MODULE 3

SMOKE CONTROL SYSTEM OPENING SERVED ON BEHALF OF BINDMANS, HICKMAN & ROSE AND HODGE JONES & ALLEN

1. INTRODUCTION

1.1 **Relevance of the Smoke Control System** It is an accident of timetable that we are considering the smoke control system in isolation. It is but one of a package of active and passive fire protection measures which existed at Grenfell. The design of the Smoke Control System **("SCS")** should have taken into account (but did not) the efficacy of the other passive and active fire protection measures and the existing condition of Grenfell.[1] Given the fact of the *Stay Put* strategy, and the extended travel distances from some of the flats, the SCS assumed greater significance than it might otherwise.[2] It should be remembered that the SCS was only ever supposed to operate on one floor at a time (the underlying assumption being that there will only be one fire at a time in a building) and therefore the SCS failing to operate as intended might ordinarily be regarded as having little causative effect. In the case of Grenfell, however, the operation of the SCS and the component parts of it contributed to smoke spread throughout the building on the night of the fire by trapping smoke within the South shaft and then allowing it to leak out through open (and closed) vents into the lobbies but providing no means of extracting the smoke as it should have; this was a serious breach of compartmentation. A permanently open damper, and substandard dampers also likely resulted in a breach of compartmentation in the North shaft. The SCS therefore actively posed a very significant hazard to life safety which cannot be underestimated.

1.2 **SCS Mirrors Grenfell Themes** In several respects, the design and commissioning of the SCS mirrors themes with which we have become familiar at Grenfell, namely deliberate non-compliance, inadequate/partial testing of products and commissioning and maintenance failures, all of which, instead of being identified as non-compliant and rejected by Building Control **("RBKC BC")** were, on the contrary, approved formally by the Completion

[1] *"Smoke Control systems form an element of the overall fire engineering strategy for apartment buildings and should not be designed in isolation. It is the responsibility of the designer of the smoke control systems to ensure that any proposed systems complement the fire safety strategy and provide a suitable level of fire safety"* **{LFB00059241/5}** s2 Smoke Control Association *Guidance on Smoke Control to Common Escape Routes in Apartment Buidlings Rev 1 : June 2012*. References in these submissions to this SCA Guide are to the 2012 version **{LFB00059241}** unless otherwise stated. For content concerning commissioning of the SCS in 2016, the 2015 version is cited **{RBK00001778}** unless otherwise stated.

[2] See Lane Phase 1 Report s3 Building Description and fire safety requirements paragraphs 3.2.10-3.2.27 **{BLAS0000003/10}** which explained that GT's design was supposed to comply with the British Standard Code of Practice 3 Chapter IV *Precautions against fire Part 1* which introduced the concept of Stay Put and required various passive measures (including travel distances from flats) and active measures including lobby and stair ventilation.

Certificate. Insofar as non-compliance is concerned, it seems Hugh Mahoney of PSB, the SCS designer and an individual influential in drafting the available guidance concerning ventilation systems, was aware at the time he designed the SCS, and certainly asserts now (albeit changing his evidence from that contained in his first statement) that the SCS did not comply with the British Standard incorporated by reference in Approved Document B, Vol. 2 **("ADB2")**. Mahoney's position is somewhat perverse in that he seeks to make an artificial distinction between his definition of a *"depressurisation system"* and a pressure differential system, albeit the available guidance defines a depressurisation system as one of two types of *"pressure differential system"*. The fundamental tenet of despressurisation systems as defined by the guidance is that the areas to be protected (lobbies and stairs) are not depressurised relative to the areas around them, whereas Mahoney asserts that his design was a depressurisation system of a type which is nowhere described in any standard/Code of Practice, but which did depressurise the lobbies. He is dancing on a pin head. If he is to be believed, deliberate non-compliance of the type reflected in his design is *"...widely adopted as a type of smoke control system..."*.[3] If true, that would be of grave concern, in that the SCS does precisely the opposite of what it should achieve (keeping the lobbies and stairs relatively free of smoke) and instead draws smoke from flats into the protected lobbies, with the result that the only protected areas was the staircase.[4] This fundamental flaw was exacerbated by Mahoney's incorrect design assumption that only one door would be open at once: thereby overlooking entirely reasonable, foreseeable and necessary firefighting activities.

1.3 **Divergent expert opinion** There is a divergence of opinion between the Inquiry's experts on the viability of the SCS design: Menzies considers that the adoption of a 2m/s flow rate at the open lobby/stairwell door was appropriate and that PSB's system rev 3 as conditionally accepted by RBKC BC was acceptable in principle[5] (albeit Menzies considers that RBKC BC's Acceptance Certificate should not ultimately have been issued[6]). Dr Lane's opinion is that the design was fundamentally flawed from the outset, did not change substantially between the first and final revision[7] and that its design assumption that only a single door would be open was also flawed. Insofar as the viability of design is concerned it is submitted that Dr Lane's evidence is to be preferred.

---

[3] Mahoney second statement [2/41] **{PSB00001373/8}**

[4] Lane Smoke Control System Report Phase 2, 4.3.33 **{BLARP20000035/55}** and graphically represented at Fig 5.7**{BLARP20000035/155}** ***N.B references to this SCS report hereafter will be to "Lane, Phase 2" [Report]***

[5] Menzies Supplementary Report 304 **{BMER0000007/69}**

[6] Menzies Supplementary Report 312-313 **{BMER0000007/70}**

[7] Lane Phase 2, 5.5.28 **{BLARP20000035/147}**

2. DESIGN OF THE SMOKE CONTROL SYSTEM AT GRENFELL

2.1 **The Original System** The original SCS at Grenfell Tower **("GT")** was a natural ventilation system, with the facility for the fire brigade to engage additional mechanical ventilation if required.[8] Following a *"catastrophic"* failure of the ventilation system during a fire in 2010,[9] the system was inspected by maintenance company RGE who advised TMO that the smoke dampers were *"unreliable"* and *"may not operate on every activation"*.[10] TMO failed to address this dangerous state of affairs for many years, despite repeated unambiguous warnings. In 2011, RGE advised that "***WE CANNOT GUARANTEE CONFORMITY WITH FIRE REGULATION***", explaining that lobby vents were *"no longer reliable"* and that *"actuation systems are not fit for purpose"*.[11]A review of an FRA Action Plan in April 2013 revealed TMO continued in its failure to address these issues at that time: *"Reported since 2009 that RGE cannot guarantee that in the event of an emergency this system will work..."*.[12] According to 2014 emails from RGE, the same advice was repeatedly given to the TMO.[13] On 24.3.14, the LFB issued a deficiency notice,[14] explaining that 25% of smoke vents at GT were non-functioning, and yet still the TMO delayed in addressing these issues.[15]

