tower refurbishment was not, I understand, required to comply with NHBC standards, I would expect the cladding industry to have been familiar with these NHBC standards, as NHBC certification was, and remains, quite common for housing projects. I would therefore expect a reasonably competent cladding contractor to have been aware that, to satisfy NHBC standards, any extruded polystyrene insulation should be of the fire retardant grade.

10.7 Local Authority Building Control

10.7.1 My understanding of the Local Authority Building Control (LABC) is that it is a body which, among other roles, maintains a central registry of approvals for construction products, to assist Building Control Officers in carrying out their duties. For the purpose of deciding which products can be included in the registry, the LABC issues the 'LABC Warranty Technical Manual'. Section 7.7 of the 2012 version[45] covers cladding and contains the following requirements.

10.7.2 Under the heading 'Design', item iii states that this must meet the requirements of the relevant Building Regulations, British Standards and Eurocodes.

10.7.3 In clause 7.7.2.1 there is a requirement that:

'Curtain walling systems should have third party certification confirming satisfactory assessment in accordance with the Centre for Window and Cladding Technology (CWCT) Standard for Curtain Walling. The CWCT Standard provides detailed guidance on performance and testing.'

---

[44] {NHB00000768}
[45] {LABC0007892}

10.7.4 In that context I would interpret 'third party' as referring to a facade engineer, facade consultant or testing house. Although this clause uses the phrase 'curtain walling systems', in the context I would understand this to apply to cladding as well.

10.7.5 While the LABC provides some relevant guidance as described above, it is not a document as widely known within the cladding industry as the NHBC guidance, the latter being much more detailed.

10.7.6 Nevertheless, for manufacturers, inclusion of their products within the LABC registry would have been very important, because it was referred to by Building Control Officers.

10.8 Loss Prevention Certification Board

10.8.1 The Loss Prevention Certification Board (LPCB) evolved from the Loss Prevention Council (LPC), which had been formed in 1984. In 2000 the LPCB became part of BRE Global. My understanding of the role of the LPCB is that it sets standards for fire and security products. Of relevance to the fire safety of the facades of buildings, the LPCB has published the following standards:

- LPS 1581 (Issue 2.1, 2014) *Requirements and tests for LPCB approval of non-loadbearing external cladding systems applied to the masonry face of a building*[46].

- LPS 1582 (Issue 1.1, 2014) *Requirements and tests for LPCB approval of non-loadbearing external cladding systems fixed to and supported by a structural steel frame*[47].

10.8.2 These documents correspond to the two parts of BS 8414[48] and refer to the reaction to fire classifications in BS EN 13501-1[49]. They include details of tests for 'glowing combustion' of insulation, and also set out details of full scale system tests to BS 8414. They also give classification guidance, similarly to BR 135.

10.8.3 The LPCB documents, as well as BR 135, were referenced in a presentation given by the BRE (under the banner of the LPCB) at the Annual General Meeting of the CWCT in October 2014. Representatives of the industry, including cladding contractors, were free to attend this event. Some were indeed on the attendance list. Those in attendance would have become aware of the ways in which fire performance of cladding systems could be classified, and the LPCB's potential role in this.

---

[46] {INQ00011370}
[47] {INQ00013964}
[48] BS8414-1 {BSI00000163}, BS8414-2 {BSI00000097}
[49] 2007 version {BSI00000122}, 2002 version {BSI00000620}

11. Understanding by the cladding industry of restrictions on use of combustible materials in tall buildings

Q: Between January 2012 and June 2017, how did the cladding industry understand paragraph 12.7 of Approved Document B, and, in particular, did it consider that the guidance it contained applied to the core of an ACM panel? If so, which parts of paragraph 12.7 were thought to be applicable?

11.1 In the following and subsequent references to 'the cladding industry' this is taken to refer primarily to specialist cladding contractors and specialist cladding designers. However, it is relevant also to consider the understanding by manufacturers of the use of combustible materials.

11.2 ADB2 states at paragraph 12.7:

Insulation Materials/Products

12.7 *In a building with a storey 18m or more above ground level any insulation product, filler material (not including gaskets, sealants and similar) etc. used in the external wall construction should be of limited combustibility (see Appendix A). This restriction does not apply to masonry cavity wall construction which complies with Diagram 34 in Section 9.*

11.3 Limited combustibility is defined in Table A7 of ADB2[50]. To meet the definition, materials must either be non-combustible or meet certain criteria when tested in accordance with BS 476-11 or be equal to or better than Class A2-s3, d2 to BS EN 13501-1.

11.4 In the case of insulation, Table A7 (at item d in the 'National Class' column) gives the following criteria for the classification of limited combustibility when tested in accordance with BS 476-11:

- Maximum rise in furnace temperature during test: 25°C
- Maximum rise in specimen temperature during test: 35°C
- Maximum total duration of flaming during test: 10 seconds
- Minimum density of material being tested: 300 kg/m^3

11.5 I consider that a cladding contractor would have considered paragraph 12.7 to refer to insulation used as part of the external facade system.

11.6 The term 'filler material' in clause 12.7 is, however, unclear. I would consider that it was intended to refer to gap fillers such as expanding foam fillers. I do not think it was intended to refer to the core of an ACM panel, which I have never heard referred to as 'filler'. I also think that a reasonably competent cladding contractor or product manufacturer would have had a similar view.

[50] {CLG00000224}

11.7 As written, paragraph 12.7 does not appear to refer to the cladding material itself. There is a question, however, of whether the core of an ACM panel should be regarded as 'insulation'. Although the core has *some* insulating effect, that is not its primary purpose. (See Section 16 of the present report.) I also note that the insulating properties of the panels do not appear to be quoted in Reynobond's technical data, which confirms my view that insulating is not the primary function of the core. My own conclusion therefore is that the core of the cladding should not be regarded as 'insulation'.

12. Understanding by the cladding industry of fire test evidence

Q: To what extent was it common within the cladding industry in the period between January 2012 and June 2017 for specialist cladding designers or contractors to request fire test evidence from manufacturers or suppliers of cladding products and, if received, to scrutinise it? In particular:

a. Would you expect a specialist cladding designer or contractor to read any available fire test evidence relating to a product in full, including any reservations about the product's fire performance?

12.1 Specialist contractors or their cladding designers would normally have referred to the manufacturers' technical literature and/or relevant certification for the products they were considering. Such certification would have included, for example, BBA or LABC certification. These certificates in turn may have given relevant BS, EN or fire test references and strictly the cladding contractor or their designers should have looked at this background information. However, in my view, most cladding contractor/designers would have regarded the BBA or LABC as an authority, and they would have been content to rely on the certificates, without going back to the source data, provided of course that they (the contractors) were mindful of any caveats included on the certification.

b. How common was it for specialist cladding designers or contractors to ask manufacturers of cladding products for information relating to their fire test performance in addition to that contained in publicly available product literature?

12.2 I cannot answer this question directly, as I am unsure how common it would have been, in practice, for cladding designers or contractors to seek further fire test information. However, I would have expected them to seek further information if their proposed system did not conform exactly to the system for which any test certificate was issued.

c. Would you expect a specialist cladding designer or contractor to ask for test data supporting information about a product's fire test performance referred to in product literature?

12.3 This question seems to me to be very similar to Question b above.

13. BBA certification relating to aluminium composite panels

Q: Would you expect a specialist cladding designer or contractor to read the whole of a certificate such as BBA Certificate 08/4510[51] issued on 14 January 2008 (see copy attached) and to understand and appreciate the significance of the information contained in section 6, as well as the information contained on the first page?

13.1 The British Board of Agrément (BBA) publishes certificates indicating the suitability and limitations of construction products.

13.2 The cladding used on the Grenfell Tower refurbishment comprised Reynobond Architecture Wall Cladding Panels. I understand that there have been a number of certificates for this product, but I have been asked specifically to address the BBA certificate 08/4510 dated 14 January 2008.

13.3 In my opinion, most members of a cladding contractor's staff would have been content to see that a product was covered by a BBA certificate and would probably not have read the details on that certificate. However, those members of the cladding contractor's staff with technical or design responsibility would be expected to be more familiar with the details of the certificate and I would expect them to have read it in greater detail.

