BIM4Housing's Expert's Recommendations on Mitigating Risk to Sprinkler System, while Strengthening the Golden Thread

(In their own words with edits)

Second Edition

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And the experts listed in Appendix 3

Below are recommendations that we, as BIM4Housing, are putting forward as the findings of our subject matter experts. We do not claim these findings to be definitive, but we would hope that they would provide 'accountable' and 'responsible' persons with some of the detail they would require to ensure that risks are mitigated.

Format

The structure of this set of information is designed to be consumed in various ways by different stakeholder groups doing different things. Therefore, information mentioned in one section may be repeated in another, so they can be applied to a particular activity.

Also, we have sought to organize the information to make it more machine-readable so, although the lists could be reduced by combining similar items, this would make them less easily used in applications.

Despite the need to edit and contextualise, we have tried to retain the authentic voice of our experts throughout. This is especially so in the Appendices, where no colloquialism is left unturned.

Terms of use

This document is not intended as an end-result, but as a snapshot of a dynamic, on-going piece of work being developed by Subject Matter Experts who represent the different interest groups.

We hope it is helpful, but it should not be used in isolation, since, as we have learned from our collaboration, no one knows everything- and experts often disagree. It should therefore be used to supplement other sources of information, all of which should be validated by a responsible person applying it to a project.

Comments and additional contributions are welcome, and a panel of volunteer experts will review suggestions to assess/validate them and augment our recommendations as required.

This document can be viewed, downloaded, and commented upon at https://bim4housing-blackbox.com/publications/

INTRODUCTION

BIM4Housing Structure

We have six Working Groups of experts who understand the individual Stakeholder needs of Development, Design, Construction, Manufacturing, Operations, and the specialist Advisors who support the whole process. Each Working Group determines the problems they are experiencing that could be alleviated by better information, often from a different Stakeholder group and they collectively establish Workstreams to collaborate and share knowledge to come up with practical solutions.

They have established Workstreams for MMC, Data Standardisation, Sustainability and Fire Safety and the latter has, in turn, established Round Table workshops that bring together SMEs who really understand specific asset types.

(See Appendix 1 for Structure Diagram)

Fire Safety Methodology

In 2021 it was determined to take individual fire-critical assets and examine impacts and influences through their lifecycle. A series of online discussions were held, along with one-on-one calls and an email gathering of views and inputs. In 2022 this consultation culminated in a series of Roundtable discussions, each with a clear focus and targeted output. BIM4Housing's expert team was enhanced by guests from the GTI, along with other fire safety specialists throughout the process.

Phase 1 defined the over-arching questions that need to be answered, for each asset type, to deliver the BIM-plus solution necessary to the effective functioning of the Golden Thread in terms of Fire Safety.

The questions defined are:

- What risks does the asset mitigate?
- To what risks is the asset, itself, susceptible?
- What information is needed about an asset, to ensure it performs as required?
- What tasks/method statements/procedures are required to ensure the asset is installed, commissioned, inspected, and maintained properly?
- What level of competency/training needs to be in place?
- How should product changes be recorded?

Phase 2 sought to answer those questions, offering a set of recommendations to mitigate risk and to help to deliver The Golden Thread, through the effective management of required information.

Phase 3 saw the Recommendations published on the BIM4Housing Blackbox web site enabling further comment and input to enhance the document.

Phase 4 saw a second tranche of roundtables, which sought to update the Recommendations in the light of the Fire and Building Safety Acts and other industry changes. This Second Edition is the result.

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Round Tables

Sprinkler System Methodology

The output from a Roundtable (17th September 2021) was collated and contextualized and combined with further subject matter expert input. Significant participant engagement was achieved prior to the event. The resulting report was then peer-reviewed.

Now, eighteen months on, we are reviewing the Recommendations in light of recent legislation and any change in industry practice.

What is a Sprinkler System?

A fire sprinkler system is an 'active' fire protection method, consisting of a water supply system, providing adequate pressure and flowrate to a water distribution piping system, onto which fire sprinklers are connected.

Although historically only used in factories and large commercial buildings, systems for homes and small buildings are now available.

Fire sprinkler systems are extensively used worldwide, with over 140 million sprinkler heads fitted each year.

Even though residential fire sprinkler systems are a life safety system and are not necessarily designed to protect the building, 96% of fires in residential buildings that were completely protected by residential fire sprinkler systems were controlled or extinguished by the fire sprinklers alone.