2.2 Regulatory Requirements for the Upgraded System

2.2.1When TMO eventually upgraded the SCS as part of the 2014-2016 refurbishment, the SCS was controllable work under the Building Regulations 2010 as amended **("BR")** because it was potentially a material alteration (of a controlled fitting[16]). As a potential material alteration, the application under the BR needed to demonstrate that the alteration made the system no more non-compliant than it had previously been under the so called *"non-worsening"* principle.[17] In the event, it was not possible for TMO/its designers to demonstrate that the proposed system would not be a material alteration (namely, make the system more non-compliant than it had been) and as a result, instead of applying the non-worsening principle, RBKC BC required the

---

[8] Max Fordham document entitled *"Employer's Requirements for MEP Services"* dated 28.11.13 **{MAX00006475}**
[9] Email LFB to TMO dated 6.5.10 **{LFB00000760}**
[10] RGE Report dated 12.5.10 **{RBK00013637/7}**
[11] RGE Report dated 9.8.11 {**TMO00894311/5}**
[12] Record of Significant Findings and Action Plan dated November 2012, but see column entitled *"FRA reviewed April 2013 & outstanding actions raised"* at Item 23c **{MAX00001426}**
[13] RGE email to Max Fordham dated 23.01.14 **{MAX00004262}** Claire Williams (TMO) claimed she never saw this email and was not aware that RGE had stated they could not gurantee the system would work **T121/110:15-111:15** albeit she accepted that she knew part of the system was not fully functional.
[14] **{JSW00002917}**
[15] **{TMO00856900}**
[16] Reg 2(1) *Controlled service or fitting* means one to which Part L (amongst others) applies. Part L requires that fixed building services are energy efficient and have effective controls and are commissioned to ensure they use no more power than is reasonable.
[17] Reg 3(2)

SCS to comply with the relevant functional requirements of Schedule 1 of BR. Menzies endorses this approach as reasonable.[18] That being so, the SCS was required to comply with B1 Means of Warning and Escape and B5 Access and Facilities for the fire service, but also B3 Internal fire spread (structure) as the North and South shafts penetrated internal compartmentation.

2.2.2 ADB2 provides guidance on how to achieve the functional requirements. In respect of B1, ADB2 states the purpose of smoke control in common escape routes as "*ventilating the common corridors/lobbies to control smoke and so protect the common stairs*" as well as providing "*some protection to the corridors/lobbies*";[19] albeit since the lobbies at GT were non-compliant due to some flats having extended travel distances, protection of the lobbies was of even more importance (as explained below). ADB2 suggests means of compliance by two alternative types of system: natural or mechanical. Paragraph 2.27, which deals with mechanical ventilation, states "*Guidance on the design of smoke control systems using pressure differentials is available in BS EN 12101-6:2005*". That guide lists some prescriptive requirements for system types (e.g. for a Class B system which would have been required at GT[20] airflow criterion 2.0m/s at both open door to lobby/flat and at the stair door and door opening force not to exceed 100 N[21]).

2.2.3 Following the guidance within ADB2 was not the only means of compliance with the functional requirements of the BR: it was permissible, and sometimes necessary, due to constraints imposed by a building, to adopt an alternative solution. An alternative solution was required at GT due to excessive travel distances and the fixed positions of the smoke shafts[22]. Whilst ADB2 expressly directed the reader to BS EN 12101-6:2005 for mechanical systems (as above) further industry guidance was available in the Smoke Control Association "*Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)*" **("SCA Guide")** which provided for a performance based design .[23] In this case, as explained at 2.3.4 below, RBKC BC had in fact required that either an equivalent system to the old should be provided, or the design should comply with the SCA Guide. In the event, as explained above it was not possible to demonstrate equivalence and also the physical contrainsts at GT namely

---

[18] Paragraphs 34-38 **{BMER0000007/8}**
[19] Paragraph 2.25 of ADB **{CLG10003130/30}**
[20] Given it was required for both MOE and firefighting purposes Lane Phase 2, 4.3.9-4.3.14 **{BLARP20000035/51}**
[21] BS12101-6 para 4.3.1 and 4.3.2.2 **{BSI0000132/19-20}** and Lane Phase 2, 4.3.16-4.3.10 **{BLARP20000035/52}**
[22] Lane Phase 2 5.1.2-5.1.4 **{BLARP20000035/114}**
[23] See Footnote 1 above

travel distances and the fixed positions of the moke shafts necessitated a performance based design. Accordingly PSB should have followed the SCA Guide. Further guidance relevant to GT contained in BS 9991:2011 for mechanical smoke ventilation systems was also available.[24]

2.3 **PSB Design: Key Failures**

2.3.1 **The Lead Designer**

(1) PSB was the specialist ventilation designer engaged in around May 2014.[25] The lead designer of the upgraded SCS was Hugh Mahoney of PSB. Mahoney was, on the face of it, a highly experienced and knowledgeable specialist in the industry. Whilst he does not have any notable academic qualifications concerning smoke control,[26] he does have in excess of 35 years' experience in designing smoke control systems.[27] Of particular note is his involvement with certain leading industry bodies, in particular the SCA which he joined in 1992 and of which he was Chairman between 1998-2000.[28] The SCA produced a guide for smoke control in apartment buildings which was first issued in 2010, then 2012 and 2015. Mahoney was intimately involved in each of these revisions; he was Chairman of the Working Group for the 2012 version,[29] which was current at the time he commenced his design of the SCS at GT. The 2015 guide was issued prior to completion of his design at GT, [30] at which time he remained an active member of the working group.[31]

(2) Mahoney was also a member of the BSI's FSH25 Committee for Smoke Control Systems between 1994-2014 and during that time was the Committee's representative on the European Working Group responsible for drawing up BS EN 12101-6:2005, he was also the UK's Principal Expert on that Working Group.[32]

(3) In addition to ADB2 itself and BS 9991:2011, BS EN 12101-6 and the SCA Guide were the most prominent guidance documents dealing with smoke control in residential buildings at the time of the GT refurbishment. Mahoney's intimate involvement with BS EN 12101-6 and the SCA Guide must carry an inference of an equally intimate knowledge of their content. Despite his apparent experience and knowledge, his design was woefully inadequate in multiple

[24] **{LFB00024106}**
[25] Mahoney Second Statement at [24] **{PSB00001373/5}**
[26] This appears to be limited to a 632 City and Guilds qualification in heating and ventilation: See [10] of his first statement **{PSB00001329/2}**
[27]See [4] of his first statement **{PSB00001329/1}**
[28] Mahoney Second Statement at [11] **{PSB00001373/3}**
[29] SCA Guide 2012, Foreword **{LFB00059241/4}**
[30] Mahoney undertook to check the guidance and consider any impact on the GT design **{PSB00000780}**
[31] Mahoney Second Statement at [16] **{PSB00001373/4}**
[32] Mahoney Second Statement at [21] **{PSB00001373/4}**

respects, and he failed to adhere to even the most basic and fundamental aspects of the available guidance to which he himself had contributed.

