IN THE GRENFELL TOWER PUBLIC INQUIRY

MODULE 3 | SMOKE CONTROL OPENING STATEMENT ON BEHALF OF PSB UK LIMITED

1. This Opening Statement is submitted on behalf of PSB UK Limited [Company number 04006640] ("**PSB**"). It relates to that part of the Module 3 hearings allocated by the Inquiry to the topic of smoke control. PSB has provided the Inquiry with full disclosure, an initial Position Statement, a Phase 1 Opening Statement and a Phase 1 Closing Statement.

2. The Inquiry and those with an interest in this topic will know that PSB was a sub-sub contractor on the Grenfell Tower ("**the Tower**") refurbishment project. By way of seven individual purchase orders[1] PSB was contracted to JS Wright ("**JSW**"), the MEP sub-contractor, who in turn were contracted to Rydon as the Principal Contractor ("**Rydon**"). PSB was engaged to "*design only for AOV System*" the refurbishment smoke control system ("**the System**"), provide certain kit and components and, following the installation of the System by JSW and its other sub-sub contractors, to test and commission the installed System. The total value of the orders was £69,219.34.

3. PSB reaffirms its commitment to afford the Inquiry its full cooperation and to assist as best it can. Before setting out its position in this Opening Statement, PSB should want to say that all those concerned with the refurbishment project at the company are acutely conscious of the lost and devastated lives because of the fire at the Tower. It is appreciated that yet further submissions from yet more corporate Core Participants which do not accept failings or admit that they fell short are, to put it mildly, unwelcome. However, as counterintuitive as it might seem, it is important for the inherent integrity of the Inquiry's work that Core Participants are afforded a reasonable opportunity to challenge the evidence where they do not agree with it. That way, and cognisant of the additional pain that that entails for those who have already suffered, there is at least the potential for the work of the Inquiry to be robust and correct. It is in that spirit that PSB provides this Opening Statement.

The Inquiry procedure

4. The Inquiry has chosen to deal with the topic of smoke control in the manner scheduled calling six factual witnesses, so described, and Dr Barbara Lane and Beryl Menzies. Dr Lane and Ms Menzies are identified by the Inquiry as experts in respect of the field of smoke control.

5. Expert reports on the topic of smoke control have been disclosed to Core Participants only very recently. The Report of Ms Menzies contains 71 pages and is dated 20 April 2021. It was provided

[1] Design order {PSB00000113}, Controls order {PSB00000120}, Fans order {PSB00000125}, Commissioning order {PSB00000140}, New zones order {PSB00000144}, Additional kit order {PSB00000153}, Fan invertor order {PSB00001074}

to Core Participants on 4 May 2021. The Report of Dr Lane contains thirteen sections dated 21 May 2021, 4 June 2021 and 9 June 2021. The Report is comprised of 685 pages. Disclosure of the Report was completed on 9 June 2021. Nine additional individuals are named on the face of the Report as supporting Dr Lane in the preparation of the Report.

6. This chronology places PSB and witnesses from whom the Inquiry wishes to hear in an invidious position with exceptionally short time to consider 756 pages of detailed expert evidence and respond in a meaningful way. The Reports are still being assessed by PSB and those advising it.

7. The Inquiry has made some adjustment to the timetable with Ms Menzies expected to be called at the end of July and Dr Lane now postponed until September. The Inquiry has given Core Participants until 12 July 2021 to settle any questions for both experts. To the extent that it is possible to address the Reports within that timeframe PSB will certainly want to submit questions. To be plain, on first reading PSB does not accept the assessment made by Dr Lane and will look to challenge it. An application for the Inquiry to receive additional advice on the topic of smoke control from experts specific to the field is not discounted.

8. In respect of the witnesses to be called from PSB, namely the principal designer of the System, Mr Hugh Mahoney, and the commissioning engineer of the System, Mr Granville Partlow, they wish to give their evidence in accordance with the Inquiry's published timetable. It is now over five years since the work of PSB at Grenfell Tower was completed on 28 April 2016. Mr Mahoney and Mr Partlow understand the legitimate expectation of those whose lives have been deeply affected by the Grenfell Tower fire for the Inquiry to move forward.

9. Nevertheless, the Inquiry has afforded very little opportunity for the witnesses to know and understand those aspects of the recently disclosed Reports that touch on them, and any criticisms levelled against them. As the Inquiry takes the evidence on this topic and hears from the witnesses, it is respectfully asked to bear that in mind and to ensure that the questioning process is fair.

Summary of PSB's position

10. PSB anticipates that some aspects of the forthcoming evidence will be challenging for it. Following several years of microscopic scrutiny by lawyers and experts appointed by the Inquiry, there may well be aspects of its work on the Grenfell Tower project that could have been done better. The time afforded to the Inquiry to scrutinise the work done by PSB was not available to its employees at the coal face whilst undertaking this work.

11. PSB has thought carefully about its position and the evidence available to it. Notwithstanding that PSB is necessarily still considering the Reports most recently provided, a summary of PSB's position on some of the principal issues that may arise during the evidence follows.

12. The System designed by PSB for Grenfell Tower was, in all the circumstances, a reasonable design response. It fell within the range of design responses that a reasonably competent designer exercising skill and care may have presented at the time. It was assessed to be so by others throughout the currency of the project and was formally approved as satisfactory by an experienced and competent individual at the Building Control Body ("**BCB**").

13. Where the Building Regulations 2010 ("**the Building Regulations**") apply to the System, it complied with the relevant requirements of Schedule 1. So far as relevant to its part of the works, the System provided, so far as was reasonable, appropriate means of escape in the event of fire (B1). Likewise, the System provided, so far as reasonable, reasonable facilities to assist firefighters (B5).

14. In the alternative, and so far as relates to the works to the System, the building was "*no more unsatisfactory*" in relation to the relevant requirements of Schedule 1 than it was before the work was carried out, thereby meeting the requirements of the Building Regulations.

15. In relation to the testing and commissioning of the System, PSB is considering the opinion evidence recently provided by Dr Lane. Whilst acknowledging that the paperwork and record keeping was less than optimal in relation to the testing and commissioning process, PSB presently considers that the testing and commissioning of the System was completed satisfactorily. The System was witnessed on a number of occasions by a number of parties and no concerns were raised at any time during or after any such demonstration. When PSB left site in April 2016, the System was working as intended.