A glass bulb type sprinkler head will spray water into the room if sufficient heat reaches the bulb and causes it to shatter. Sprinkler heads operate individually.

From the British Standards:

Sprinkler heads should have a thermal sensitivity rating conforming to BS EN 12259-14. Fusible link sprinklers should be colour coded on the frame or sprinkler body. Glass bulb sprinklers should be

colour coded by the bulb liquid and conform to BS EN 12259-14 or BS EN 12259-1. They are defined in these standards as follows:

3.61

Sprinkler, fusible link-

Sprinkler which opens when a component provided for this purpose melts.

3.62

Sprinkler, glass bulb-

Sprinkler which opens when a liquid-filled glass bulb bursts.

FINDINGS

It was determined to look to 'codify' risks to enable teams to coalesce around tackling a problem, run scenarios to simulate what might happen and how collaboration can reduce the risk of them happening.

Clearly, it is not desirable for the 'Accountable Person' to be absolved of responsibility for not anticipating a risk, simply because it was not on this list of suggested risks- which should be considered a 'steer' not an absolute. However, without a list, it becomes impossible to define and deliver the information needed.

Q1. What are the component elements of a Sprinkler system?

a) Pipework
b) Alarm flow switch
c) Water supply – water mains, booster pump or a pump and tank
d) Pipework Materials
e) Pipework Supports
f) Valve types (stop valves, alarm valves and check valves as well as drain valves.)
g) Primary Electric Pumps
h) Secondary Diesel/Electric Pumps
i) Zonal Alarm indicators
j) Zonal Test Pumps
k) Drain down pipework/valves
l) Dry system plant/change over arrangements
m) End of line test points
n) Bells - water flow alarms
o) Sprinkler head
p) Data labels
q) Panels
r) Uninterruptible Power Supplies (UPS)
s) zone valves
t) Padlocks
u) Sprinkler monitoring panel, electric pump control panel, diesel pump control/battery charger
v) Leak Detection Equipment- Alarms

Are there any dependencies on other systems?

a) Generator systems
b) ATS electrical
c) Fire Alarm / interfaces
d) Sump and drain systems
e) Ventilation for diesel pumps (Combustion / Fresh air)
f) Open plan offices where the spacing is an issue
g) Water supply if from the main
h) Dry Systems gas supply
i) Electronic fire detection
j) Electrical supply/secondary supply
k) Managerial controls

l) Boosted domestic water system
m) Telephone system

Q1a. What risks does a Sprinkler system mitigate?

a) Reduces the potential of a flashover
b) Reduces overpressure so that smoke does not spread as readily
c) Fire growth
d) Fire size
e) Heat build-up
f) Structural failure
g) Property loss
h) Loss of life for persons in and amongst the property
i) Loss of fire services attendees' lives
j) Spread between buildings
k) Risk of fire spread as well as that of smoke, CO2 and other pollutants that can be released in a fire
l) Financial loss
m) Environmental impact of fire

NB: Sprinklers control and suppress 96% of residential fires.

Q1b. To what risks are Sprinkler systems susceptible?

a) Being turned off
b) Valves being turned off by residents
c) Cover plates of concealed sprinklers may not release if they are painted over
d) Wrongly placed deflectors
e) Incorrect hydraulic calculations
f) Undersized drainage systems for drain downs, i.e., floods the sprinkler room
g) Undersized power suppliers for Star Delta start
h) Undersized power suppliers for rotor locks
i) Undersized generator supplies for both the above scenarios
j) Diesel pump ventilation system not sized and incorrect
k) Diesel pump flue arrangement failure
l) Battery failure on the diesel pump
m) Product failure
n) Poorly maintained zonal alarm valves, pumps, control panels
o) Poorly maintained fire alarm interfaces
p) Incorrect power supply fuses and ratings
q) Wrong compartmentation of the floor valve riser cupboard within the FFL shaft. Should always be horizontal and vertical. Not vertical only
r) Corrosion of pipework, poor water quality
s) Vandalized
t) Replaced valves that look different and are operated incorrectly
u) Corrosion of dry pipe systems
v) CPVC pipework compatibility with fire stopping products

w) Human error
x) Systems not being commissioned
y) Heads being obstructed
z) Backup power not installed. Power cut-residents light candles increasing fire risk-no cover from sprinklers during high-risk period if no back up power
aa) Water freezing
bb) Interruption of water supply
cc) Damaged during other maintenance work
dd) Improper activation of heads
ee) Room changes leaving sprinkler heads in the wrong position within the space/no head within the space
ff) Inadequate spares
gg) Failure to isolate omission of shut-off valves for each flat

Q2. What information is needed about Sprinkler systems to ensure they perform as required?