13.4 BBA certificate 08/4510 states on the first page, under the heading 'Behaviour in relation to fire":

"... the panels may be regarded as having a Class 0 surface in England and Wales, and a 'low risk' material in Scotland (see section 6)."

13.5 In my opinion, this is misleadingly drafted, in that it gives the impression that the product has a Class 0 rating, without qualification. However, on turning to Section 6, it is apparent that this contains vital information about the details and limitations of the fire testing carried out. I consider that a reasonably competent cladding contractor should have read Section 6 in full. Had they done so, they would have been alerted to the fact that the BBA certificate was very specific in its scope.

13.6 Section 6 contains much technical detail which requires significant analysis to obtain a clear understanding of what exactly are the fire properties of the product. In clauses 6.1 and 6.2 of the certificate, details of the samples tested are given as:

- PE core achieving Class B to EN 13501-1
- FR core achieving Class B to EN 13501-1
- FR core achieving Class 1 to BS 476-7[52] and fire propagation index 0 to BS 476-6[53].

---

[51] {ARC00000687}
[52] {BRE00005558}

13.7 In my opinion a cladding contractor would probably have scanned this and read in 6.3 that *'the products may be regarded as having a Class 0 surface'*, and would not have interrogated the rest of the detail. The BBA is generally considered to be a reputable body in the construction industry and most cladding contractors would have been content to accept their statements.

13.8 However, clause 6.4 of the certificate states *'These performances may not be achieved by other colours of the product'*, and goes on to say that, if another paint finish is used, the designations for a particular colour should be confirmed by *'test or assessment in accordance with Approved Document B, Appendix A, Clause 1'*. This clause broadly requires further testing and assessment by suitably qualified specialists.

13.9 I also note that the mention in Section 6.2 of the BBA certificate of the existence of the FR-cored ACM product, which appears to achieve National Class 0, as required, would at the very least have informed a cladding contractor that an FR-rated version of the product was available. I would expect the manufacturer (Alcoa in this case) also to raise this with a cladding contractor. Knowing that such variants were available, I would expect the cladding contractor to have then raised this issue with the main contractor and the architect.

13.10 Furthermore, I note that clause 1.1 of the certificate states that "*The panels are available either plain edged (riveted system) or flanged (cassette system) to suit architectural requirements (see Figure 1*). Figure 1 shows illustrations of both systems.

13.11 Notwithstanding the apparent alternatives shown in Figure 1, in clause 1.4 of the certificate, there is the statement '*Plain edged panels are riveted directly to the aluminium sub-frame. Flanged panels are hung from the sub-frame using T-slots fitting onto pintle on the sub-frame*', with a footnote stating: *'Not covered by this certificate'*.

13.12 The statement *'Not covered by this certificate'* is, in my opinion, ambiguous, as it is not clear exactly what is not covered, whether the whole cassette system or the sub-frame supporting it. Although the sub-frame has been noted as being outside the scope of the certificate, in the General section on page 3 of the certificate, it is not clear to me whether the note *'Not covered by this certificate'* in 1.4 is a repeat of what has been said in the General section, or whether it is new information.

13.13 At the very least, therefore, the doubt about whether the certificate covers cassette panels or not should lead a cladding contractor to raise the question with Alcoa of whether a cassette system is or is not covered.

---

[53] {BRE00005557}

14. Understanding by the cladding industry of 'Class 0'

Q: Between January 2012 and June 2017, to what extent was there an awareness and understanding within the industry of the following:

a. National class 0;

b. The European classification regime EN13501;

c. The BS 8414 test and the BR 135 criteria?

14.1 National Class 0 is defined as follows in Appendix A paragraph 13 of Approved Document B:

The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:

a. composed throughout of materials of limited combustibility; or
b. a Class 1 material which has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6.

Note: Class 0 is not a classification identified in any British Standard test.

14.2 My understanding is that Class 0 was introduced in about the mid-1960s. There are also classifications given in EN 13501-1[54]. These are not exactly equivalent, as the tests are different, and the EN classifications include smoke performance and the presence of flaming droplets or particles. Despite that, it is implied by ADB2 Diagram 40 that, for the purpose of satisfying the requirements of ADB2, either National Class 0 or Class B-s3, d2 to EN 13501-1 2007[55] are allowed. The s3 designation implies no limit on smoke production, and the d2 designation implies no limit on flaming droplets or particles.

14.3 I have been asked to address the extent of awareness and understanding within the cladding industry of National Class 0. To give some context to that it is useful to outline how Class 0 is assessed.

14.4 The surface spread of flame test is covered by BS 476-7[56]. The equipment described in this test involves a test sample 885mm x 270mm mounted in a specially constructed apparatus, with the sample then being exposed to a gas burner. The arrangement shown in Figure 4 of BS 476-7 is such that the top and bottom edges of the sample are covered by the supporting frame, as is the vertical edge closest to the furnace. In the case of an ACP sample therefore, the core would not be exposed directly to the flame in this test, although it would become hot through conduction.

---

[54] 2007 version {BSI00000122}, 2002 version {BSI00000620}
[55] {BSI00000122}
[56] {BRE00005558}

14.5 The fire propagation index I is obtained from the test described in BS 476-6. In that test the sample is 225mm x 225mm and edges of the sample are masked by the carrier frame, so that the sample edges are not exposed directly to the heat source. Thus, it is only the outer surface of the sample that is exposed directly to the furnace heat and the gas flame. The test is used as part of the classification for Class 0 and is not a test of general combustibility of the sample.

14.6 There was certainly an *awareness* within the UK cladding industry of National Class 0. Whether there was a clear *understanding* of it is another question. This is addressed in paragraphs 14.11 to 14.13 below.

14.7 I have addressed in Section 10.3 the industry's awareness of BR 135, and I repeat here what I said:

I would expect most specialist contractors to have been aware of the existence of BR 135, because of its reference in clause 12.5 of ADB2. I would imagine, however, that most of them would not have read it or understood exactly how the tests were classified. Some of the more conscientious and technically aware specialists would probably have studied BR 135 and so would have had a better understanding of how the classifications were made.

In the case of manufacturers of cladding products I would expect them to have been fully aware of the detailed requirements of Appendices A and B of BR 135. Each of these appendices is only 4 pages, and contains vital information about the criteria for BS 8414 (Parts 1 or 2) test success or failure.

14.8 It is worth noting, however, that most cladding contractors would have been aware that the system fire tests that BS 8414 and BR 135 were aimed at measuring the rate of spread of fire through the system, but they would not have known the specific criteria against which success or failure was determined. On the other hand, relevant product manufacturers would have been fully familiar with these criteria.

14.9 BS EN 13501 gives the Euronorm classifications for resistance to fire, as discussed above. It uses different test methods from those in BS 8414-1[57] and BS 8414-2[58] and also the classifications are different. In my experience, UK cladding contractors during the period being assessed would not have been familiar with the EN classifications and they would normally have referred to 'Class 0'. Manufacturers would probably have had a better understanding of the EN classifications, but would have tailored their approach in the UK to what the UK industry was familiar with, so would have referred mostly to 'Class 0'.

[57] {BSI00000163}
[58] {BSI00000097}

Q: As far as you are aware, was there during that period any misunderstanding within the industry about:

a. the meaning of National class 0;

b. what National class 0 covered or applied to; or

c. what products National class 0 was applied to?

Please describe any misunderstanding which you consider existed.

14.11 I think that most cladding contractors considered that 'Class 0' referred broadly to a fire rating, with an emphasis on the surface spread of flame, and that is what I would have expected from a reasonably competent cladding contractor. However, in my experience that did not apply to all, and occasionally I have come across confusion between the idea of Class 0 and general combustibility.

14.12 I think that most people in the cladding industry would have understood that 'Class 0' related to external cladding and facades and to internal surfaces, because those are the contexts in which the term 'Class 0' is used in sections B2 and B4 of ADB2.

Q: Have you ever come across the expression "Class 0 throughout"? Between January 2012 and June 2017, did it have any generally accepted meaning within the cladding industry? If so, what was it?