16. Whether the System operated as intended or not on the night of the fire (some thirteen and a half months after PSB's work was complete) is addressed by Dr Lane in her most recent Report. As the Inquiry would expect, prior to receipt of that Report, PSB has considered this matter most carefully with those advising it. PSB is confident that a complete and objective view of the evidence ought to result in the conclusion that the System did operate on the night of the fire, at least during the period when the circumstances remained within the designed for conditions.

17. The extent to which the System may or may not have contributed to internal smoke spread within the building by way of any breach of compartmentation or otherwise is a live issue. PSB is reviewing such evidence as has been disclosed and the opinion evidence of Dr Lane. PSB presently sees no basis upon which to reasonably draw any conclusion that the System caused or materially contributed to a breach of compartmentation within the building when the circumstances remained within the designed for conditions. As a result, PSB considers that, so far as it relates to the System, the Schedule 1 requirements in respect of internal fire spread (structure) (B3) were complied with.

18. It is not feasible to expand on all the matters summarised above in this document, limited to 20 pages. To assist, issues in respect of the design of the System and compliance are set out below.

About the events of the night, PSB will say more when it has had a reasonable opportunity to assess the opinion evidence of Dr Lane and Ms Menzies and the evidence that is relied upon.

What is smoke control?

19. Smoke control is defined as the "*management of the movement of smoky gases within a building to ensure adequate fire safety*"[2]. Smoke control may be achieved by: a) smoke containment; b) smoke clearance; c) smoke dilution; d) smoke exhaust ventilation; e) pressurisation; f) depressurisation[3]. These methods are delivered by different types of smoke control system.

20. There are two principal categories of smoke control systems: natural and mechanical. No one document covers all the different types of smoke control system which fall into these two categories. BS 9991:2011 and 2015 "*Fire safety in the design, management and use of residential buildings: Code of Practice*" ("**BS 9991**")[4] and the Smoke Control Association guide "*Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)*" 2010, 2012 and 2015[5] ("**the SCA Guide**") come closest to providing a comprehensive overview of the system types.

Where do smoke control systems fit in as an active fire protection measure?

21. It is essential to remember that a smoke control system is but one part of the passive and active fire protection measures that are required to ensure adequate fire safety. Within a building, the smoke control provisions include compartment walls, the external wall system, flat entrance doors, fire stopping to services, stairway doors, stairway enclosures and a smoke control system. Adequate protection is only ensured if these measures contribute as required. In the helpful wording of Ms Menzies, "*the circle of mutually supportive measures must be complete*"[6].

22. Maintaining compartmentation within a tall residential building is the fundamental principle on which adequate fire safety is ensured. The failure of some of the above passive measures can have a significantly greater impact than others, not least because active measures, such as a smoke control system, depend on those passive measures to deliver the conditions under which smoke is expected to arise so that it can be reasonably managed.

[2] BS EN 12101-6, 3.1.34 {RBK00045054/0015}
[3] BS EN 12101-6, 0.3 {RBK00045054/0010}
[4] {CTAR00000040} (2011 Edition), {CTAR00000041} (2015 Edition)
[5] {LFB00059241} (2012), {RBK00002932} (2015)
[6]{BMER00000007/049}

23. A common mode failure across all, or some, of these essential passive measures is capable of having a devastating effect on the capacity of a smoke control system to function as intended and contribute its part to the circle of mutually supportive measures. In plain terms, any assessment of a smoke control system, and evidence pertaining to it, should only be undertaken in circumstances where evidence relating to the other mutually supportive measures is retained firmly in the mind.

What is expected of smoke control systems?

24. As per our previous written submissions[7], there seems to be a persistent disconnect revealed in the evidence of witnesses between the purposes to which smoke control systems were (and are) properly and legitimately designed and the practical expectations of witnesses in terms of what they believe such systems should deliver on the ground. It is therefore equally important when taking evidence to remember the proper and legitimate design bases for these systems when assessing the evidence provided by witnesses. These are: (1) fires do not normally start in two different places in a building at the same time and that there is a low probability that a fire will spread beyond the flat of fire origin[8]; (2) the assumed design fire in Approved Document B[9] ("**ADB**") is a fire starting in a single location and being contained within a single compartment[10].

25. Smoke control systems are therefore only intended to address the effects of a fire on one floor and to deal with smoke from a single compartment fire[11]. Consequently, the System was intended to operate on one floor only[12]. The System could not have prevented smoke from fires on multiple floors impacting lobbies and the common stair on multiple levels[13] [14].

What were the particular constraints in respect of the System works at the Tower?

26. PSB was engaged late in the construction journey. Neither Exova, as fire engineer, or Max Fordham as part of the Design Team resolved the smoke control requirements before the refurbishment works were tendered. There was an old and likely inoperative smoke control system ("**Existing System**") in the Tower, in respect of which the London Fire Brigade served a deficiency notice.

27. There were particularly acute constraints presented by the Tower, which had a considerable impact on the approach that could be taken to the design of the System. PSB was required to re-use the existing smoke extract/inlet shafts on floors 4 to 23. Moreover, it was required that those shafts be

[7] {INQ00000552/0006} §30
[8] Dr Lane, Report, 12 April 2018. Appendix J, J3.2.1 {BLAR00000025/007}. Report, 24 October 2018. Appendix J, J5.1.1 {BLAS0000031/0020}
[9] {CLG00000224} Fire Safety, Approved Document B, Volume 2 – Buildings other than dwellinghouses 2006 edition (as amended 2007, 2010, 2013)
[10] Dr Lane: Report, 12 April 2018. Appendix J, J3.2.2 {BLAR00000025/007}. Report, 24 October 2018. Appendix J, J5.1.2 {BLAS0000031/0020}
[11] Dr Lane: Report, 12 April 2018. Appendix J, J2.1.11 {BLAR00000025/006}. Report, 24 October 2018. Appendix J, J5.1.2 {BLAS0000031/0020}
[12] Dr Lane: Report, 12 April 2018. Appendix J, J9.4.3 {BLAR00000025/0030}. Report, 24 October 2018. Appendix J, J1.1.24 {BLAS0000031/0008}
[13] Dr Lane: Report, 12 April 2018. Appendix J, J9.4.4 {BLAR00000025/0030}. Report, 24 October 2018. Appendix J, J1.1.24 {BLAS0000031/0008}
[14] Dr Lane's evidence, 26 November 2018, Page 182, line 16

extended down to the lower levels of the Tower such that a complete smoke control system encompassing all floors of the building could be created.