It is important to understand how the information will be used and how the context will vary what information is required. Initially, this was the subject of quite a lot of debate – largely driven by a worry about 'information overload'. However, with a truly cross disciplinary team of SMEs, it was possible to drill down to understand the detail of why a role would need certain information.

The aim was to collect all the information all stakeholders need against all products and leave it to each role to configure their software applications to see only the information they need for that individual task.

a) Location (inc xyz)
b) Manufacturer
c) Model number
d) Installer
e) Zone it protects
f) Connection points (Drawings and schematic)
g) Activation alarm strategy (Cause & effect)
h) Response rating of sprinkler heads
i) Category of system
j) Pump power rating
k) Manufacturer's O&M manual and assurance of adherence from your contractor / operative.
l) Design calcs; is it housed (i.e., in boxing); does it have cover plates?
m) Maintenance regime
n) Test results
o) Commissioning certificates
p) Method used for testing
q) Installation date
r) Expected life
s) Planned to be replaced on "Shelf Life" basis- assessment of condition from maintenance or a planned review - or 'run to fail'
t) Call outs breakdowns / remedial works (to determine an appropriate replacement date)
u) Water supply
v) Any modifications
w) Fault finding procedure
x) Fixings (components) to keep in place
y) Mastic Condition (good or bad)
z) Compatibility of Mastic with Pipe
aa) Type of Mastic
bb) Impairment procedure
cc) Are there adequate Spares?
dd) Recommended stock spare parts should be included in the O&Ms
ee) Need for system components to be compliant with the relevant standards, tested and third party certificated or listed

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Q3. What tasks are required to ensure Sprinkler systems are installed, commissioned, inspected, and maintained properly?

It should be a given that any work on fire safety critical assets should always be undertaken by competent people, probably 3rd party accredited. However, that person must be supported with any information that they might need to reduce the risk of an important step being missed and to provide an auditable record of what tasks were completed. This is common practice in M&E maintenance, where the industry has developed a significant library of standard procedures and tasks lists, along with roles/competency required.

An air-conditioning unit is maintained by a qualified air conditioning engineer, but the engineer is also issued with a check list for them to record what was done.

A similar industry-wide check list for installation, commissioning, handover, maintenance, and recycling could be agreed.

a) In a residential building over 18m if the sprinkler system is off or at fault it must be reported to FRS within 24 hours
b) Review system coverage when space changes are made in the building or areas become higher risk
c) https://www.bafsa.org.uk/wp-content/uploads/bsk-pdf-manager/2020/10/BIF16b.pdf
d) Residential: https://www.bafsa.org.uk/wp-content/uploads/bsk-pdf-manager/2017/09/WEB_BIF16A.pdf
e) Industrial and Commercial: https://www.bafsa.org.uk/wp-content/uploads/bsk-pdf-manager/2020/10/BIF16b.pdf

Example of industry-standard maintenance instructions – extract from BESA's SFG20.

Tasks

#	Task	Action
1	System checks - weekly	The following must be checked and recorded (in sprinkler Log Book): 1. all water and air pressure gauge readings on installation, trunk mains and pressure tanks; 2. all water levels in elevated private reservoirs, rivers, canals, lakes, water storage tanks (including pump priming water tanks and pressure tanks); 3. the correct position of all stop valves which control the flow of water to the sprinkler system(s) from the water supply, up to and including the installation control valves stop valves but excluding the water undertaker's stop valve on a town main supply to the system.
2	Water motor alarm test	Each water motor alarm should be sounded for no less than 30 seconds.
3	Automatic pump starting test - electric motor	Test automatic pumps and include the following: 1. water pressure on the starting device should be reduced to simulate the condition of automatic starting; 2. when the pump starts, the starting pressure should be checked and recorded.
4	Automatic pump starting test - diesel	Test automatic pumps and include the following: 1. check the fuel and engine lubricating oil levels in diesel engines; 2. water pressure on the starting device should be reduced to simulate the condition of automatic starting; 3. when the pump starts, the starting pressure should be checked and recorded; 4. the oil pressure on diesel pumps should be checked, as well as the flow of cooling water through open circuit cooling systems; 5. check the correct operation of any automatic ventilation louvres.
5	Diesel engine restarting test	Immediately after the pump start test, diesel engines should be tested as follows: 1. the engine should be run for 20 minutes, or for the time recommended by the supplier. The engine should then be stopped and immediately restarted using the manual start test button; 2. the water level in the primary circuit of closed circuit cooling systems should be checked. Oil pressure (where gauges are fitted), engine temperatures and coolant flow should be monitored throughout the test. Oil hoses should be checked and a general inspection made for leakage of fuel, coolant or exhaust fumes.
6	Trace heating and localised heating systems	Heating systems to prevent freezing in the sprinkler system should be checked for correct function.
7	Fire and rescue service and remote central station alarm connection	The equipment for automatic transmission of alarm signals from a sprinkler installation to a fire and rescue service or remote manned centre shall be checked for: 1. continuity of the connection; and 2. continuity of the connection between the alarm switch and the control unit, if the circuits are continuously monitored. Also refer to TB236 and in particular, clause TB236.1.2 regarding verifying remote central station alarm connections.