14.13 I do not recall having come across the expression 'Class 0 throughout' during the period being addressed. However, I have since become aware that some manufacturers were using it. The classification 'Class 0' is arrived at through flame being applied to the surface of the material, so it does not refer to the body of the material being tested. In my opinion, the expression 'Class 0 throughout' would suggest a confusion, or an attempt to mislead, between the idea of combustibility of the material with that of meeting 'Class 0'.

15. Awareness within the cladding industry of alternative routes to compliance for external wall construction

Q: To what extent was there a general awareness and understanding within the cladding industry of the alternative routes to compliance allowed by the Building Regulations 2010 for exterior wall construction?

15.1 For the Building Regulations 2010, the applicable guidance document is ADB2[59], which effectively gives three routes to compliance within Regulation B4, the limitation of external fire spread. These are:

- Clause 12.7 states that insulation materials used in external walls should be of limited combustibility. This, together with the requirements of clauses 12.6 to 12.9, has been referred to as the 'linear route'.
- Clause 12.5 states that external walls should meet the requirements of clauses 12.6 to 12.9, or satisfy the requirements of report BR135 when the wall is fire tested in accordance with BS 8414-1[60] or BS 8414-2[61], as applicable. This latter is the 'fire test' route.
- Clause 0.30 allows 'fire safety engineering' to BS 7974[62]. This would involve a holistic view of the building, analysing the fire risk overall.

15.2 'Limited combustibility' is tested, if following the national class system in Table A7 of ADB, in accordance with BS 476-11 (1982) and requires a cylindrical sample of 45mm diameter and 50mm high. Recognising that materials of limited combustibility were not always used, and considering it to be too onerous to require a system fire test for every external wall type, the Building Control Alliance (BCA) published their Technical Guidance Note 18 (Issue 0 June 2014[63] and Issue 1 June 2015[64]). This is discussed in more detail in Section 10.5 of the present report. These documents suggested that a 'desktop study' could be carried out by a competent fire specialist, *provided that* it was based on an extrapolation from previous relevant fire testing.

15.3 From my experience there was awareness within the cladding industry of these alternatives. However, on considering what cladding contractors in particular would have been aware of, my opinion is that they would have been mostly aware of either the 'linear' route or the 'fire test' or 'desk study' routes. I do not think they would normally have been aware of the 'fire safety engineering' route, as this would not have been common on the sort of buildings worked on by UK cladding contractors.

---

[59] {CLG00000224}
[60] {BSI00000163}
[61] {BSI00000097}
[62] {BSI00000099}
[63] {BCA00000001}
[64] {BCA00000002}

15.4 Manufacturers would have been much more aware of the precise details of the alternative routes to compliance, as it would have been in their interests to show to potential customers how versatile their products were.

16. Factors leading to the use of aluminium composite panels with a polyethylene core for buildings above 18m

Q: As far as you are aware, between January 2012 and June 2017, what factors commonly led to the selection of ACM panels with a PE core as suitable for use on high-rise buildings above 18m? Were they rejected with any material frequency, and if so what factors commonly led to their being rejected?

16.1 The height of 18m relates to the height of the highest habitable floor above ground level, as shown on Diagram 40 of ADB2[65].

16.2 Aluminium used in construction is nearly always in alloy form, i.e. during manufacture it is mixed with small amounts of other metals to improve its properties. However, for brevity the term 'aluminium' will be used in the following to include 'aluminium alloy'.

16.3 The aluminium composite panels (ACP) used on Grenfell Tower are understood to comprise two 0.5mm sheets of aluminium with a 3mm lightweight polyethylene (PE) core sandwiched between them. Like many composite materials the purpose of this construction is to create a lightweight but stiff panel, because the effective thickness of this panel exceeds that of a panel with the same amount (1mm total) of aluminium. As stiffness is an important property in a cladding panel, to enable it to resist wind pressure and damage due to impacts, there is an advantage in using an ACP, as it uses less aluminium than a conventional aluminium panel with no core. In addition the stiffness creates a flatter panel, which is architecturally more acceptable.

16.4 ACPs contain roughly one-third the aluminium of aluminium panels of the same stiffness. As aluminium is relatively more expensive than the PE core, an ACP will therefore be relatively cheaper than a panel of the same stiffness using just aluminium.

16.5 Also, because PE has lower density than aluminium, an ACP is also lighter in weight, having about two-thirds the weight of an aluminium panel of the same stiffness. This makes the panels easier for operatives to handle on site, which is a useful property, particularly when working at height.

16.6 However, the technical factors that would lead to the ACP *not* being selected for use are:

i. The PE core is combustible.
ii. The panels require careful detailing to avoid unsightly edges being visible.

[65] {CLG00000224}

iii. The method of forming tight corners requires milling the inner aluminium sheet along the fold lines, thus exposing the combustible core.

iv. Some architects have a preference for materials which are homogeneous, and are not keen to consider composite materials.

16.7 Of the above, the combustibility of the core is clearly the most important issue from a safety point of view.

17. Sufficiency of Class 0 in selecting Reynobond ACM PE panels

Q: The Inquiry would be grateful if you would answer the following question as part of your discussion of Diagram 40 in ADB2: At the time the cladding was being selected for the Grenfell Tower project (i.e. in 2014), was Class 0 enough to select Reynobond ACM PE panels (assuming there was a BBA Certificate which clearly confirmed they were Class 0) given:

(1) what a reasonably competent cladding contractor should have understood class 0 to relate to;

(2) given what is said in paragraphs 12.5 to 12.9 of ADB2 (including the warning in paragraph 12.5 and what is said/shown in 12.6 and Diagram 40);

(3) given what was said in other industry guidance; and

(4) given what should have been known about PE and its properties and its role in international cladding fires?

17.1 The factors that would lead a cladding contractor to select a PE-cored ACP for cladding a building with a floor above 18m have been discussed in section 16. The following is based on the *hypothetical* assumption (as raised in the question posed) that the BBA certificate had clearly confirmed that the panels, of the correct type, colour and system, met Class 0. For the avoidance of doubt, and with reference to section 13 of the present report, my opinion is that the BBA certificate did not in fact confirm this.

17.2 Clause 12.5 of ADB2 states:

'The external envelope of a building should not provide a medium for fire spread if it is likely to be a risk to health or safety. The use of combustible materials in the cladding system and extensive cavities may present such a risk in tall buildings.'

17.3 As written, this clause acts as a general introduction to the requirements. More specific details of the requirements with respect to external surfaces, insulation materials/products and cavity barriers are then given in clauses 12.6-12.9. I consider that a reasonably competent reader of this part of ADB2 would consider the more specific requirements of clauses 12.6-12.9 to outweigh the general requirement of clause 12.5.

17.4 Clause 12.6 of ADB2 requires that 'The external surfaces of walls should meet the provisions of Diagram 40[66]'. Diagram 40 shows that surfaces on buildings should meet Class 0 for floors above 18m. I am aware that there are differing views on how 'external surfaces' is interpreted. In this context, my opinion is that a reasonably competent practitioner in the cladding industry would have

[66] { CLG00000224 }

an everyday interpretation of this, and would consider that a panel that met Class 0 when tested would satisfy this clause. I do not consider that they would have considered this to apply *separately* to the core of an ACP.

17.5 The industry's understanding of 'Class 0' has been discussed in section 14 of the present report. I consider that a reasonably competent cladding contractor would have interpreted paragraph 12.6 of ADB2 and Diagram 40 as containing all the requirements for fire performance of the cladding, namely a Class 0 National classification or the related EN classification shown on Diagram 40. I do not consider that they would have thought that other aspects of fire performance of the cladding needed to apply.

17.6 Relevant other industry guidance during the period in question has been discussed in section 10 of the present report. Of these documents the most relevant would be the BCA's TGN 18, published as Issue 0[67] in June 2014 and Issue 1[68] in June 2015.

17.7 It is of note that both versions of TGN 18 give a broader interpretation of the applicability of 'limited combustibility' materials than that stated in ADB2. While 'limited combustibility' is stated in paragraph 12.7 of ADB2 to apply only to insulation materials, TGN 18 states that the term applies for 'all elements of the cladding system', if the 'linear route' to compliance is being followed. This would have precluded the use of ACPs for cladding buildings with a floor higher than 18m above ground level, unless a successful fire test or desk-top study were carried out.