28. The dimensions of the existing shafts were particularly small. The shafts each had an area of c.0.24m^2. As they were arranged in pairs, they provided an overall shaft area of c.0.48m^2 to the north side of the lobby, and the same again to the south side of the lobby. The shafts typically expected for a benchmark natural shaft system, as per the ADB, would be 1.5m^2 in area, considerably above that which was available at the Tower. It was also a requirement to use the existing apertures in the smoke shafts on floors 4 to 23. The Tower was to remain occupied throughout any works.

What were the regulatory requirements in respect of the System at Grenfell Tower?

29. There is no specific provision in relation to smoke control systems within the Building Regulations 2010 ("**the Building Regulations**"). Where smoke control works are subject to the Building Regulations, they will be relevant to certain functional requirements of Schedule 1: including under B1, that *"the building shall be designed and constructed such that there are…<u>appropriate means of escape in case of fire</u> from the building to a place of safety outside the building capable of being safely and effectively used at all material times."*; and, under B5, that *"the building shall be designed and constructed so as to provide <u>reasonable facilities to assist fire fighters</u> in the protection of life".*

30. The requirements under Schedule 1 are 'functional' in the sense that they set out the *outcomes* to be achieved, rather than *how* such outcomes are to be achieved. Moreover, in requiring the provision of *"appropriate"* means of escape, or *"reasonable"* facilities for fire fighters, they do not themselves set out what specific standards are thus required.

31. In practice, the BCB had advised the Design Team on the Tower project that the requirements under the Building Regulations would be met if the System was no worse than the Existing System.[15] As a black-letter analysis, the application of Regulations 3 and 4 of the Building Regulations to the provision of the System is perhaps not so straightforward or clear cut.

32. Regulation 4(1) would apply if the System is classed as *"building work"* within the meaning of the Regulations. If the System is seen simply as building work, the work would have to be carried out so that it complied with the applicable requirements of Schedule 1. Regulation 4(3) would apply if the System is classed as building work amounting to a *"material alteration".* If the System is seen as building work amounting to a *"material alteration"* of the building, which did not previously comply with the requirements of Schedule 1, the only requirement imposed by Regulation 4(3) is that the

[15] See email 11/11/13 (John Allen) {SEA00009805}; Paul Hanson first w/s {RBK00033894} §99-100

building is "*no more unsatisfactory*" in relation to the relevant requirements of Schedule 1 than it was before the work was carried out, commonly referred to as the "*non-worsening*" provision.

33. Regulation 8 of the Building Regulations is relevant, as it provides that: *"Parts A to D…of Schedule 1 shall not require anything to be done except for the purpose of securing reasonable standards of health and safety for persons in or about buildings…"*. This provision (re)affirms that the requirements under Schedule 1 are not absolute: the overarching standard is one of 'reasonableness'.

34. Under Regulation 11(1) of the Building Regulations, a local authority building control body may dispense with or relax any requirement contained therein where *"the operation of a requirement in building regulations…would be unreasonable in relation to the particular case"*.

35. Thus, there is the flexibility within the building control process itself, not only to subject the functional requirements under Schedule 1 to a test of 'reasonableness' by way of Regulation 8, but also to dispense with those requirements under Regulation 11 if the operation of a requirement would be *'unreasonable'* in the circumstances of a particular case. Moreover, the requirements under Schedule 1 relate to the *"building"* as a whole, so great care ought to be taken if an overtly prescriptive and dogmatic approach to assessing compliance is advised of the Inquiry in relation to individual aspects of the works in isolation. At the core of any assessment under the Building Regulations is the concept of 'reasonableness'.

36. Compliance with Schedule 1 of the Building Regulations is (fundamentally) tested by whether the relevant functional requirements of parts B1 - B5 are satisfied and delivered, using appropriate materials and workmanship, in accordance with Regulation 7, and documented in accordance with Regulation 38. Compliance is ultimately tested by adequacy and the demonstration of adequacy is a matter for the BCB (or, ultimately, the Courts). In any event, compliance is categorically not defined by whether a particular Standard or item of Guidance has been met or not in a given project.

How did PSB look to meet the functional requirements with its design?

37. Guidance for a designer looking to meet the functional requirements of the Building Regulations is available in a number of documents. Principally: a) ADB; b) BS 9991; c) The SCA Guide; and d) BS EN 12101-6:2005 "Specification for pressure differential systems – Kits"[16] ("**BS EN 12101-6**").

38. However, there is no obligation to adopt any specific Standard or Guidance and a designer may choose to meet the requirements in some other way. Moreover, there is no prescribed hierarchy of guidance which places statutory guidance, such as ADB, above other guidance.

[16] {RBK00045054}

39. ADB clearly states that the document is only intended for some of the more common building situations and that there is no obligation to adopt the guidance in any Approved Document. ADB says: "*Thus there is no obligation to adopt any particular solution contained in an Approved Document if you prefer to meet the relevant requirement in some other way*."[17] This is expressed by certain of the Inquiry's experts. Ms Menzies, states that there is no obligation on persons carrying out building work to adopt any specific guidance[18]. Mr Todd, states that "*...the designer is not compelled to comply with the recommendations of ADB, but only with the functional requirements set out in Part B of Schedule 1 to the Regulations*"[19].

40. A certain precedence has seemingly been given to ADB during certain parts of the evidence before the Inquiry. That may be appropriate in respect of other matters, but in respect of the topic of smoke control very little assistance is afforded to the designer.

41. Paragraph 2.25, states that ventilation of common lobbies: "*...can be achieved by either natural means in accordance with paragraph 2.26 or by means of mechanical ventilation as described in paragraph 2.27.*"[20]. Paragraph 2.27 states that: "*As an alternative to the natural ventilation provisions in paragraph 2.26, mechanical ventilation to the stair and/or corridor/lobby may be provided to protect the stair(s) from smoke. Guidance on the design of smoke control systems using pressure differentials is available in BS EN 12101-6:2005.*".

42. BS EN 12101-6 provides guidance and information on smoke control using pressure differentials, but only in respect of pressurisation and depressurisation techniques that are set out in that document. There are six classes of systems from A to F.