2.3.2 **Absence of Justification of the Design**

(1) The SCS design was primarily set out in PSB's Technical Submission **("TS")**.[33] PSB's design did not seek to comply with the provisions of ADB2 as a means to compliance with the functional requirements of the BR, and therefore an alternative route to compliance was required. In any event, given that RBKC BC had required that the SCA Guide be followed if an equivalent system to the original could not be provided and given the physical constraints at GT, it was inevitable that an alternative route was followed as the SCA Guide only provided for a performance based (as opposed to prescriptive) solution. One of Dr Lane's most damning criticisms of Mahoney is that (contrary to the SCA Guide) he did not in any contemporaneous design documents, set out a clear basis or explanation for the alternative solution he proposed, including the assumed design conditions and resulting performance standard for review by RBKC BC.[34] Lane also observes, correctly, that Mahoney has failed in his two witness statements to set out a clear basis of, or explanation for, the alternative solution he proposed.[35] The most likely explanation for this is that Mahoney had no proper basis for his design and had not addressed what the design conditions were, still less the performance standard he hoped to achieve. It appears likely that at some point originally, and before caveating his design, he intended to comply with BS12101-6 but simply overlooked the airflow criteria that 2m/s velocity was required both at the open stair door and the open flat door[36] and failed to appreciate the extent to which doors would be open.

(2) The *only* guidance referred to in the TS was BS 12101-6. Despite claiming in his first statement (dated 28.8.18) that the SCS was designed in compliance with this standard,[37] Mahoney asserts in his second statement (dated 26.3.21) that in fact he did not design the system in accordance with BS 12101-6,[38] and that it was a *"performance-based building appropriate solution"* which he describes variously in his statement as a *"mechanical extract depressurisation system"*, a *"Colt Shaft mechanical shaft system"* and *"similar to but not the same as, the Mechanical Extract, Natural Inlet system detailed in the SCA Guide 2012"*.[39] No such explanation, as far as it goes, appears in the contemporaneous design documents. Rev 1

[33] Which went through 6 revisions: Rev.6 **{PSB00000214}**
[34] Dr Lane, Phase 2, 5.1.7 and 2.1.8 **{BLARP20000035/114} {/11}**
[35] Dr Lane, Phase 2, 4.2.10 **{BLARP20000035/47}**
[36] Lane table 4-2 **{BLARP20000035/52}**
[37] Mahoney First Statement at [26], [27], [51], [52], [54] **{PSB00001329}**
[38] Mahoney Second Statement at [40] **{PSB00001373/8}**
[39] Mahoney Second Statement at [40] and [52] **{PSB00001373/8}** and **{/11}**

of the TS had contained at paragraph 1.1.2 a caveat that the system "*…is not deigned* [sic] *to comply with all the requirements of the aforementioned Code of Practice* [i.e. BS EN 12101-6]".[40] However, Paul Hanson of RBKC BC requested that this caveat be removed, as it did not accord with the discussions to date.[41] Mahoney duly deleted the paragraph, which never reappeared,[42] such that the TS recorded that the velocity of 2.0m/s was *"in accordance with the recommendation for a class B pressure differential system as defined by the code of practice BSEN12101 part 6…"* . The caveat had been the only indication that the route to compliance was *not* via BS 12101-6. Without the caveat and given the TS did expressly suggest compliance with BS EN 12101-6, there was no reason to think otherwise, as no other guidance was referred to in the TS.

2.3.3 Dr Lane has concluded that the design did not comply with the requirements of BS 12101-6, BS 9991:2011 or the SCA Guide.[43] She also concludes that the system was not, and was not similar to, a ColtShaft system.[44] It seems therefore that Mahoney did not follow any of the available guidance in designing the SCS at GT. Instead, it seems that he produced a design which he himself deemed to be a "*building appropriate solution*", without seeking to demonstrate whether that solution complied with the Building Regulations. Despite not having received any such explanation, RBKC BC entirely failed to raise this fundamental issue, and seems to have been of the view that the design was produced in compliance with the SCA Guide (despite the guide not being referenced in the TS and the fact that Hanson is contemporaneously recorded as considering the design route being pursued was compliance with BS EN 12101-6).[45]

2.3.4 **Relevance of the SCA Guide** The SCA Guide contains a methodology for the production of "*performance based solutions*" where prescriptive methods of smoke control cannot be implemented.[46] As Mahoney himself noted in the Foreword of that document "*the prevention of smoke spread through buildings is of critical importance, but little guidance is currently available in one publication*". Dr Lane considers that the performance based design methodology set out in the SCA Guide is a "*reasonable*" methodology for any designer of a lobby smoke control system to rely upon when formulating a performance based solution,

[40] **{PSB00001235/3}**
[41] Email JSW to Mahoney dated 11.6.15 **{PSB00000569}**
[42] Email Mahoney to JSW dated 12.6.15 **{PSB00000575}**
[43] Lane Phase 2, Table 5-6 at **{BLARP20000035/156}**, Table 5-7 at **{/159}** and Table 5-2 at **{/139}-{/145}**
[44] Lane Phase 2, 4.6.7 **{BLARP20000035/75}**
[45] Hanson Statement Paragraphs 52-58 **{RBK00033894/9}** and email JSW to Mahoney dated 11.6.15 **{PSB00000569}**
[46] SCA Guide 2012, Section 2 **{LFB00059241/5}**

particularly for an existing condition such as GT, which had dry risers positioned in the lobby not the stair (meaning the lobby door of the floor below the fire floor would also need to be open during fire-fighting) and extended travel distances.[47] Given those conditions, whilst compliance with the SCA Guide was not ordinarily mandatory (albeit in this case it had been required by RBKC BC) it was the most appropriate guide to follow and Mahoney ought to have realised this, particularly since PSB appears to have been in possession of RBKC BC's memorandum setting out two alternative approaches to compliance: providing equivalence with the original system, or a performance based design in accordance with the SCA Guide.[48] Mahoney's failure to observe even the most basic and fundamental principles of the guide is particularly troubling in light of his inherent knowledge of it.

2.3.5 **System Objectives and Performance Criteria**

(1) One of the fundamental concepts of the SCA Guide is that where the route to compliance is an alternative performance-based solution, it is "*necessary*" to consider the objectives and performance criteria for the system.[49] The objectives of the SCS are simple: to keep the stairs relatively free of smoke under design conditions, and to promote tenable conditions for travel through the ventilated corridors during the escape period. [50] PSB's design considered the first of these objectives,[51] but entirely failed to consider the second (developed further in section 2.3.9 below).