17.8 TGN 18 provided guidance to Building Control Officers and others on how the requirement of ADB2 should be interpreted. At the very least I would therefore expect a Building Control Officer to be aware of its contents. As I said in paragraph 10.5 above, it is less clear how TGN 18 would have been disseminated to cladding contractors.

17.9 It is clear that there was a mismatch between what was stated in ADB2 and what was stated in TGN 18. Both of these documents act as 'guidance' and in the end the Building Regulations themselves carry the greatest weight.

17.10 With reference to earlier clauses 8.1.1 and 9.4 of the present report, I consider that a reasonably competent cladding contractor or manufacturer would have been aware of the combustibility of PE-cored ACPs, particularly after the UAE fires. However, in my opinion they would nevertheless have deferred to the guidance given in ADB2. Therefore, while ADB2 section 12 remained unchanged, and was silent about the use of ACPs, a cladding contractor would have interpreted this that the use of ACPs was still allowed.

---

[67] {BCA00000001}
[68] {BCA00000002}

17.11 I note, however, that ADB2 is not itself the Building Regulations and that the 2010 Building Regulation B4(1) itself states:

'The external walls of the building shall adequately resist the spread of fire over the walls ...'

17.12 Therefore, I consider that the use of PE-cored ACP for cladding a building with a floor higher than 18m above ground was unwise, given the known combustibility. In such circumstances, I consider that failure to consider adequately the combustibility of the materials would fall below the standard expected of a reasonably competent practitioner in the cladding industry. This would apply even more so to a situation where such materials were being proposed as a cost saving measure, where it would be essential to verify whether the cheaper product would perform adequately by comparison with the product for which it was being substituted.

18. Relationship between cladding contractor and fire engineer

Q: Between January 2012 and June 2017, on construction projects in England:

a. To what extent was it the practice for fire safety or fire strategy reports prepared by fire engineers to be considered by specialist cladding designers or contractors;

18.1 Fire safety and fire strategy reports contain much information relevant to their subject matter. I would expect a cladding contractor to have read these reports and to take note of any matters which affected their work, particularly with regard to materials and design detailing.

b. If a fire engineer had been appointed, to what extent was it the practice for there to be collaboration between the fire engineer and the cladding designer or contractor.

18.2 Following on from their reading of the fire strategy or fire safety reports, or related risk assessments, the cladding contractor might have questions and seek clarification on some issues. During the course of a contract I would therefore expect them to raise these questions with the appropriate party. Contractually, this would normally be via the main contractor, but in practice the cladding contractor might address the architect on this, or even the fire consultant directly, provided that all correspondence is copied to the main contractor. If the cladding contractor were to deal with the fire consultant directly in this way, they would need to have been authorised to do so by the main contractor.

19. Construction Design and Management Regulations

Q: Between January 2012 and June 2017, on construction projects in England:

a. To what extent was it the practice for the CDM Co-ordinator or Principal Designer to be involved in the design of the cladding so as to be able to influence its fire safety?

19.1 The Construction Design and Management (CDM) Regulations[69] were established in 1994. The intention of the regulations was to improve health and safety in relation to the design, construction and use of buildings. The regulations created the role of Planning Supervisor to act as the lead in ensuring compliance. In 2007 they were revised, and the title 'Planning Supervisor' was replaced by that of 'CDM Coordinator'. In 2015, the title 'CDM Coordinator' was replaced by that of 'Principal Designer'. This latter change took effect in October 2015.

19.2 In my experience the CDM Coordinator had a role distinct from the design team, and was the person responsible for ensuring that other members of the team complied with CDM requirements, for example in carrying out risk assessments and in compiling Health and Safety documentation. In my experience the CDM Coordinator would not have had much detailed knowledge of the design of cladding, and the role would have been only to check that those who did (e.g. the architect, facade consultant or specialist cladding contractor) carried out the relevant risk assessments and contributed to the Health and Safety file. I have not come across a CDM Coordinator asking questions about fire safety of cladding.

19.3 After the change in October 2015, the 'Principal Designer' for CDM purposes could well have been the architect. In that case, I would expect the role to involve much more detailed technical knowledge of cladding matters, and I would expect fire safety to have been one of the important considerations.

19.4 It should be noted that I was away from the UK from approximately March 2016, so I had limited overlap with the post-October 2015 CDM regime.

[69] 2007 Regulations {INQ00011315}, 2015 Regulations {INQ00011316}

b. To what extent was there a general understanding among cladding contractors of CDM responsibilities and duties?

19.5 In my experience cladding contractors would have had a good general understanding of their CDM responsibilities. However, that understanding would probably have been focused on how the site work was to be carried out safely, dealing with such matters as handling of heavy loads, falls from height, dropping of components and tools from height, and so on. They would probably not have focused on the as-built safety of the overcladding system, as, for CDM purposes, they would probably have considered that to have been the responsibility of others.

20. Conclusions

20.1 The following conclusions are given roughly in the order in which the issues have been covered in the present report, and not in any order of priority.

20.2 There is an important distinction to be drawn between product manufacturers and contractors, in that the manufacturers usually make a limited range of products within a specific category, and therefore would be expected to know all the details of legislation and testing in relation to those products, or at least be advised by a local agent or consultant, where supply is to an unfamiliar jurisdiction. On the other hand, a cladding contractor deals with a wide range of products, so would not be expected to be as knowledgeable as the manufacturer, for each product.

20.2 When considering 'reasonable skill and care', I have considered any differences between the UK-based cladding contractors dealing with overcladding projects such as on Grenfell Tower and the 'top tier' international facade contractors. In considering 'reasonable skill and care' I am considering that which is applicable to UK cladding contractors carrying out overcladding work similar to that on the Grenfell Tower refurbishment. While the level of technical expertise of such contractors may differ from that of their international counterparts, I consider that the expected level of 'reasonable skill and care' is the same.

20.3 A reasonably competent cladding contractor would be expected to have a person or people in their technical department who had the expertise necessary to deal with the design and technical matters that were likely to arise. Such people would be expected to recognise where there were gaps in their expertise, and to know how to go about filling those gaps, either through research or by consulting others with the appropriate expertise.

20.4 Where the cladding contractor sub-contracted design work to another company, I would expect the cladding contractor to review, and take responsibility for, any design or technical information provided by their sub-contractor. The same would apply to matters of compliance with regulations, where that formed part of the sub-contractor's appointment.

20.5 The advantage of facade consultancy or engineering for the building owner or architect is that the technical advice given is not attached to any commercial interests. The engineers involved are expected to have detailed technical knowledge of the construction industry, and thereby to act as a trusted intermediary between the architect or building owner and the industry.

20.6 In the case of the Grenfell Tower refurbishment I would expect the appointment of a facade consultant or engineer to have been considered by the Tenant Management Organisation, in dialogue with Studio E, during the pre-novation phase. The dialogue would have needed to address whether Studio E had the required experience and/or technical expertise in overcladding a tall residential building, and whether there were other parties involved who could provide this.

20.7 The issue of who would pay the fees for facade consultancy or engineering would always be a factor in the discussion. Some building owners consider that they are already paying the architect to design and specify the facade of the building, and they do not see a need to pay another consultant to do this. In cases where the building is large or of a complex nature, the architect may nevertheless convince the building owner that the appointment of a facade engineer is necessary.

20.8 The main ways in which technical information would have been conveyed to the industry in the period being considered are by notifications of updates to codes and standards, articles in trade journals and magazines, technical training and courses, manufacturers' direct marketing and seminars and conferences. Of these, there were relevant technical publications and courses available and also important seminars on fire safety in facades held in Paris in 2013 and Lund in 2016.

20.9 The fires during the period being addressed that would, in my opinion, have been more widely known were the fires in the United Arab Emirates (UAE), particularly in Dubai in 2012-2016, because they were well covered in the UK news media and technical press at the time. The fire risks of ACM panels and of some insulation products should therefore have been known to the UK cladding industry.

20.10 With reference to Approved Document B to the Building Regulations 2010, Volume 2 (ADB2)[70], I would expect a cladding contractor to have been fully aware of the requirements of section 12 of that document, as the primary business of a cladding contractor concerns the external walls of buildings. The same applies even more so to manufacturers of cladding products.