43. Mechanical ventilation is <u>not</u> limited to only those classes of systems specified in BS EN 12101-6. Other types of mechanical ventilation are available and indeed, as Mr Mahoney confirms in his written evidence to the Inquiry[21], were (and are) considerably more common in the UK than any of the classes of pressure differential system identified in BS EN 12101-6.

44. This distinction is also made in the SCA Guide 2012 which, at Section 6.3[22], addresses pressure differential systems with specific reference to the system classes described in BS EN 12101-6, separately from other mechanical (powered) smoke control systems (which it addresses at 6.4[23]).

45. Mr Mahoney is a competent designer of smoke control systems of considerable experience. As outlined in his written evidence, he was an independent member of the British Standards Institute's

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17 {CLG00000224/0007}
18 Beryl Menzies Report, Building Control (October 2019) {BMER0000001} §118
19 Colin Todd Report, Legislation, Guidance and Enforcing Authorities (March 2018) {CTAR0000001} §5.2.2
20 {CLG00000224/0031}
21 Mr Mahoney second w/s §38 and 41{PSB00001373}
22 {LFB00059241/0021}
23 {LFB00059241/0024}

FSH25 Committee for Smoke Control Systems. He sat on Working Group 6 responsible for drawing up BS EN 12101-6. He was a past Chairman of the Smoke Control Association responsible for proposing and coordinating the production of the SCA Guide. He is named in each iteration of the SCA Guide.

46. Mr Mahoney's professional judgement, as per his written evidence, was that given the constraints of the project, as presented to him, it was not reasonably practical to design a System for the building which precisely met the terms of any specific Standard or Guidance document; it would be necessary to meet the relevant requirements by way of an alternative performance-based building appropriate solution[24].

47. Mr Mahoney's design was born of his experience as a practical designer of smoke control systems. He came to the project from a practical engineering perspective. It is acknowledged that the contemporaneous documents do not reference a number of the available Standards and Guidance documents, but that may not be uncommon in practice. Nonetheless, PSB considers that his design aligns with the principles set out in the SCA Guide 2012; noting that Mr Mahoney was instrumental in producing that Guide which was current at the time of his Technical Submission Rev.03[25].

48. The design for the System was submitted to JSW for consideration and in turn JSW provided Technical Submissions to Max Fordham for comment and approval. The System design was approved by Max Fordham, subject to comment, on 12 January 2015[26].

49. On 24 June 2015, Technical Submission Rev.03 was approved as satisfactory by the BCB[27]. The Inquiry is aware that the approver of the System at the BCB, Mr Paul Hanson, was also a member of the Technical Committee of the Smoke Control Association and acknowledged in the SCA Guide 2015. It follows that this aspect of the refurbishment project at the Tower was considered by two competent individuals of considerable experience.

What type of smoke control system was the PSB design?

50. The System was not a pressure differential system, within the meaning of BS EN 12101-6, and as referred to in ADB or the SCA Guide. It was never intended to be. It was not stated to be.

51. The System was, within the meaning of the SCA Guide, a mechanical (powered) smoke control system. The SCA Guide provides specific details and guidance regarding such mechanical (powered) smoke control systems. Mr Mahoney confirms that the System was a mechanical extract

[24] Mr Mahoney second w/s §41 {PSB00001373}
[25] {PSB00000209}
[26] {RYD00036067}
[27] {MAX00002217}

system similar to, but not the same as, the "Mechanical Extract, Natural Inlet" system detailed in the SCA Guide 2012[28].

What were the design bases and objectives of the System?

52. As may be derived from the PSB Technical Submission documents, the bases of the PSB design were a single flat fire location; a single floor of operation (with opportunity for duly authorised persons to change floor manually); reliance on the "*stay-put/defend in place*" strategy; automatic operation (with manual override); and a focus on protecting the stair. These bases of design set the purpose and objectives of the System.

Was the design objective to focus on protecting the stair a reasonable one?

53. PSB says that this was a reasonable design decision. It was a decision made to provide adequate protection to the most critical element of the means of escape from the Tower: the single escape staircase for all occupants and firefighters. It was a decision consistent with extant Standards and Guidance, namely: a) ADB at paragraph 2.25[29]; b) BS 9991 which makes the normative recommendation that residential buildings designed with a stay put strategy *should* have additional protection to the staircase in the form of a smoke control system, but comments that extended travel distances in lobbies *may* be supported by smoke control systems; c) The SCA Guide at paragraph 5.2.1 which states, quite plainly: *"it is clear that it is considered more important to protect the stairs than the corridors"*[30]; and, d) The LGA Guide 2011 *"Fire safety in purpose-built blocks of flats"* ("**the LGA Guide**")[31] at paragraphs 58.10 to 58.11 which states that current benchmark design guidance is to protect the common stairways. It was also a decision reflecting the practical reality.

54. ADB makes the protection of the common stair the priority, with any protection of the common lobby being a resultant benefit. See paragraph 2.25[32], which states: *"Despite the provisions described in this Approved Document, it is probable that some smoke will get into a common corridor or lobby from a flat on fire, if only because the entrance door will be opened when the occupants escape. There should therefore be some means of ventilating the common corridors/lobbies to control smoke and so protect the common stairs. This offers additional protection to that provided by the fire doors to the stair. (The ventilation also affords some protection to the corridors/lobbies.)*

55. Under Table 1 of ADB, referred to at paragraph 2.23, the recommended maximum distance of travel from a flat entrance door to a common stair (where means of escape is in one direction only) is stated

[28] Mr Mahoney second w/s §52 {PSB00001373}
[29] {CLG00000224/0031}
[30] {LFB00059241/0010}
[31] {CLG00000453/0085}
[32] {CLG00000224/0031}

as 7.5m[33]. Paragraph 2.23 itself states *"However, there may be circumstances where some increase on these maximum figures will be reasonable."*. ADB provides no guidance as to the circumstances where *"some increase"* on the maximum figures *"will be reasonable"*, nor how that may interact with the provision of smoke control in the building. ADB does suggest, however, that even in the *"common building situations"* to which ADB applies, the limit of 7.5m is not a firm limit and a longer distance may be *"reasonable"* – such a notion of reasonableness is consistent with Regulation 8 of the Building Regulations and the non-prescriptive nature of the requirements under Schedule 1.