(2) In order to demonstrate that those objectives are satisfied, designers are to set performance criteria based on tenability and in particular: visibility, temperature, thermal radiation and toxicity in corridors/lobbies. For stairs the same criteria should be considered but should ensure the stairs are "*relatively smoke free*", [52] which reflects the guidance in ADB2 that protected stairways are to provide virtually "*fire sterile*" areas.[53] Unless a comparative design approach is taken,[54] the designer will be required to set acceptance limits for these performance criteria.[55]

(3) The performance criteria cannot be considered in a vacuum, and consistently with *all* of the published guidance documents there is a need for relevant scenarios to form the basis of the

[47] Dr Lane, Phase 2, 2.5.1-2.5.5 **{BLARP20000035/32}**
[48] RBKC BC Memo dated 10.11.14 **{PSB00000205}**
[49] SCA Guide 2012, Section 5.2 & 5.3
[50] SCA Guide 2012, Section 5.2.2
[51] See TS Rev.6 at 1.1.2 "*The Final smoke control system has been designed to provide the existing stairwell with protection from the ingress of smoke, from a fire within a dwelling, by means of a mechanical extract system*" **{PSB00000214/3}**
[52] SCA Guide 2012, Section 5.2.2
[53] ADB 2013, B1.ix **{CLG00000224/18}**
[54] i.e. comparing the performance of the system with an ADB2 compliant system to demonstrate equivalence.
[55] SCA Guide 2012, Section 5.3.2.1.2

design.[56] The term "*relevant scenarios*" refers simply to the likely events that the SCS will have to deal with during a fire, such as doors opening during occupant escape and firefighting. The SCA Guide refers to these as design conditions and offers two methods for establishing them: steady state or time dependant. The ultimate difference between these methods is that the former results in a steady extract rate throughout all stages of the fire and the latter results in a variable rate to reflect the different stages that occur during a fire.[57] Both methods require some form of analysis in order to determine whether the performance criteria are met under the relevant design conditions, this is done either by manual calculations or computer model analysis. Both design conditions and performance criteria should be agreed with the approving authority in advance of detailed calculation or modelling.[58] Such careful and detailed analysis is conspicuously absent from Mahoney's design.

(4) Mahoney says he chose two *"performance criteria"*: a velocity of 2m/s through the open door to the stair; and a differential pressure of -25Pa between the stair and the lobby ensuring a door opening force of less than 100N.[59] The 2m/s velocity was cherry picked from the BS 12101-6 standard without explanation (as was the 100N);[60] even now, Mahoney's best explanation as to why he chose this flow rate is that he knew "*from experience*" that the 2m/s figure was required to keep smoke out of the stair.[61] There is no evidence that these criteria were selected in order to meet any particular acceptance limits for visibility, temperature, thermal radiation and toxicity,[62] nor in fact that any such acceptance limits were even considered. Moreover, and crucially, far from relevant scenarios forming the basis of the design, Mahoney appears to have designed the system on the basis of a *single* design condition: the door between the stair and lobby being either open or closed. His failure to account for other scenarios, including a reasonably foreseeable scenario that occurred on the night of the fire is causative of the failure of SCS to achieve its primary objective that night (as further explained at 2.3.8 below). There is no evidence that these performance criteria, or the single design condition were agreed with RBKC BC.[63]

2.3.6 **Failure to Document**

---

[56] Lane, Phase 2, 10.6.1 {**BLARP20000036/8**}
[57] Lane, Phase 2, 10.6.14 {**BLARP20000036/10**}
[58] SCA Guide 2012, Section 5.3.1
[59] Mahoney Second Statement at [73] {**PSB00001373/14**}
[60] See TS Rev.6 at 1.1.2 "*This velocity is in accordance with the recommendation for a Class B pressure differential system as defined in Code of Practice BSEN12101 Part 6…*" {**PSB00000214/3**} ; and "*The control system will also have pressure sensors…to ensure that when the doors on the escape route are closed that the opening force on the door does not exceed 100N as detailed in BSEN12101-6*" {**PSB00000214/4**}.
[61] Mahoney Second Statement at [67] {**PSB00001373/13**}
[62] Dr Lane, Phase 2, 5.3.28 {**BLARP20000035/123**}
[63] Dr Lane, Phase 2, 5.11.36 and 5.11.39 {**BLARP20000035/175**}

(1) The SCA Guide makes it clear that the results of the analysis described above should be presented in an appropriate form for each agreed performance criterion. It also states that sufficient information should be provided to allow relevant parties to assess the analysis undertaken in relation to checking and meeting the required performance criteria.[64] Dr Lane considers that for *any* alternative solution to comply with ADB, the solution and final performance standard derived should be set out for review and consideration by the approving authority, with an explanation as to how the system meets the relevant functional requirements.[65]

(2) PSB's design documents do not achieve these goals. They do not seek to present either a comparative or deterministic analysis demonstrating that the design objectives and performance criteria have been met by the design. In short, there was absolutely no attempt to demonstrate numerically that a velocity of 2m/s through the open door to the stair is sufficient to protect the stair from smoke.

2.3.7 **BCO Failure to Scrutinise** Paul Hanson of RBKC BC claims in his witness statement that the SCS was designed in accordance with the SCA Guide 2012.[66] It is notable that Hanson was listed as a contributor to the SCA Guide 2015, and as such was familiar with its content.[67] Upon receipt of Rev.3 of the TS, Hanson confirmed that the proposal was "*satisfactory*" and Menzies agrees.[68] This is despite the fact that the TS does not even refer to the SCA Guide, let alone provide the detailed analysis required by that guide. As Dr Lane concludes, for this performance-based design, the designer was required to set out foreseeable scenarios under which the system was required to perform and set the resulting performance criteria; RBKC BC, as Hanson well knew, needed to understand this in order to confirm approval for the system.[69] It appears that they did not, and therefore should not have approved the system.

2.3.8 **Failure to Consider Multiple Door Open Scenarios**

(1) As noted above, *all* of the published guidance documents are consistent in stating that there is a need for relevant scenarios to form the basis of the design,[70] and one of the most important considerations is the number of doors that may be open or closed at any given time during a fire.