20.11 BS 9999 (2008)[71] and BS 9991 (2011)[72] concern fire safety of buildings. As these documents are wide ranging I would expect a cladding contractor to be aware of their existence but not necessarily to be familiar with their contents. However, if the documents were specifically referenced in the cladding contractor's contract or the specification I would expect the cladding contractor to have referred to them, particularly the sections dealing with construction, such as clauses 30-36 in BS 9999 and clauses 27-31 in BS 9991. If the documents were not referred to in the cladding contractor's contract or specification, I would not expect the cladding contractor to have referred to them.

[70] {CLG00000224}
[71] {BSI00000064}
[72] {BSI00000059}

20.12 BR 135 (2nd edition 2003[73] and 3rd edition 2013[74]) is a technical publication by the Building Research Establishment (BRE) dealing with fire performance of external insulation in tall buildings. I would expect most specialist cladding contractors in the period being addressed to have been aware of the existence of BR 135, because of its reference in clause 12.5 of ADB2. I would consider, however, that many cladding contractors would not have read it or understood exactly how the tests were classified, nor would I expect them to have read the more general sections of BR 135. Some of the more conscientious and technically aware cladding contractors would probably have studied the document and so would have had a better understanding of the general requirements and how the classifications were made. In the case of manufacturers of cladding products, I would expect them to have been fully aware of the detailed requirements of Appendices A and B of BR 135.

20.13 The same considerations would have applied to the cladding contractors' and product manufacturers' appreciation of BS 8414-1[75] and BS 8414-2[76], the standards relating to fire testing of external walls.

20.14 The Centre for Window and Cladding Technology (CWCT), based in Bath UK is the main technical umbrella organisation for facade technology in the UK. I would expect all cladding contractors to have been aware of the contents of the 'CWCT Standard for systemised building envelopes' in detail, and to have been aware of the subjects covered by the CWCT Technical Notes, reading specific notes as required. For example Technical Note 73: 'Fire performance of curtain walls and rainscreens' was published in March 2011[77], and gives an important summary. This applies particularly to those contractors who were members of the CWCT.

20.15 The Building Control Alliance (BCA) published Technical Guidance Note 18 (Issue 0[78], June 2014, and Issue 1[79], June 2015). In my opinion a reasonably competent cladding contractor working on tall buildings would have been aware of this through conversations with peers, or communications from the CWCT, and would have read it.

20.16 I would expect the cladding industry to have been familiar with the National House Building Council (NHBC) standards, as NHBC certification was, and remains, quite common for housing projects. I would therefore expect a reasonably competent cladding contractor to have been aware that, to satisfy NHBC standards, any extruded polystyrene insulation should be of the fire retardant grade.

---

[73] {BRE00005554}
[74] {BRE00005555}
[75] {BSI00000163}
[76] {BSI00000097}
[77] {CWCT0000019}
[78] {BCA00000001}
[79] {BCA00000002}

20.17 With reference to the use of combustible materials in the overcladding of tall buildings, I consider that a cladding contractor would have considered paragraph 12.7 of ADB2 to refer to insulation used as part of the external facade system.

20.18 The term 'filler material' in clause 12.7 is, in my opinion, unclear. I would consider that it was intended to refer to gap fillers such as expanding foam fillers. I do not think it was intended to refer to the core of an ACM panel, which I have never heard referred to as 'filler'. I also think that a reasonably competent cladding contractor or product manufacturer would have had a similar view.

20.19 With respect to their understanding of fire test evidence, in my view, most cladding contractor/designers would have regarded the BBA or LABC as an authority, and they would have been content to rely on their certificates, without going back to the source data, provided of course that they (the contractors) were mindful of any caveats included in the certification. I would, however, have expected them to seek further advice if their proposed system did not conform exactly to the system for which any test certificate was issued.

20.20 With respect to British Board of Agrément (BBA) certification relating to aluminium composite panels (ACP), in my opinion, most members of a cladding contractor's staff would have been content to see that a product was covered by a BBA certificate and would probably not have read the details on that certificate. However, those members of the cladding contractor's staff with technical or design responsibility would be expected to be more familiar with the details of the certificate and I would expect them to have read it in greater detail.

20.21 In my opinion, BBA certificate 08/4510[80], covering Reynobond Architecture Wall Cladding Panels, is misleadingly drafted, in that it gives the impression on the first page that the product has a 'Class 0' surface, without qualification. However, on turning to Section 6, it is apparent that this contains vital information about the details and limitations of the fire testing carried out. I consider that a reasonably competent cladding contractor would read Section 6 in full. They would thus be alerted to the fact that the tests mentioned in the BBA certificate were for specific core types, paint types and colours. The implication of this is that, at the very least, a cladding contractor should raise queries with the product manufacturer. It would also mean that they should consider discussing this issue with the architect, the fire consultant and/or the Building Control Officer, to establish whether project-specific system testing was required.

20.22 With regard to the cladding industry's understanding of 'Class 0', I think that most competent practitioners in the cladding industry understood the meaning of 'Class 0'. However, in my experience that did not apply to all, and some people seemed to confuse the idea of Class 0 with general combustibility.

---

[80] {ARC00000687}

20.23 I do not recall having come across the expression 'Class 0 throughout' during the period being addressed. 'Class 0' is based on flame and heat being applied to the surface of the material, and it does not refer to the body of the material being tested. In my opinion, the expression 'Class 0 throughout' would suggest a confusion, or an attempt to mislead, between the idea of combustibility of the material and that of Class 0.

20.24 Concerning alternative routes to compliance with ADB2, from my experience there was awareness within the cladding industry of these alternatives. However, on considering what cladding contractors in particular would have been aware of, my opinion is that they would have been mostly aware of either the 'linear' route or the 'fire test' or 'desktop study' routes. I do not think they would normally have been aware of the 'fire safety engineering' route, as this would not have been common on the sort of buildings worked on by UK cladding contractors.

20.25 One factor that would have been behind the decision to use aluminium composite panels (ACP) with a polyethylene (PE) core for buildings with a floor above 18m was that ACPs contain roughly one-third the aluminium of aluminium panels of the same stiffness. As aluminium is relatively more expensive than the PE core, the ACP will therefore be relatively cheaper than a panel of the same stiffness using just aluminium. Also, because PE has lower density than aluminium, an ACP is also lighter in weight, having about two-thirds the weight of an aluminium panel of the same stiffness. This makes the panels easier for operatives to handle on site, which is a useful property, particularly when working at height.

20.26 When considering the requirements of Section 12 of ADB2[81], I consider that this section does not disallow the use of ACPs, including those with a PE core. However, the Building Regulations themselves require that external walls should 'adequately resist the spread of fire'. Therefore, despite their weight and cost advantages, I consider that the use of PE-cored ACP for cladding a building with a floor higher than 18m above ground would have been unwise, given the known combustibility. In addition, BCA TGN 18, published in June 2014, advised that, if following the 'linear route' to compliance with ADB2, all elements of the cladding system should be of limited combustibility. In such circumstances, I consider that failure to consider adequately the combustibility of the materials would fall below the standard expected of a reasonably competent practitioner in the cladding industry. This would apply even more so to a situation where such materials were being proposed as a cost saving measure, where it would be essential to verify whether the cheaper product would perform adequately by comparison with the product for which it was being substituted.

[81] {CLG00000224}

20.27 Considering any interactions between the cladding contractor and the fire engineer, fire safety and fire strategy reports contain much information relevant to their subject matter. I would expect a cladding contractor to have read these reports and to take note of any matters which affected their work, particularly with regard to materials and design detailing. During the course of a contract I would therefore expect the cladding contractor to raise any fire related questions via the main contractor, but in practice the cladding contractor might address the architect on this, or even the fire consultant directly.

20.28 Concerning the cladding contractor's understanding of their duties under the CDM Regulations (2007[82] or 2015[83]), in my experience cladding contractors would have had a good general understanding of their CDM responsibilities. However, that understanding would probably have been focused on how the site work was to be carried out safely, dealing with such matters as handling of heavy loads, falls from height, dropping of components and tools from height, and so on. They would probably not have focused on the as-built safety of the overcladding system, as, for CDM purposes, they would probably have considered that to have been the responsibility of others.