56. Generally, the flexibility inherent in ADB on this point is repeated in BS 9991:2011. In its Introduction at internal page 2[34], BS9991:2011 states that it: *"provides a level of flexibility that allows the fire protection measures and the risks to be assessed to enable reasonable practical solutions to be designed"*[35] . The (informative, not prescriptive) Annex E.5 of BS 9991:2011 provides that where there is an 'extended' travel distance, for example, where the lobby travel distance is over 7.5m: *"...a fire-engineered MSVS [mechanical smoke ventilation system] may*[36] *be provided to compensate for the extended travel distance. The primary objective for this type of system is to maintain tenable conditions within the extended corridor and the associated staircase enclosure..."*.

57. Annex E.5, which is not a normative element of BS 9991:2011, does not say that any smoke control system serving a travel distance over 7.5m must be a 'fire engineered' mechanical smoke ventilation system with enhanced objectives to maintain tenable conditions in the corridor and the staircase.

58. By contrast to the flexibility inherent elsewhere in the guidance, paragraph 26.1.1 BS 9991:2011 states: *"In residential buildings designed with a stay put strategy, additional protection to the staircase should be provided in the form of a smoke control system"*. This is a *"recommendation"* within the presentations convention of the Standard, to be contrasted with the informative advice of Annex E.

59. Paragraph 6.1 of the SCA Guide 2012, which provides a commentary on the system types available, states that: *"Mechanical systems...may be designed to allow extended travel distances subject to the approving authorities"*. Again, this is an option – not a requirement. Further, paragraph 6.4.1 says that *"It is possible to design systems providing a higher performance that may then be used to allow extended travel distances in corridors... in this case the system objectives and performance should follow the guidance in Section 5"*. Again – not a requirement, and dependent on the case.

60. In any event, a commentary on the relative importance of the objectives of a smoke control systems (as between the protection of a lobby and the stair) is provided at paragraph 5.2.1 of the SCA Guide

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[33] {CLG00000224/0030}
[34] {CTAR00000040/0010}
[35] {CTAR00000040/0010}
[36] {CTAR00000040/0160} The use of the word *"may"* in this sentence is important. The *"presentational conventions"* at Page v of BS9991 {CTAR00000040/0007} says that the Standard's *"...recommendations are expressed in sentences in which the principle auxiliary verb is "should". Commentary, explanation and general informative material is presented in small italic type and does not constitute a normative element."*.

2012 as follows: *"Recent work by the BRE, confirmed in ADB, has made it clear that it is not possible to keep common corridors and lobbies free of smoke (except possibly by pressurisation systems with protection extended to the entrance door of each dwelling). Furthermore, it is clear that it is considered more important to protect the stairs than the corridors as stairs will be used by greater numbers of people if a fire occurs."*.[37]

61. Guidance specifically tailored to the refurbishment of legacy, purpose-built blocks of flats was provided in the LGA Guide[38]. In its discussion of *"benchmark design guidance"* at paragraphs 58.10 to 58.11[39], the LGA Guide reflects ADB and places it in the context of earlier guidance, as follows: *"The current benchmark design guidance is based on using smoke control to protect the common stairways. While this may afford some protection to the corridors and other horizontal routes, this is not the design intent. The emphasis in previous design guidance has been on protecting not only the stairways, but also the entire horizontal route to them. The current approach is that of smoke containment, with ventilation of lobbies and corridors where they adjoin a stairway. That ventilation can be achieved by natural or mechanical means."*.

62. Paragraph 62 the LGA Guide gives specific advice in respect of *"blocks of flats that do not meet the current design benchmarks for means of escape"*. The LGA Guide provides an explanation of the change in smoke control systems' design benchmarks from smoke dispersal to smoke containment at paragraphs 62.9 and 62.10: *"…in relation to smoke dispersal previous benchmark design guidance is far removed from what is acceptable today…smoke dispersal has proved to be very unreliable for a number of reasons, and is no longer seen as an accepted method of smoke control. In existing blocks of flats with smoke dispersal, action should be taken to review both the smoke control arrangements and the existing travel distance. The advice of specialists may need to be sought."*.

63. In respect of buildings with travel distances above current design benchmarks, the LGA Guide states at paragraph 62.6: *"The travel distances specified earlier [i.e. the 7.5m maximum travel distance] have been found to achieve the requisite level of safety, but were never intended to be hard and fast, and different limits have applied in the past (see Appendix 1). The acceptance of increased distances of travel may be considered appropriate in individual circumstances. This will be particularly relevant in older types of property, where there will be little scope to reduce the existing travel distances or provide alternative means of escape."*

64. At paragraph 62.7 the LGA Guide states that *"[s]mall increases in travel distance can be accepted in most situations without any additional measures"*. In the table following, entitled *"benchmarks for*

[37] {LFB00059241/0010}
[38] {CLG000000453}
[39] {CLG00000453/0085}

existing blocks of flats (corridor or lobby approach) – single direction escape" the LGA offers as an example that *"increases from 7.5m up to 10m"* in smoke ventilated lobbies *"are likely to be acceptable in most situations with no additional measures".*

65. Insofar as PSB's design response was concerned, this was not a *"common building situation"* to which the guidance in ADB could provide the answer and it was necessary for PSB, as a designer to determine appropriate, yet practical, objectives for the smoke control system.

66. The primary design constraint was the size and location of the existing smoke extract/inlet shafts. Given that the shafts directly abutted 4 flats on each floor (which were to remain occupied during the refurbishment) there was no realistic way in which the size of the shafts could themselves have been increased. Further, given that each lobby was 'landlocked', and surrounded by flats, there was no permission to, nor any realistic possibility of, introducing further vents or ductwork as would be required for Pressure Differential Systems of the type referenced in BS EN 12101-6[40].

67. Faced with these constraints, Mr Mahoney held genuine concerns that a push-pull system (i.e. using one set of shafts for inlet, the other for outlet) which aimed to provide some protection to the lobby by way of 'dilution' or 'dispersion' of the air therein, would not be effective to protect either the lobby or the stair given their size and location[41]. These concerns appear, in the main, to have been accepted as valid by Dr Lane[42].