---

[64] SCA Guide 2012, Section 5.4

[65] Dr Lane, Phase 2, 2.1.8 **{BLARP20000035/11}**

[66] Witness Statement of Paul Hanson at [52] **{RBK00033894/9}**

[67] SCA Guide 2015 **{RBK00001778/2}**

[68] Memorandum dated 24.6.15 **{RBK00033900}**Menzies paragraphs 303-304**{BMER0000007/69}**

[69] Lane, Phase 2, 5.11.51 **{BLARP20000035/176}**

[70] Lane, Phase 2, 10.6.1 **{BLARP20000036/8}**

(2) Mahoney designed the system on the basis of a *single* design condition: the door between the stair and lobby being either open or closed. As such, he failed to account for flat doors opening as occupants escaped, and crucially, the reasonably foreseeable (if not inevitable) scenario during firefighting whereby the stair/lobby door was propped open by a fire hose and the fire flat door is open.[71] This occurred between 1:14am and 1:17am on the night of the fire, and it appears that by 01:25am, "*thick black smoke*" was observed "*coming in from the hallway into the stairs*" at Level 4 during one occupant's escape down the stairs.[72] Dr Lane concludes therefore that by 01:25am (30 minutes after activation of the smoke detector), the SCS had failed in its, as designed, primary objective of protecting the stairs from smoke in the Level 4 lobby and that the cause of this failure was the "*entirely expected*" condition of the stair door and fire flat door being open at the same time.[73] The fact that PSB's design did not account for this design condition is all the more shocking since Mahoney expressly acknowledged the likelihood of this scenario occurring in an email to Max Fordham in August 2016.[74]

2.3.9 **Failure to Adequately Protect the Extended Corridor** The corridors in GT were non-compliant with ADB as they exceeded the maximum travel distances of 7.5m in the lobbies. A "*reasonable travel distance*" from the flat entrance door to the protected stair is a performance requirement to comply with Regulation B1 of the Building Regulations,[75] and as such in order to comply, the design of the SCS had to compensate for this non-compliance. Whilst ADB did not contain guidance on the circumstances when extended travel distances may be acceptable, both BS 9991 and the SCA Guide 2012 did. The effect of this guidance is, in short, that a *higher* performance requirement is imposed which elevates the importance of maintaining tenable conditions in the *lobby* as well as the stairs.[76] Notwithstanding this fact, the *only* objective stated in the PSB TS is to prevent smoke from entering the stair, and the fact of the extended corridor is not even mentioned, let alone taken into account. Indeed, the entire design concept was in complete contradiction to this guidance, and was flawed, because it intentionally depressurised the lobby relative to the stair and accommodation thereby creating a foreseeable risk of smoke being drawn *into* the lobby from the fire zone.[77]

---

[71] This occurred at around 1:14am, Dr Lane, Phase 2, Section 12.8 **{BLARP20000037/24}**

[72] Dr Lane, Phase 2, Section 12.8 **{BLARP20000037/24}**; Witness Statement of Mohammed Ahmed at [38] **{IWS00001113/5}**

[73] Dr Lane, Phase 2, Section 12.31.4 **{BLARP20000037/80}**

[74] Mahoney email to David Bradbury (JSW) dated 2.8.16 **{ART00004481/1}**Mahoney's comments in red within Matt Cross-Smith email to Bradbury on**{/2}**: "*During firefighting operations air will again be pulled in from the stairwell. Should a window, in the fire affected flat, break then some smoke may be extracted during firefighting operations i.e. the flat door is open and the stairwell door is open*"

[75] Dr Lane, Phase 2, 2.2.39 **{BLARP20000035/19}**

[76] Dr Lane, Phase 2, 2.2.44 to 2.2.58 **{BLARP20000035/20}**10.7.4 and 10.7.24 **{BLARP20000036/11}**

[77] Dr Lane, Phase 2, 10.7.25**{BLARP20000036/14}**

2.3.10 **Component Selection: Dampers**

(1) PSB's design failures also extended to their specification of certain components within the SCS, which were non-compliant. Of particular causative relevance was the specification of the dampers for the lobbies. Dampers are moveable closures within a duct designed to prevent the passage for fire or smoke or both. There are three types of dampers available (fire, fire and smoke, and smoke control); in order for the SCS at GT to have satisfied ADB2, "*smoke control dampers*" were required. Smoke control dampers are tested to BS EN 1366-10-:2011 and classified to BS EN 13501-4:2007. Dr Lane confirms that the smoke control dampers at GT were required to have a classification of E120S.[78] PSB specified Gilbert Series 54 dampers,[79] which the TS described as "*fire dampers*" tested to BS EN 1366-2.Therefore, PSB specified the wrong type of damper; a mistake exacerbated by the fact that ADB2 in *two* locations expressly states that fire dampers are inappropriate for use on protected escape routes.[80] Worse still, review of the test report for the product (and PSB's quotation for the product[81]) reveals that in fact the product was not fully tested even to BS EN 1366-2, and in any event also failed the smoke leakage criteria.[82]

(2) The potential impact that this non-compliance had on the night of the fire should not be overlooked. The North and South shafts at GT were required by ADB2 to be protected shafts in order to maintain compartmentation in compliance with Regulation B3(3). The performance of the dampers was integral to that purpose. The fact that PSB selected the *"lowest possible damper standard"*[83] is therefore an egregious failure, which put relevant persons at unnecessary additional risk.[84] It is a terrible indictment of PSB's and indeed the Design Team's lack of competence that each of them failed to appreciate that the lobby smoke control system (North and South shafts) at GT, both the new elements and existing builders' work shafts were protected shafts[85]. At 13.7 of her report, Dr Lane summarises witness evidence concerning smoke leakage through the lobby dampers: this appears to have occurred from at least 01:16am, and was observed on Levels 6, 20 and 23 in the South shaft.[86] As explained further in Section 4 below, due to a failure of the Level 2 smoke extract fans, it is likely that, rather than being

---

[78] Dr Lane, Phase 2, 4.8.101**{BLARP20000035/99}**
[79] Rev.6 of PSB TS, Section 2.1 **{PSB00000214/6}**
[80] ADB 2 at 5.48 and 10.13 **{CLG10003130/61}** and **{/88}**; Dr Lane, Phase 1, 10.8.18 **{BLARP20000036/15}**
[81] Under "*Additional Notes*" it is stated that *"The damper has undergone an EN1366-2 test started from the closed position and lasted over 60 minutes for both fire integrity and smoke leakage (ES60) but has no formal certification"* **{PSB00001240}**
[82] Dr Lane, Phase 1, 6.5.51 **{BLARP20000035/223}**
[83] Dr Lane, Phase 1, 10.8.21 **{BLARP20000036/15}**
[84] Dr Lane, Phase 1, 13.17.38 **{BLARP20000038/41}**
[85] Dr Lane Phase 2 13.2.13 **{BLARP20000038/7}**
[86] Dr Lane, Phase 1, 13.7 **{BLARP20000038/19}**

extracted down away from Level 4, upon entering the South shaft smoke in fact began to rise up the South shaft due to the stack effect[87] and smoke buoyancy with no escape route at the top of the building (hence smoke leakage being observed from South shaft dampers *above* Level 4). The combination of the failure of the Level 2 smoke extract system (resulting in a failure to depressurise the shaft relative to the lobbies, thus allowing smoke leakage) and the fact that the dampers did not meet the required smoke leakage requirements, means it is likely that leakage through closed dampers was more severe than it otherwise would have been.