[82] {INQ00011315}
[83] {INQ00011316}

Statement of truth

I confirm that I have made clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

Conflicts of interest statement

I confirm that I have no conflict of interest of any kind, other than any which I have already set out in this report. I do not consider that any interest which I have disclosed affects my suitability to give expert evidence to the Inquiry on any issue on which I have given evidence and I will advise the Inquiry if, between the date of this report and the Inquiry hearings, there is any change in circumstances which affects this statement.

Duty to the Inquiry

I understand my duty to the Inquiry, and have complied with that duty; and I am aware of the requirements of Part 35, this practice direction and the Guidance for the Instruction of Experts in Civil Claims 2014 if and insofar as they are relevant to the Inquiry.

Signed:

Jonathan Hugh Sakula

Date: 13 March 2021

Appendix A: Annex to instructions

ANNEX TO INSTRUCTIONS TO JONATHAN SAKULA: QUESTIONS

The Inquiry wishes to understand more about the cladding industry in the period January 2012 to June 2017. In asking you about the state of knowledge within the cladding industry during that period, we would like to understand what a specialist cladding contractor exercising reasonable skill and care would have appreciated and understood about certain matters, as set out in the questions below. Except where indicated otherwise, we would ask you to examine the position (i) in England and Wales and (ii) in the rest of the UK, if possible.

In providing an opinion on these matters we are particularly interested to know whether you can point to any industry conferences, journals and other publications, circulars or guidance available during the relevant period which provide objective evidence of the information that was available about these matters within the industry. To the extent that the position changed between 2012 and June 2017, please describe those changes when answering the questions and explain why they occurred. Please also explain any differences of opinion, understanding and practice within the industry during that period.

1. Between January 2012 and June 2017, what was the state of knowledge within the cladding industry of:
    a. The fire risks posed by Aluminium Composite Panels (ACP) with a polyethylene (PE) core;
    b. The fire risks posed by polyisocyanurate insulation boards;
    c. The fire risks posed by phenolic insulation boards;
    d. The fire risks posed by cladding panels containing extruded polystyrene ('XPS');
    e. Cladding fires, both in different parts of the UK and overseas, which involved external fire spread, including those which involved, or were suspected to have involved, Aluminium Composite Panels (ACP) with a polyethylene (PE) core?

2. Between January 2012 and June 2017, would you have expected a competent cladding contractor working on projects in England and exercising reasonable skill and care to be:
    a. Aware of the guidance on fire safety contained in Volume 2 of Approved Document B (2006 edition incorporating 2007, 2010 & 2013 amendments) at Section 12 "Construction of external walls";
    b. Aware of the guidance contained in BS 9999:2008 and BS 9991:2011;
    c. Aware of the guidance contained in BR 135 *Fire Performance of external thermal insulation for walls of multi-storey buildings (Second Edition), 2003*;
    d. Aware of the guidance in BR 135 *Fire Performance of external thermal insulation for walls of multi-storey buildings (Third Edition), 2013*;
    e. Members of the Centre for Window and Cladding Technology ('CWCT');

f. Aware of the following CWCT guidance:
    i. *Standard for Systemised Building Envelopes*, Part 6, Fire Performance dated September 2008;
    ii. *Technical Note 73 Fire performance of curtain walls and rainscreens* dated March 2011;
g. Aware of the guidance in the Building Control Alliance (BCA)
    i. Technical Guidance Note 18, Issue 0 dated June 2014;
    ii. Technical Guidance Note 18, Issue 1 dated June 2015;
h. Aware of any other guidance relevant to the fire performance of external walls?

3. Between January 2012 and June 2017, how did the cladding industry understand paragraph 12.7 of Approved Document B, and, in particular, did it consider that the guidance it contained applied to the core of an ACM panel? If so, which parts of paragraph 12.7 were thought to be applicable?

4. To what extent was it common within the cladding industry in the period between January 2012 and June 2017 for specialist cladding designers or contractors to request fire test evidence from manufacturers or suppliers of cladding products and, if received, to scrutinise it? In particular:
    a. Would you expect a specialist cladding designer or contractor to read any available fire test evidence relating to a product in full, including any reservations about the product's fire performance?
    b. How common was it for specialist cladding designers or contractors to ask manufacturers of cladding products for information relating to their fire test performance in addition to that contained in publicly available product literature?
    c. Would you expect a specialist cladding designer or contractor to ask for test data supporting information about a product's fire test performance referred to in product literature?

5. Would you expect a specialist cladding designer or contractor to read the whole of a certificate such as BBA Certificate 08/4510 issued on 14 January 2008 (see copy attached) and to understand and appreciate the significance of the information contained in section 6, as well as the information contained on the first page?

6. Between January 2012 and June 2017, to what extent was there an awareness and understanding within the industry of the following:
    a. National class 0;
    b. The European classification regime EN13501;
    c. The BS 8414 test and the BR 135 criteria?

7. As far as you are aware, was there during that period any misunderstanding within the industry about:
    a. the meaning of National class 0;
    b. what National class 0 covered or applied to; or
    c. what products National class 0 was applied to?

    Please describe any misunderstanding which you consider existed.

8. Have you ever come across the expression "Class 0 throughout"? Between January 2012 and June 2017, did it have any generally accepted meaning within the cladding industry? If so, what was it?

9. To what extent was there a general awareness and understanding within the cladding industry of the alternative routes to compliance allowed by the Building Regulations 2010 for exterior wall construction?

10. As far as you are aware, between January 2012 and June 2017, what factors commonly led to the selection of ACM panels with a PE core as suitable for use on high-rise buildings above 18m? Were they rejected with any material frequency, and if so what factors commonly led to their being rejected?

11. Between January 2012 and June 2017, on construction projects in England:
    a. To what extent was it the practice for fire safety or fire strategy reports prepared by fire engineers to be considered by specialist cladding designers or contractors;
    b. If a fire engineer had been appointed, to what extent was it the practice for there to be collaboration between the fire engineer and the cladding designer or contractor;
    c. To what extent was it the practice for the CDM Co-ordinator or Principal Designer to be involved in the design of the cladding so as to be able to influence its fire safety;
    d. To what extent was there a general understanding among cladding contractors of CDM responsibilities and duties?

12. In England, between January 2012 and June 2017:

    a. What was the role of a specialist façade engineer or consultant? Would you expect such a person to have been a member of any professional organisation?

    b. If a façade engineer or consultant was not instructed on a project, who would you expect to undertake that role or perform the duties ordinarily carried out by such a person?

    c. How would that person's role relate to the role of the architect? If both were appointed, which of them would normally take primary responsibility for designing the façade?

    d. How common was it to instruct a specialist façade engineer or façade consultant on a project involving the addition to a high-rise residential building of an overcladding system comprising thermal insulation protected by rainscreen panels?

    e. Would you expect consideration to have been given to the appointment of a façade engineer or consultant to advise a Local Authority on a project such as the refurbishment of Grenfell Tower? If so, by whom would you expect such an appointment to have been considered?

Further question:

13. The Inquiry would be grateful if you would answer the following question as part of your discussion of Diagram 40 in ADB2: At the time the cladding was being selected for the Grenfell Tower project (i.e. in 2014), was Class 0 enough to select Reynobond ACM PE panels (assuming there was a BBA Certificate which clearly confirmed they were Class 0) given:

    (1) what a reasonably competent cladding contractor should have understood class 0 to relate to;

    (2) given what is said in paragraphs 12.5 to 12.9 of ADB2 (including the warning in paragraph 12.5 and what is said/shown in 12.6 and Diagram 40);

    (3) given what was said in other industry guidance; and

    (4) given what should have been known about PE and its properties and its role in international cladding fires?

Appendix B: Curriculum vitae

Jonathan Sakula

MA CEng FIStructE FICE
Facade engineering consultant
Expert adviser on facades and glass

Over the course of my career, I have been responsible for over 150 projects throughout the world, including design and specification for new buildings, diagnostic appraisal of existing buildings and expert advisory work.

Summary CV

I studied engineering at Cambridge University in the UK, graduating in 1974. The first part of my career was as a structural engineer with Arup, working mostly in London, but also in Qatar for three months, and as leader of Arup's Zambian practice in Lusaka from 1983 to 1987. Prior to working in Zambia I spent three years in rural Tanzania developing small industries making cementitious materials from volcanic ash and lime.