68. Mr Mahoney's concerns with a dilution type system also reflect those as discussed in the LGA Guide and the BRE's Report *"BD2410: Smoke ventilation of common areas of flats and maisonettes – final factual report"*[43] *("***BD2410***")*. Appendix A to BD2410, under "*dilution (dispersal)*" [pg.6] states that *"a number of problems have been identified"* with the dilution/dispersal method, in particular that "*the required volume of fresh air is high, making both mechanical and natural ventilation problematic.*".

69. In considering the reasonableness of PSB's approach to the design of the System, and to complying with the requirements of Schedule 1, the Inquiry is invited to consider the lack of feasible alternative design approaches.

70. A central tenet of the criticism made by Dr Lane is the alleged failure to recognise the travel distances within the common lobbies at the Tower as extended, resulting in the alleged consequent failure to proceed to address the required dual design objectives of protecting both the stair and the lobbies.

71. As a matter of fact, the travel distances are in dispute. Dr Lane uniquely claims that the maximum travel distance in the lobbies on the existing floors was 10.5m[44]. By contrast, the BRE, following their

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[40] Mr Mahoney second w/s {PSB00001373/0008}
[41] Mr Mahoney first w/s at §23 {PSB00001329} and Mr Mahoney second w/s §29 {PSB00001373}
[42]{BLARP20000035/0132} §§ 5.4.25 to 5.2.48
[43] {CTAR00000050}
[44] {BLARP200000035/0032}§2.5.4

detailed investigations on site found that the lobby maximum travel distance was 9.3m[45]. In determining the travel distance, the assessment should take account of the definition of *"travel distance"* in BS 9991:2011 as the *"actual distance to be travelled by a person along an escape route"*; and the measurement of *"travel distance"* in ADB as *"by way of the shortest route"*.

72. It follows that on the BRE's investigations the maximum travel distance in the existing lobbies was less than 10m. This is below the upper 'benchmark' described by the LGA Guide as *"likely to be acceptable in most situations with no additional measures"*. For this and the reasons set out above, PSB's considered position is that Dr Lane is wrong in asserting that travel distances had to be considered 'extended' such that, in order to be compliant, the dual design objectives of protecting the stair and the lobbies had to be pursued by the System.

If the design objective was to focus on protecting the staircase, were the performance criteria selected appropriate and sufficient for means of escape and firefighting phases?

73. The two principal performance criteria selected for the System were: a) A minimum air velocity of 2.0 m/s across the stair door to protect the staircase when that door was open[46], and b) A maximum door opening force for closed escape route doors of 100N achieved by limiting the pressure differential between the lobby and the stair to -25Pa[47]. The Inquiry will note that the 2.0m/s velocity criterion and the -25Pa differential are the same as those in the LABC-registered *ColtShaft* system[48].

74. Mr Mahoney says that the performance criterion of a minimum 2.0 m/s velocity across the open stair door was taken from BS EN 12101-6 as the velocity required across an open stair door for a Class B Pressure Differential System[49]. Mr Mahoney considered this criterion appropriate as, although the System was not intended to operate in the same way as a Class B Pressure Differential System, the airflow the System was itself required to generate across the stair door in the circumstances set out in Mr Mahoney's Technical Submission was similar to that aspect of a Class B Pressure Differential System's performance[50]. Mr Mahoney also says[51], that he knew from experience that 2.0 m/s velocity through an open door is the airflow required to enable smoke to be kept out of the stair.

75. Explanation of, and support for, the 2.0 m/s velocity criterion comes both from the commentary within BS EN 12101-6 itself, and, in the context of mechanical extract systems, from CFD modelling carried out by the BRE and presented in its Report BD2410. As part of the research for BD2410 the BRE performed "*over 500 numerical simulations of the relative performance of a wide range of smoke*

[45] {MET00039807/0024}§32
[46] {RBK00003780/0003}
[47] {RBK00003780/0004/0018}
[48] {BLARP20000035/0079-0080} Table 4-6
[49] {PSB00001329/0006}
[50] {PSB00001373/0013} §66
[51] {PSB00001373?0013} §67

management schemes"[52] using the BRE CFD fire model. Based on this modelling the report concluded that a mechanical ventilation system which operated by extracting air from the common lobby could protect the stair when it operated with an open stair door velocity which was *"broadly compatible with those currently in BS 5588 Part 4"*[53]. Part 4 of BS 5588 was the precursor to BS EN 1201-6 and the open-door velocity being referred to by the BRE was 2.0 m/s. The BRE report further stated that: *"[i]ndeed, the numerical simulations indicated that in non-firefighting simulations there could arguably be scope to reduce the design criteria".*

76. Having selected the 2.0m/s velocity performance criterion, Mr Mahoney set out his proposals for the volumetric flow rate to be produced by the System in his initial Technical Proposal dated 22 April 2014[54]. Mr Mahoney explains how he first calculated the necessary volumetric flow to be obtained at the stair door to achieve a velocity of 2.0 m/s by multiplying that figure by the area of the open lobby door (1.6m^2), resulting in a figure of 3.2m^3/s[55]. Mr Mahoney explains how he then added 50% to this volumetric flow rate to take account of *"unidentified fabric losses and close motorised damper leakage"* to obtain a rate of 4.8m^3/s. This uplift of 50% was taken from BS EN 12101-6 which Mr Mahoney considered appropriate. A further margin of comfort was added by reason of the fans ultimately being specified to produce an extract rate of 5.6 m^3/s.

77. The robustness designed into the System can be seen from the readings of the System's performance taken by Mr Partlow during commissioning in April 2016[56]. Relevantly, in the context of a fire starting on the 4th floor, Mr Partlow's readings showed the System achieving velocities of between 3.0 and 4.4 m/s at the stair doors on the 4th floor all the way to the 23rd floor. It is to be noted that, on each of those floors, the System was therefore providing a velocity at the stair door *at least 50% greater* than the performance criterion of 2.0m/s.

78. In the means of escape phase, the scenario that a smoke control system is required to meet is straightforward; the bar is not set high. However, it is less clear what is required during the firefighting phase in a residential building such as the Tower. This is because of the guidance in 17.14 of the ADB which, in respect of a residential building, results in the position whereby the means of escape measures would generally be adequate for firefighting access[57]. The SCA Guide says this: "*There is often confusion regarding firefighting stairs in residential buildings. Fire fighting stairs are recommended when the top story is more than 18m above fire service access level. However, as long as the building layout conforms to ADB and the normal corridor/lobby ventilation is provided,*

[52] {CTAR00000050/0002/0008}
[53] {CTAR00000050/0011}
[54] {PSB00001233}
[55] {PSB00001371/0013} §68
[56] {PSB00000234}
[57] {BMER0000007/0010} §53

there is no requirement for a dedicated fire fighting lobby and the more onerous ventilation recommendations for a fire fighting lobby do not apply. See clause 17.14 of ADB:2006"[58].