3 COMMISSIONING AND MAINTENANCE

3.1 **Commissioning: Key Failures** Commissioning is a critical part of any new SCS because without it there can be no evidence that the SCS can "*adequately perform the functions*" for which it is designed, as required by Regulation 7 of the Building Regulations 2010.[88] Naturally, if it has not been established that the SCS can perform as such, it also follows that compliance with Schedule 1 of the BR has not been established.[89] For the SCS at GT, the commissioning process was inadequate and did not therefore comply with the Schedule 1 or Regulation 7 of the BR.[90]

3.1.1 **Failure to Adhere to Any Guidance** The commissioning engineer for GT was Granville Partlow of PSB, it was his responsibility to create a commissioning process which verified that the SCS (as installed) functioned as intended under all of the scenarios relevant to the design and its performance criteria.[91] It appears that both RBKC BC, and JS Wright, were under the impression that Section 9 of the SCA Guide was the relevant guidance for commissioning (albeit this in turn refers to BS 7346-8 and BS EN 12101-6 as the relevant guidance).[92] However, neither of Partlow's two witness statements, or any of the commissioning documents, reveal what (if any) guidance or British Standards were used to develop the commissioning methodology.[93] It is unlikely that any such guidance or standards were followed, since Dr Lane concludes that there is limited documented evidence that the commissioning tests recommended by *any* of the relevant guidance documents (namely, the SCA Guide 2015, BS

[87] Movement of smoke upwards in a shaft due to internal air being warmer than external. The stack effect is exacerbated in tall shafts such as GT - Lane Phase 2 **{BLARP20000038/33}**
[88] See Dr Lane, Phase 2 at 8.2.5 **{BLARP20000035/329}**
[89] See Dr Lane, Phase 2 at 8.2.14 **{BLARP20000035/330}**
[90] See Dr Lane, Phase 2 at 10.12.1 and 10.13.1 **{BLARP20000036/24}**
[91] See Dr Lane, Phase 2 at 8.2.35 **{BLARP20000035/332}**
[92] See emails dated 4.5.16 between Alan Whyte and Paul Hanson **{JSW00000020/3-4}**
[93] See Dr Lane, Phase 2 at 8.4.22 **{BLARP20000035/347}**

EN 12101-6 or BS 7346-8) were undertaken by Mr Partlow in their entirety.[94] The commissioning process was therefore at best carried out on an *ad hoc* basis.[95]

3.1.2 **Inadequate Methodology** There was a method statement for the commissioning of the SCS, which Mr Partlow now acknowledges he produced and which "*contains errors and does not accurately reflect the system*".[96] The document is in any event entirely inadequate, as it gives no details about how the system would be commissioned or the methodology to be followed. As Dr Lane observes, it does not set out which measurements should be taken (and where) to demonstrate that the system met the performance criteria set out in the TS.[97] Despite Max Fordham raising entirely reasonable concerns about the adequacy of the document and requesting it be revised, it appears the document was never revised.[98]

3.1.3 **Lack of Adequate Cause and Effect Analysis** Dr Lane's view is that it was the responsibility of the designer to adequately document all the cause and effect scenarios needed to demonstrate the performance criteria for the SCS have been met,[99] this is also reflected in the documents required to be produced in the SCA Guide 2015.[100] This document should show the required sequence of operation for all relevant scenarios the system has been designed for, and is critical to ensure that the performance of the SCS is clearly narrated to those commissioning and maintaining it.[101] Whilst PSB does appear to have provided a cause and effect matrix, Dr Lane has concluded that it was "*over simplistic*" and for many performance requirements, simply wrong.[102] This was one of the most significant failures, since it caused an inadequate set of test procedures to be relied upon by Partlow during commissioning.[103] Without testing each sequence of operation for all relevant scenarios, it was not possible to certify that the SCS was operating as intended at the time of commissioning.

3.1.4 **Failure to Adequately Record Commissioning** The only contemporaneous documents recording the results of the commissioning process were: PSB's Commissioning Report dated 28.4.16[104] and a document entitled "*Grenfell tower readings in fire*".[105] The Commissioning

---

94 See Dr Lane, Phase 2 at 8.13.3 **{BLARP20000035/409}**

95 See Dr Lane, Phase 2 at 10.11.26 **{BLARP20000036/23}**

96 *Method statement & risk assessment* dated 1.2.16 **{PSB00000941}**; Partlow Second Witness Statement dated 26.3.21 at [11] **{PSB00001372}**

97 See Dr Lane, Phase 2 at 8.9.65 **{BLARP20000035/371}**

98 Email from Max Fordham to Rydon dated 5.2.16 **{JSW00002309/2}** and on 1.3.16 **{ART00005660/7}**

99 See Dr Lane, Phase 2 at 8.2.34 **{BLARP20000035/332}**

100 Section 9.2 of the SCA Guide 2015 requires a complete set of documentation to be produced and lists the minimum documents required, including a "control philosophy or cause and effect diagram". **{RBK00001778/56}**

101 See Dr Lane, Phase 2 at 8.4.5-8 **{BLARP20000035/346}**

102 See Dr Lane, Phase 2 at 8.9.56 **{BLARP20000035/370}**

103 See Dr Lane, Phase 2 at 8.13.4 **{BLARP20000035/409}**

104 **{PSB00000224}**

105 **{RBK00003781}**

Report is nothing more than an unsubstantiated tick box list, which does not identify, and therefore does not permit any analysis of, the tests carried out or their results. The only detailed description of the commissioning process appears in Mr Partlow's first witness statement to this Inquiry, which only underlines the problem since rather than making firm assertions about the steps that he took, Mr Partlow describes what he "*would have*" done; in other words, he relies upon assumption.[106] The "*Grenfell tower readings in fire*" document records the results of airflow tests carried out by Mr Partlow which record five measurements on each floor: one through the open stair door and the others through the north and south shaft dampers when the fan is operating at "high" and "low" speed respectively.[107] Whilst Mr Partlow claims that he took 10 to 12 readings on each door and recorded an average (BS 12101-6 requires a minimum of 8 readings per door[108]) there is no evidence of this since he disposed of the readings, and this conflicts with his earlier evidence that he only took three readings per door.[109] With only these documents to demonstrate the commissioning process carried out, it is unclear how RKBC BC felt able to sign off the SCS.

3.2 **Maintenance**

3.2.1 **Minimum Maintenance Requirements** Dr Lane has concluded that the minimum maintenance requirements for the SCS comprised of daily, weekly, monthly, quarterly, six monthly and annual checks. All but the six monthly and annual inspections could be carried out by suitably trained KCTMO staff.[110]

3.2.2 **Planned Maintenance Schedule** The information within the Building Manual was inadequate for the purposes of developing an appropriate programme of maintenance for the SCS[111]. Whilst there were planned maintenance schedules from Rydon and PSB within the Building Manual, Dr Lane has concluded that they were substantially incomplete and therefore inadequate[112]. Further, of the 15 components within the SCS, the Building Manual contained manufacturers' literature for just 5 components, and only 2 of those documents contained maintenance instructions[113] .