Returning to London in 1987 I became design team leader for large, multi-disciplinary projects, including the redevelopment of the Spitalfields Market in London. In 1991 I spent a period on secondment as a Research Manager for the Construction Industry Research and Information Association (CIRIA), before becoming in 1992 a founder member of Arup Façade Engineering. I was design team leader for the bronze and glass fenestration of Portcullis House (the New Parliamentary Building) in Westminster, from 1994 to 1997.

I joined Dewhurst Macfarlane and Partners in 1997, as a senior associate, with responsibility for projects all over the world, mostly involving glass, including the cable-hung glass walls at the Kimmel Center in Philadelphia, USA.

In 2001 I joined Yolles in London as a director, with responsibility for glass and façade engineering. Projects included detailed design of the new glass vestibule for the Victoria & Albert Museum in London and 18m high cable-truss glass atrium walls for the Fairmont Heliopolis Hotel in Cairo.

Following the acquisition of Yolles by Halcrow in 2004, I became a technical director for Halcrow Yolles in 2005, with responsibility for glass engineering and facade consultancy in the UK and related markets. Façade consultancy projects included the 20 Fenchurch Street tower ('The Walkie-Talkie Building') in London EC3, at scheme stage. I also worked on a number of projects where diagnostic work was required on existing buildings, and also as an expert adviser. During the period with Yolles and Halcrow Yolles I also worked for main contractors as a reviewer and for specialist facade contractors on detailed design.

In 2010 I joined Buro Happold Facade Engineering in London as technical director, with overall global technical leadership of the facades work, liaising with the China and USA offices, and also dealing more directly with the London group of 20

specialists. I led the New York facades team from 2016 to 2017, prior to leaving Buro Happold in June 2017. I set up Sakula Consulting Limited in January 2019, where I work as an expert adviser for building facades.

I have written a number of papers and articles on facade and glass topics, and was a member of the Institution of Structural Engineers Steering Group for the 2014 update of their structural glass design guide.

Educational and professional qualifications

MA Engineering, University of Cambridge

Chartered Engineer

Fellow of the Institution of Structural Engineers

Fellow of the Institution of Civil Engineers

Languages

English	Mother tongue
French	Intermediate
Swahili	Intermediate
German	Basic

Selected project experience

Royal Mint Court, London. EC3 Led multi-disciplinary engineering team during construction stage, 1987.

Spitalfields Market Redevelopment, London EC2. Led multi-disciplinary engineering team during planning application stage, 1988 - 1990.

355 Queensbridge Road, Hackney, London E8. Overcladding of 20-storey residential tower, 1993.

Portcullis House, London SW1. Led facade design team. Responsible for specification, blast engineering and research and development for bronze and brass alloys, 1994 - 1997.

Kimmel Center, Philadelphia, USA. Responsible for analysis of 25m high cable-hung glass gable walls, 1999 - 2001.

Stratford Eye Tower, London E15. Review of facade matters for main contractor for 20-storey residential tower.

HSBC Tower, Canary Wharf, London E14. Diagnostic advice to building owner, 2004.

30 St Mary Axe, London EC3 ('The Gherkin'). Regular facade advice to owner, 2006 - 2017.

Terminal 5, Heathrow Airport. Consultant to Heathrow Express for investigation, design, specification and testing of new glass flooring, 2008 - 2010.

West Kowloon Terminus, Hong Kong. Technical review of glazed wall and hot smoke performance, 2010 - 2012.

Msheireb Downtown Doha (Phases 2 and 3), Qatar. Led teams for façade engineering for 27 new buildings in city centre, 2010 - 2015.

Tottenham Court Road Underground Station glass entrances. Specification and third party structural check at design stage and prior to public opening, 2010 - 2016.

5 Broadgate, London EC2. Responsible for blast engineering for facade of new bank headquarters, 2011 - 2012.

National Bank of Kuwait Headquarters, Kuwait. Led facade team during construction stage, 2014 - 2017.

MahaNakhon Tower, Bangkok, Thailand. Structural design of glass sky deck and helical access staircase, 2014 - 2017.

Key projects as expert adviser

In addition to many projects involving diagnostic and remedial work, I have given formal expert advice on the following:

Onslow House, Guildford.

Wallop Defence Systems, Middle Wallop, Hampshire.

Fire Control Centre, Castle Donington.

Dubai Airport Terminal 3 glass canopy.

The Corniche, Battersea, London SE1.

Project Peach, Arena Central, Birmingham.

Publications

5 Broadgate: the development of large, flat, stainless steel cladding panels (with Louise Sullivan), in International Conference on Building Envelope Systems and Technology (ICBEST 2014), June 09-12 2014, Aachen, Germany.

Adaptive building facades for thermal comfort in hot-humid climates (with B. Ogwezi, G. Jeronimidis, G. Cook and S. Gupta), University of Reading, July 2012.

Glass floor plate design for sustainable building operation, Challenging Glass 2, Delft, Holland, May 2010.

The Aurora Building, Glasgow: design of an all-glass double height entrance (with Karen Hoad), in International Conference on Building Envelope Systems and Technology (ICBEST 2007) Proceedings, Centre for Window and Cladding Technology, Bath, March 2007.

How we cracked it, Building Design, 3 March 2006.

Minimising the risk of glass falling from height, Building Engineer, June 2005.

Structural design of large glass doors, Conference on Glass in Building 2, Centre for Window and Cladding Technology, Bath, April 2005.

Braced for the worst (with Hansie Buys), Canadian Property Management Magazine, Vol. 18, No. 3, June 2003.

Interaction of height-dependent performance properties for facades of tall buildings, Proceedings of the CIB-CTBUH International Conference on Tall Buildings, Malaysia, May 2003.

Glass connection, Glass Today, December 2002.

The ultimate bond, RIBA Journal, December 2002.

See-through structure, Canadian Architect, November 2002.

Lo sviluppo dell'architettura di vetro come conseguenza dei progressi nella tecnologia delle giunzioni (The development of glass architecture in response to advances in glass connection technology), in Le Giornate del Vetro (Glass days), Reed Elsevier, Venice, June 2002.

A touch of glass, Building for Leisure, May 2002.

Design and analysis of the cable-supported glass gable walls for the Regional Performing Arts Center, Philadelphia, (with Tim Macfarlane and Damian Murphy), in International Conference on Building Envelope Systems and Technology (ICBEST 2001) Proceedings Volume 2, Institute for Research in Construction, Ottawa, June 2001.

Freistehende Ganzglastragwerke – Beispiele aus der Praxis (Free-standing all-glass structures – practical examples), in Deutsche Bauzeitschrift 3/2001.

Konstruktiver Glasbau (Structural glass engineering), with Philip Wilson, *in Glas Konstruktion und Technologie*, edited by Sophia and Stefan Behling, Prestel Verlag, Munchen 1999.

The design of building facades for blast resistance, in Proceedings of International Conference on Building Envelope Systems and Technology (ICBEST 1997), Centre for Window and Cladding Technology, Bath 1997.

Advanced technologies in adaptive building facades, in Proceedings of International Conference on Building Envelope Systems and Technology (ICBEST 1994), Nanyang Technological University, Singapore 1994.

Fassaden in Zukunft (Facades of the future), in *Fenster*, book edited by G Uhlig, N Kohler and L Schneider, Vieweg, 1994.

Small-scale limeburning - woodfuel section, book by Michael Wingate, Intermediate Technology Publications, London 1985.

Field Engineering – pozzolanas section, book edited by Peter Stern, Intermediate Technology Publications, London 1983.

Lime-pozzolana as an alternative cementing material (with R J S Spence), in Appropriate technology in civil engineering, Institution of Civil Engineers, London 1981.

The SIDO lime-pozzolana project, University of Dar es Salaam, 1979.

Documentary

Glass houses, for BBC2 First Sight series, December 2000.

Appendix C: Extract from Society of Facade Engineering website[84]

Downloaded 5 November 2020

What do Facade Engineers do?

Façade engineers concern themselves with everything to do with a building's external envelope above ground level. Many names can be used to describe the envelope, for instance:

- Cladding
- Curtain wall
- Stonework
- Glass
- Masonry
- Other materials and cladding types
- Some façade engineers are also skilled in roofing.