79. It follows that a designer may do the bare minimum because the normal lobby ventilation for means of escape will generally be adequate. For example, a designer may design a system with an open lobby door velocity of say 0.75m/s (which is the open door velocity for a Class A Pressure Differential System most commonly associated with lobby ventilation in residential buildings for means of escape). That ventilation measure may then be deemed adequate for the fire fighting phase.

80. However, Mr Mahoney did not do the bare minimum. He looked to do better by specifying for the System a volume extract rate associated with a velocity flow rate of at least 2m/s through the open stair door in the circumstances set out in his Technical Submissions. This meant that, even if an additional door was opened to the fire flat, in circumstances that a path to outside was also provided, Mr Mahoney was confident that the specified volume extract rate would be sufficiently robust to continue to provide reasonable protection to the stair even if the door to the fire flat was opened by the firefighters and even if the airflow across the open stair door reduced as a result.

81. The design criterion of a velocity of 2.0m/s across the stair door was a robust, yet practicable, figure that would, in the context of a residential building, be sufficient to provide reasonable protection to the stair in means of escape and firefighting phases. The selection of such a velocity is supported by Ms Menzies who says *"[i]n my opinion the adoption of this flow rate as a design principle was reasonable in the circumstances"*[59]. Ms Menzies also opines that the selection of a velocity of at least 2.0m/s at the open stair door *"…was appropriate for the means of escape and firefighting phases"*[60].

82. The velocity obtained by the System at the fire floor stair door would not be prejudiced by stair (or other) doors being open on other floors. This can be seen from the calculations performed by Mr Mahoney which reflect the fact that, in a mechanical extract system, the velocity achievable at the stair door on any particular floor was the function of the volumetric flow rate at the extract grilles on that floor and any leakages present as between those grilles and the stair door.

83. A potentially limiting factor to this velocity would be a lack of 'inlet' air from within the stair itself. Such air would, in the case of floors 4 to 23, continually be provided by the 'penthouse' louvre at the top of the stairs. Insofar as doors were opened into the stair on other floors, their only (potential) effect would be to provide more inlet air to make up the flow of air extracted across the stair door on the floor that the System had operated. As the System was found to achieve the necessary velocity across the stair door on each floor during commissioning *without* any other stair door being held

[58] {LFB00059241/0016}
[59] {BMER0000007/0068} §290
[60] {BMER0000007/0007} §26

open, the System was able to achieve (and exceed) its designed performance criterion without any additional 'make up' air being provided from other floors.

84. The second principal performance criterion was that closed escape route door opening forces did not exceed 100N[61] by way of a -25Pa pressure limit criterion as between the fire floor lobby and the stair. The 100N criterion is accordance with the guidance given in paragraph 5.3.2.1.2 of the 2012 SCA Guide[62] and the means of achieving this objective through the use of a -25Pa pressure limit was consistent with the *ColtShaft* approach[63]. This was not interlinked with the 2m/s velocity criterion, which applied when the stair door was open, and the extract fans were ramped to full capacity. Ms Menzies understands this, for she says: *"the proposed system was a mechanical extract system designed to depressurize the lobby and induce an air flow from the ventilated stair into the lobby. In my opinion this satisfied the relevant aspects of Requirements B1 and B5 of the Building Regulations. I do not believe the system described in Revision 03 was intended to be a pressure differential system designed in accordance with BS EN 12101-6."*[64].

85. The distinction understood by Ms Menzies is an important one. The System was designed to achieve its objective of protecting the stair when the fire floor stair door was opened by the creation of a specified <u>velocity</u> at the open stair door, not by creating a specified <u>pressure difference</u> between the stair and the lobby. The selection of this performance criterion was, by itself, adequate without the need for a further pressure difference criterion.

Would the System make lobby conditions unacceptably <u>worse</u> by drawing smoke from a fire flat?

86. Dr Lane has raised the issue that the -25Pa differential limit could be lost due to *"a flat-entrance door being opened when a window in that flat is also open (either left open or broken open by a fire)"*[65]. Dr Lane criticises PSB's design for not considering how the loss of the pressure differential might affect the tenability of the lobby space in circumstances where *"...the pressure difference between the stair and the lobby will reduce as both spaces are directly connected to the outside"*. In appraising the validity (or relevance) of this concern, PSB invites the Inquiry to consider the following points.

87. First, the System's objective was to protect the stair when the stair door was open (thus when the -25Pa differential between the lobby and the stair could not be maintained in any event). Albeit the System extracted smoke from the lobby, the protection of the lobby was not its design intent *per se*. Second, insofar as the System's effect on conditions in the fire floor lobby are to be considered, they must be considered within the context of a design fire, rather than in the abstract.

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[61] PSB's Technical Submission, Revision 6 at page 4 {RBK00003780/0004} and Mr Mahoney second w/s at §§ 71 and 72 {PSB00001371/0013-0014}
[62] {LFB00059241/0012}
[63] {BLARP20000035/0080} Table 4-6 on the row *"pressure differential controlled by sensor"*
[64] {BMER0000007/0056} §§220, 221
[65] {BLARP20000035/0270} §7.7.33 *et seq.*

88. Guidance at paragraph 2.3 of ADB is that a fire will occur in a single flat and the measures taken to satisfy functional requirement B3 will provide a high degree of compartmentation. The guidance assumed *"a low probability of fire spread beyond the flat of origin, so that simultaneous evacuation of the building is unlikely to be necessary"*[66]. The assumption made as to the compartmentation and smoke control provided by flat fire doors is seen at paragraph 2.25 of ADB, where the need for smoke control of common escape routes is premised on the escape of smoke from a fire flat occurring *"…if only because the entrance door will be opened when the occupants escape"*[67]. This is reflected in the typical timeline for a design fire at Table 5.3 of the SCA Guide 2012[68] which only envisages occupants having to escape from the fire flat, with the flat front door and the stair door closing behind them during their escape (presumably due to self-closers on these fire doors).