3.2.3 **Maintenance Carried Out by KCTMO**

---

[106] **{PSB00001309}**
[107] See Dr Lane, Phase 2 at 8.11.48 **{BLARP20000035/399}**
[108] See Dr Lane, Phase 2 at 8.11.54 **{BLARP20000035/400}**
[109] Partlow First Statement dated 28.9.18 **{PSB00001309}**; Partlow Second Statement dated 26.3.12 at [21] **{PSB00001372}**
[110] Ch.7 of Dr Lane's Module 3 Report at 5.9.108 **{BLARP20000033}**
[111] Lane 11.4.64 **{BLARP20000035/483}**
[112] Lane phase 2 11.4.24 & 11.4.49 **{BLARP20000035/476}**
[113] Lane phase 2 11.4.61**{BLARP20000035/483}**

BSR00000074_0015

(1) KCTMO had no formal or documented procedures for the maintenance of the SCS[114] and maintenance activities were limited to: weekly activation of the system by Paul Steadman, a KCTMO ESA (i.e. a caretaker); Monthly Health and Safety checks, also by ESAs; and two records of inspection/servicing by Allied Protection.[115]

(2) Whilst the SCS was a sophisticated and technical system, Dr Lane's view is that the minimum weekly and monthly checks required *could* have been performed by "*suitably trained*" KCTMO staff, however it appears that ESAs received no such training. The only training received was a system demonstration on 2.11.16[116] (6 months after issue of the completion certificate for the SCS[117]). Steadman was told (incorrectly) during this demonstration that he did *not* need to check the SCS on every floor "*as it would show on the ground floor if there were any issues...on any other floor*".[118] A "*brief*" given to Steadman purports to give guidance on "*what to check at Grenfell*", and includes a section on the ventilation system. However, it was woefully inadequate;[119] it contained no instructions on how to check that the system was operational (other than an instruction to activate the alarm using "*smoke in a can*"), and no criteria against which to measure its performance. It is likely that this was drafted by Claire Williams and Janice Wray,[120] not the designers of the system. Steadman ought to have activated the system using a different smoke detector each week and checked that the smoke dampers opened on the floor of detection, and closed on every other floor. It is clear that he did not do so, since he activated the same ground floor detector every week and never checked that the dampers on other floors closed. As such, these tests did *not* confirm that the SCS was operating as intended.[121] Moreover, despite Steadman's claim to have diligently carried out such checks "*every Friday without fail*", it seems that for 9 months post-commissioning there were no activations of the SCS, and from 20.1.17 until the night of the fire there were 5 Fridays where the system was not activated.[122] No records of these weekly checks were kept. There was a Record of Monthly Health and Safety Checks completed by ESAs, however it simply records either "yes" or "no" under a column entitled "*Are any known detection/extraction or ventilation systems in good working order*".[123] There was however no

[114] Ch.7 of Dr Lane's Module 3 Report {BLARP20000033}
[115] See Dr Lane, Phase 2 at 11.6.3 **{BLARP20000035/494}**
[116] Steadman Witness Statement at [22] **{TMO10049875}**; email from Claire Williams to Paul Steadman dated 20.10.16 **{TMO00834400/1}**
[117] Completion Certificate dated 3.5.16 **{TMOM00001862}**
[118] Steadman Witness Statement at [23] **{TMO10049875}**
[119] *See* Claire Williams' email dated 20.12.16 {**TMO00842298}** and the brief at {**TMO00842297/4}**
[120] According to the metadata, See Lane, Phase 2, 9.2.79 **{BLARP20000035/430}**
[121] See Dr Lane, Phase 2 at 11.6.29 **{BLARP20000035/500}**
[122] See Dr Lane, Phase 2 at 11.6.26 **{BLARP20000035/500}**
[123] **{TMO10017294}**

guidance concerning the steps to be taken in order to answer that question affirmatively and there is no record of any steps that were taken.

(3) The inadequacy of these checks is brought into sharp focus by the lamentable events just days before the fire. On 1.6.17, David Hughes (Rydon) identified that SCS *"vents"* were not working and notified JS Wright.[124] On 12.6.17, JS Wright was provided with a quotation from a specialist to attend to the system, but it seems it was ignored.[125] This unattended fault was well known to TMO's Claire Williams who, according to Steadman, following the fire exulted: *"good news Paul, the smoke vents worked"*.[126] Leaving aside the deplorable levels of self-interest that this comment betrays, it is also false.

3.3 Causative Relevance to the Fire at GT These failures mean that in many cases, it is impossible to discount the possibility that certain aspects of the SCS *never* worked as intended and it is possible that the cause of certain failures in the SCS on the night of the fire were directly caused by inadequate commissioning and/or maintenance (See Section 4 below).

4 PERFORMANCE OF THE SCS ON THE NIGHT OF THE FIRE

4.1 Failures of the South and North Shaft

4.1.1 **Open Dampers** Had the system operated as intended, the dampers on Level 4 should have opened whilst dampers on all other levels closed. However, post-fire investigations indicated that dampers were in the open position at Level 11 (North and South shaft) and Level 18 (South shaft),[127] and closed on Level 4. Dr Lane has identified four credible scenarios which could have caused this (two of which would be the result of inadequate commissioning/maintenance).[128] Since each lobby was connected via the North and South shafts, open dampers were a potential path for smoke to spread between floors and constitute a breach of compartmentation. Whilst Lane concludes that the roof level extract fans were likely operational, she cannot confirm whether they worked at full capacity.[129] The North shaft damper on Level 11 was likely open throughout the fire due to a commissioning/maintenance failure,[130] meaning that in the early stages of the fire (when the Level 4 damper was open) there was a clear breach of compartmentation with smoke being able to travel from the Level 4 lobby to the Level 11 lobby.[131]

---

[124] *See* David Hughes' Witness Statement at [121] {**RYD00094213**} and exhibits therein.
[125] *See* JSW Defect Log {**JSW00003989**} and PSB Position Statement at [75] {**PSB00001295_0020**}
[126] *See* Steadman's Met Statement {**MET00039814_0007**}
[127] Dr Lane, Phase 2, 12.13, **{BLARP20000037/34};** BRE Report dated 20.2.19 at [151] and [157] **{MET00039807/110}** and **{/113}**
[128] Lane phase 2 ,12.27.2 to 12.27.30 **{BLARP20000037/64}**
[129] Lane Phase 2 second row on **{BLARP20000037/60}** and Paragraphs 12.29.1 and 12.29.11 at {/**73**} and {/**74**}
[130] Lane Phase 2 at 12.31.2 (h)(i) **{BLARP20000037/78}**
[131] Lane Phase 2 **{BLARP20000038/29}**