Façade Engineers will consider the performance of such materials and systems in various respects:

- Weathertightness
- Structural behaviour
- Interaction with the primary structure
- Thermal gains and losses through the façade
- Occupant comfort and energy efficiency
- Shading
- Condensation
- Ventilation
- Durability
- Sustainability
- Natural light admittance
- Fire behaviour of the building envelope
- Acoustic performance
- Safety and serviceability
- Security
- Maintenance and buildability

Façade engineers provide advice on both existing and new buildings. They may be involved in design, working alongside the architect, QS and structural and mechanical engineers, or may work within contracting or manufacturing. Alternatively, they may be involved in surveying or diagnostic and remedial work. Some façade engineers are involved in research and testing.

[84] https://www.cibse.org/society-of-facade-engineering-sfe/about-facades

What is a façade engineer?

Façade engineers come from a range of backgrounds but most usually architectural, structural or building physics. In order then to become a facade engineer, they have then developed a wider breadth of cladding skills and a deeper knowledge than they would encounter within their original discipline.

Many façade engineers will be generalist façade engineers. These are able to advise across the full range of materials, systems and performance types.

Specialist façade engineers will typically first have attained a level of knowledge across all façade types and then have chosen to specialise in one particular aspect of façade engineering. Examples are façade engineers whose emphasis is in building envelope physics, using analytical modelling skills; or façade engineers that specialise in a particular cladding material such as stone or glass.

Parallels exist with other professions with generalist and specialist divisions e.g. legal where there are solicitors and barristers, and medicine where there are general practitioners and consultants. It may be difficult for clients at the inception of their project to decide which type of façade engineer they require. A general practice façade engineer is best placed to determine this for the particular circumstances of a client's individual project and advise on façade specialisms that may be needed.

What value can façade engineers contribute to a project?

- Performance led design. Delivering facades that do what is required of them!
- Excellence in design
- Risk control
- Driving cost out
- Continuity through fabrication and installation stages
- Attention to quality as the design becomes a physical reality
- Verifying performance
- Cladding performance when the occupants move into the building
- Troubleshooting when problems occur

How does this differ from what others in the design team already do?

Facades have become complicated beyond the skills of architects, structural and mechanical engineers. Facades require a dedicated engineer with a particular range of skills and experience, who understands their behaviour and can undertake their design, manufacture and installation better, more efficiently and more comprehensively than can a traditional architect, structural or mechanical engineer.

The role of the Society of Facade Engineering (SFE) in setting standards

The SFE was established in order to:

- Act as a qualifying body for competency in the façade engineering profession. This involves assessment of candidates' experience and knowledge in facades and their skills to handle client's façade requirements professionally and competently.
- Protect clients' interests by allowing them to identify competent façade engineers through the membership grading system.
- Act as a learned body maintaining and raising the technical and professional standards of the façade engineer.

The SFE is not a Trade Body. Membership is not achieved simply by subscription. More on SFE membership here

What levels of responsibility might the different grades of membership of the SFE be expected to take?

Affiliate
This is an entry level grade and as such, the bearer of this grade of membership will not yet have demonstrated the level of skill and professionalism in facades to be entrusted with a project without supervision.

Associate
This is an intermediate grade. Bearers of this grade of membership might be expected to deliver certain aspects of a project, whilst working under the supervision of a Member or Fellow.

Member and Fellow
The bearers of these professional grades of membership are considered capable of having the skills and experience and being competent to undertake delivery of a client's façade needs without supervision. Where Members and Fellows practise in a specialised area of façade engineering e.g. building envelope physics, they are considered to be sufficiently responsible and aware of the need to involve broader skilled façade engineers where required.

How to involve a façade engineer in your project

- Interview several candidate façade engineers in order to match their particular emphasis to the needs of your project.
- Insist upon individuals holding Membership of the Society of Façade Engineering.
- Involve façade engineers early in order to gain maximum benefit from their input.

Appendix D: Code of professional conduct of CIBSE[85]

Downloaded 6 November 2020

The Code of Professional Conduct

Members of the Institution, in all grades, are required to maintain the highest standards of professional conduct.

All members must order their conduct in accordance with this Code. Members engaged in work outside the United Kingdom shall comply as far as is possible with this Code and with any established standards of conduct that exist in that country.

Members shall:

1. At all times so order their conduct as to uphold the dignity and reputation of their profession and to safeguard the public interest in matters relevant to the art, science and practice of Building Services Engineering.

2. Exercise professional skill, care and diligence to the best of their ability and discharge their duties and responsibilities with fidelity, and with proper regard for professional standards.

3. Actively maintain, and where possible encourage others to maintain, their professional competence through systematic improvement and broadening of their knowledge and skill in accordance with Institution guidelines on Continuing Professional Development as published from time to time.

4. Reject bribery and all forms of corrupt behaviour, and make positive efforts to ensure others do likewise.

5. Avoid, where possible, real or perceived conflict of interest and disclose to their employer or client any significant interest in another company, firm or person undertaking any business which may benefit directly or indirectly from their work.

6. When acting on behalf of the institution declare their position if faced with a conflict of interest, accurately represent the views of the institution, and refrain from promoting their own or their employers' interest.

7. Take all reasonable steps to prevent avoidable danger to the health, safety and welfare of themselves, colleagues and the general public.

8. Raise a concern, either within the workplace or externally, including a danger, risk, malpractice or wrongdoing, which affects others.

[85] https://www.cibse.org/about-cibse/governance/the-code-of-professional-conduct

9. Promote the principles of sustainability and seek to prevent avoidable adverse impacts on the environment and Society.

10. Only undertake work for which they have sufficient professional and technical competence and adequate resources to meet their obligations. They should also disclose relevant limitations of competence.

11. Treat all persons fairly and with respect and embrace equality of opportunity, diversity and the elimination of discrimination.

12. Cooperate and integrate proactively and with other professionals in the built environment

13. Adopt a security minded approach and observe the proper duties of confidentiality owed to appropriate parties.

14. Notify the institution if convicted of a criminal offence or disqualified as a company director.

15. Assess relevant liability, and if appropriate hold professional indemnity insurance.

16. Notify the Institution of any significant violation of the Institution's Code of Conduct by another member.

Appendix E: 1st International Seminar for Fire Safety of Facades 2013 - List of Papers[86]

[86] http://toc.proceedings.com/21913webtoc.pdf

1st International Seminar for Fire Safety of Facades 2013

MATEC Web of Conferences Volume 9 (2013)

Paris, France

14-15 November 2013

ISBN: 978-1-63266-277-4

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571

Some format issues inherent in the e-media version may also appear in this print version.

Printed by Curran Associates, Inc. (2014)

For additional information, please contact EDP Sciences – Web of Conferences at the address below.

EDP Sciences – Web of Conferences 17, Avenue du Hoggar Parc d'Activité de Courtabœuf BP 112

F-91944 Les Ulis Cedex A France

Phone: [redacted] Fax: [redacted]

contact@webofconferences.org

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA
Phone: [redacted]

Fax: [redacted] Email: curran@proceedings.com Web: www.proceedings.com

TABLE OF CONTENTS (2013)

Appendix F: 2nd International Seminar for Fire Safety of Facades 2016 - List of Papers[87]

[87] http://toc.proceedings.com/30563webtoc.pdf

2nd International Seminar for Fire Safety of Facades 2016

MATEC Web of Conferences Volume 46 (2016)

Lund, Sweden

11-13 May 2016

Editors: Stephanie Vallerent

ISBN: 978-1-5108-2406-5

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571

Some format issues inherent in the e-media version may also appear in this print version.

Printed by Curran Associates, Inc. (2016)

For additional information, please contact EDP Sciences – Web of Conferences at the address below.

EDP Sciences – Web of Conferences 17, Avenue du Hoggar Parc d'Activité de Courtabœuf BP 112

F-91944 Les Ulis Cedex A France

Phone: [redacted] Fax: [redacted]

contact-edps@webofconferences.org

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA
Phone: [redacted]

Fax: [redacted] Email: curran@proceedings.com Web: www.proceedings.com

TABLE OF CONTENTS (2016)