89. Applying Dr Lane's concerns to the means of escape phase of a typical design fire:

90. During means of escape phase it is only the fire flat front door that will *necessarily* open.

91. Table 5.3 of the SCA Guide 2012 anticipates that occupants of the fire flat will leave their dwelling *before* a window fails due to fire. So, for the concern articulated by Dr Lane to arise it would be necessary for the fire flat to have a window open. In any event, all doors between the open (or failed) window and the front door of the flat would also need to be open to provide the required connection.

92. Even if such a direct connection to the outside were available when the flat front door opened, it would last for a matter of seconds when the occupants of the fire flat made their escape through the fire flat front door (i.e., before they shut the door, or the self-closing door closed behind them).

93. Once the fire flat front door had shut, any direct connection to the outside would be severed. The fans would operate at full capacity until the -25Pa differential had been reached. The operation of the fans at this point could continue to extract some of the smoke that had entered the lobby from the fire flat.

94. Should other occupants on the fire floor wish to evacuate, the same cycle would occur, save that no smoke should be entering the lobby from those flats (as they were not on fire). Any (re)ramping up of the fans could further extract some of the smoke that had earlier entered the lobby from the fire flat.

95. Applying Dr Lane's concerns to the firefighting phase of a typical design fire:

96. Because the System would have been operating during (and following) the immediate means of escape phase, firefighters would be able to access the building, ascend the stairs unimpeded and set up. As the firefighters entered the lobby of the fire floor and propped open the stair door, the pressure differential between the lobby and the stair would necessarily be lost. This was part of the System's

[66] {CLG00000224/0023}
[67] {CLG00000224/0030}
[68] {LFB00059241/0013}

design; to achieve an airflow velocity across the stair door to protect the stair. At this point in the design fire, the fire flat front door is assumed to be closed, limiting smoke seepage from the flat.

97. Through the rest of the firefighting operation the System will then extract smoke at full capacity as the pressure differential between the lobby and the stair would necessarily be lost. Smoke will pass into the common lobby once the fire flat front door is opened, but this is part of the System's design condition – not a design oversight. This is acknowledged, and accepted, by Ms Menzies[69].

98. Ms Menzies also says that it is recognised that at this time the only smoke control system likely to deter smoke from passing into the stair through the open stair door is a full pressurisation system, other systems will only be able to reduce/minimise the amount of smoke entering the stair[70]. A full pressurisation system was not reasonably practical in the context of the Tower[71].

Did the System meet the functional requirements as designed and as installed?

99. It is submitted that the System met the functional requirements relevant to means of escape (B1) and firefighting (B5) as designed and as installed.

100. Ms Menzies opines that:

"25. I consider that the performance based design for the lobby smoke control system {RBK00027392} as conditionally accepted by the Building Control Body (BCB), was acceptable in principle.

26. The adoption of a velocity of at least 2m/s at the open lobby/stairwell door for smoke control was appropriate for the means of escape and firefighting phases.

220. Following my review of Technical Submission Revision 3 I have concluded that the proposed system was a mechanical extract system designed to depressurize the lobby and induce an air flow from the ventilated stair into the lobby. In my opinion this satisfied the relevant aspects of Requirements B1 and B5 of the Building Regulations.

221. I do not believe the system described in Revision 03 was intended to be a pressure differential system designed in accordance with BS EN 12101-6.".

101. Dr Lane clearly takes a contrary view: "*10.13.9 I conclude that the lobby smoke control system designed and installed at Grenfell Tower did not comply with the functional requirements of Schedule 1 to the Building Regulations 2010 (B1, B3 and B5), when handed over to the KCTMO.*"[72] As stated above, PSB does not accept the assessment made by Dr Lane and will look to challenge it.

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[69] {BMER00000007/0050} §167
[70] {BMER00000007/0050} §168. {LFB00059241/0010} SCA Guide 2012, §5.2.1 "except possibly by pressurisation systems <u>with protection extended to the entrance door of each dwelling</u>"
[71] Mr Mahoney first w/s §32(4) {PSB00001329}, and Mr Mahoney second w/s §37(a) {PSB00001373}
[72] {BLARP20000036/0025}

102. The views of the experts are of course not the views of the Inquiry unless and until they are adopted or form part of the Inquiry findings. However, as the Inquiry proceeds to hear the evidence in respect of this topic it is invited to bear in mind the principle of reasonableness, which is so central to any assessment under the Building Regulations, and to keep in mind the constraints imposed by the building and the lack of feasible alternative design approaches that PSB had available to it.

About the events of the night

103. PSB will have more to say when it has had a reasonable opportunity to assess the evidence of Dr Lane including the series of "Storyboards" that Dr Lane adduces, and the opinions given therein.

104. Whether the System operated as intended on the night, the extent to which the System did or did not materially contribute to the spread of smoke within the building, and what the consequences of that were, if any, are issues seemingly to be the subject of inquiry. This kind of post fire forensic investigation and analysis is complex, multidisciplinary and a field of particular expertise. In this respect, it is noted, with some concern, that the Inquiry presently relies ostensibly on the Reports submitted to it by Dr Lane.

105. In any event, Dr Lane says this: *"13.17.3 Ultimately the events at Grenfell Tower, in terms of a detailed minute by minute timeline of fire and smoke spread within the Building, including which events were directly caused by the smoke control components, cannot be confirmed without doubt."*[73].

106. PSB is also bound to note that Dr Lane concludes in her Report that <u>from 01:26</u> the design condition for the System had been exceeded such that the System could no longer be reasonably expected to protect the stair: "*12.31.10 It is therefore reasonable to assume, as per my Phase 1 report, that from 01:26 the single floor fire design condition had been exceeded and therefore the system could no longer be reasonably expected to provide protection to the protected stair against increasingly substantial smoke spread from multiple lobbies (19 in total){BLAS0000002}."*[74].

107. As the Inquiry proceeds to consider the topic of smoke control, PSB would respectfully ask the Inquiry to ensure that its work is firmly evidence based, fair and proportionate, bearing in mind that the System was designed for a fire in a single flat on one floor only, not the undeniable catastrophic event fire and its overwhelming consequences that transpired at the Tower on 14 June 2017.

Shoosmiths LLP
25 June 2021

[73] {BLARP20000038/0038}
[74] {BLARP20000037/0080} §12.31.10