4.1.2 **Smoke Leakage** As explained above, the Gilberts dampers specified by PSB did not meet the required smoke leakage requirements, meaning that excessive smoke was able to leak through them into the lobbies. This would be mitigated by the proper functioning of the Level 2 extract system connected to the South shaft which would have ensured that the shaft was depressurised relative to the lobbies, however as explained below, this failed to operate as intended. Although the roof level fans were likely operational, this poor damper performance and the permanently open damper on Level 11 may have also negatively affected the performance of the fans, resulting in insufficient depressurisation in the North shaft and smoke being drawn back into the lobbies.[132]

4.1.3 **Failure of Level 2 Smoke Extract** The South shaft was served by a smoke extract fan at Level 2 which was designed in smoke mode to extract smoke down the South shaft and out of the building at Level 2. The design of the system of extract at Level 2 was substantially more complex than the roof level fans in the North shaft.[133] During the transition from environmental mode to smoke mode, "Damper 3" was intended to switch from a closed to open position, so as to allow the extract fan to extract the smoke from the South shaft; it could not do so if Damper 3 was closed. Dr Lane has concluded that it is likely that Damper 3 did open and the smoke extract fan operated in the early stages of the fire only, and after 01:47 the Level 2 extract fan had stopped operating on account of Damper 3 *closing* (it was found to be closed post-fire). Dr Lane has been unable to conclude definitively what caused this to occur but it seems likely that it was caused either by faulty installation (not picked up during commissioning or maintenance) or an unintentional reset of the system by LFB, and a subsequent failure of the damper to re-open. In the latter scenario, the LFB should not be overly criticised for two reasons: first, the consequences of the manual actions on the SCS were *"neither intuitive nor communicated clearly"* and there was no warning of this effect beside the HMI Panel.[134] Second, because the failure of Damper 3 to reopen post-reset is likely a fault in design.[135] In the absence of an adequate cause and effect matrix, or any adequate commissioning or maintenance evidence for the bypass dampers at Level 2, it is not possible to determine how those dampers actually responded (or were intended to respond) to signals from manual controls, nor whether their failure was caused by forseeable firefighter manual operation or by a want of care in the Level 2 smoke extract design.[136] These failures are therefore primarily PSB's responsibility.

---

[132] Lane Phase 2, Box I of 13.13 **{BLARP20000038/31}**
[133] Lane Phase 2, 12.30.1**{BLARP20000037/34}**
[134] Lane Phase 2, 12.31.2(e) **{BLARP20000037/78}**
[135] Lane, Phase 2 Table 12-6, **{BLARP20000037/76}**
[136] Lane Phase 2, 12.30.12 to 12.20.15 **{BLARP20000037/77}**

4.1.4 **Combined Impact of these Failures**

(1) With Damper 3 closed, the Level 2 smoke extract system could not draw smoke down the South shaft. Instead, smoke would enter the South shaft via the open dampers at Level 4 and as a result of the *"stack effect"* and smoke buoyancy, *rise* up through the South shaft without any means of escape. In the absence of any smoke extraction, the rising smoke could then fill the South shaft and leak through the inadequate dampers on each floor even where closed. When the Level 11 and 18 dampers opened, this allowed even more smoke to spread between floors.

(2) In Dr Lane's view therefore, the performance of the South shaft most likely *enhanced* the flow of smoke from the South shaft through the dampers into the upper lobbies of GT.[137] The same can be said of the North shaft as a result of the permanently open damper on Level 11. Accordingly, not only did the SCS not perform as intended, but it actively *worsened* conditions in the building as a whole and failed to maintain compartmentation in accordance with Regulation B3(3).

4.2 **Exoneration of the SCS as the cause of the *"hot zone"* between levels 13-16 between 2 to 2.30 am** It is important to note that Lane considers that this phenomenon, which she identified in S14 of her Phase 1 report[138] is unlikely to have been caused by any fire/smoke spread conditions as a direct result of the dampers on levels 11 (North and South shaft) and 18 (South shaft) being open simultaneously. Lane considers the hot zone probably occurred prior to the time at which the level 18 damper was open, and hence not attributable to simultaneous opening [139].The cause of the hot zone may therefore remain a mystery.

5 CONCLUSIONS

5.1 The design, installation and commissioning of the SCS is therefore a yet further example of a failure by seemingly competent persons to provide a fire safety system that both relevant persons and fire fighters could depend upon to work reliably in the event of fire.[140] In turn that is a reminder of the need for the Functional Requirements of BR Schedule 1 and the requirements of ADB2 to dovetail in a meaningful way with the outcomes intended by the RRO. For important and complex systems such as smoke control, certain key considerations, a list of *"do's and don't's"* should perhaps be spelled out in ADB2, albeit recognising that if physical constraints require a performance based solution, full prescription is neither possible nor desirable.

---

[137] Lane Phase 2, 13.17.71**{BLARP0000038/44}**

[138] **{BLAS0000014}**

[139] Lane Phase 2, 13.17.60 to 13.17.62 **{BLARP20000038/43}**

[140] Lane Phase 2, 13.17.73 **{BLARP20000038/44}**

5.2 TMO's knowledge of the fact that the SCS was not working and yet its lack of urgency in remedying it is also a salutary example of a responsible person which did not take its role in ensuring the safety of the relevant people sufficiently seriously. TMO's failure must be taken together with Stokes' failure to identify within his 2014 FRA that the risk level in GT had changed due to the non functioning of the SCS.

5.3 Perhaps the most depressing feature of the SCS design and commissioning is the degree to which the lead designer, Mahoney, appeared competent and highly conversant with the relevant principles which should have guided him to a compliant outcome. It does not however appear that the emboldened wording in guidance he assisted in drafting which placed the onus on the system designer "*…to ensure that any proposed systems complement the fire safety strategy and provide a suitable level of fire safety*"[141] weighed on him at all: there is no evidence that he considered the design conditions and or the existing condition of GT. Mahoney's failure, and indeed the failure of the entirety of the Design Team to appreciate that the shafts at GT were intended to operate as protected shafts and thus required smoke dampers is also of the greatest concern, and suggest a widespread lack of fundamental understanding of basic features of fire protection amongst designers.This brings us back to our starting point for these submissions, namely the degree to which deliberate non-compliance is tolerated within industry. Clearly there would be benefit in compulsory qualifications being required together with continuing education measured against core curricula for those who design highly specialised systems such as smoke control. The hope being that the increased competence requirements lead to a greater sense of responsibility and culture change in designers of such systems.

25 June 2021

Stephanie Barwise QC
Dalton Hale

[141] See Footnote 1 above