Q4. What level of competency/training needs to be in place?

Industry training courses are critical, but they must be complemented by additional knowledge-transfer from people with many years real experience.

Individual manufacturers have product-specific training which complements the more general training. Such training resources need to be provided in all cases where a product is used – both for new build but also as part of the long-term H&S/O&M information, ideally held as machine-readable data in the Asset information model to ensure maintenance teams have easy access to critical information.

Installation

a) Those involved in the design and installation should be able to demonstrate training /qualifications relevant to the systems they design/install and be members of a recognised organisation with accreditation through the likes of UKAS

b) Competency of individual installers demonstrated through certification with a suitable 3rd party accreditation provider. This should include the provision of the manufacturer's fitting instructions

c) Specification of which third party accreditations are acceptable should be required

d) BAFSA - https://www.bafsa.org.uk/certification-compliance-competency/

e) Warrington Certification Ltd, FIRAS scheme for Residential & Domestic sprinkler installations

f) Competency and training of installers (LPS1048/ LPS 1301; FIRAS, SDI 23)

g) The KIWA IFC Certification third party accreditation scheme for installers of residential sprinkler systems

h) BRE LPS 1048 for Sprinkler installers

i) Installer should have manufacturer-led product-specific installation training, in addition to any formal UKAS accreditation

j) Manufacturers should offer installation training, either in their own right, or sub-contracted out to a specialist to provide that service

k) Code of practice should include training materials

Maintenance

a) Manufacturer-specific installation, commissioning, inspection, maintenance/repair, replacement, and recycling requirements should be retained to inform future maintainers of the manufacturers' recommendations

b) Mandatory awareness training should be in place for all people working on site and carrying out maintenance in buildings

c) Training for the operational team should be required on Standards (BS, CEN etc.) plus to give a basic understanding of how to read drawings, commissioning certs and O&M's

d) Competency and training of installers (LPS1048/ LPS 1301; FIRAS, SDI 23)

e) BSI Flex 8670 focuses on the competence of individuals and expects that organisations use this core criteria as part of their management of competency (planning, monitoring, reviewing etc.). This also enables the capture of the skills, knowledge, experience, and behaviours necessary to the undertaking of a defined role, function, activity or task

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Q5. How are the changes from one product to another recorded?

Robust Change Management requires an information baseline against which the different states – current, proposed, final and ongoing change – can be measured and reported.

The baseline information should contain the required performance in a machine-readable/actionable form and the Change Management process should enable that to be compared with:

a) the actual performance of the designed solution (probably generic)
b) the performance of the chosen product against the generic
c) the performance of an alternative (value engineered?) product
d) the record of what was actually used/installed.

Requirements and Suggestions

a) A schedule of safety critical elements for the building, to include products specified

b) This schedule would be "Locked" at a specific design stage, after which changes to products specified should not occur except for exceptional reasons

c) Baseline against which to compare proposed alternative products (Some designers have expressed reluctance to propose (not specify) a specific manufactured product that will satisfy their design due to liability, procurement rules and fees)

d) A formal change management system is required to ensure that any unavoidable changes, such as to the building layout, are validated by a 'responsible' person e.g., original designer and/or fire engineer

e) There is a well-established change management process in construction called Technical Submissions in which requested changes from the specifications/recommendations, that were created by the designers (and selected manufacturers), need to be formally reviewed and approved. Design-and-Build procurement has affected that process and it should be reestablished in a way that the performance of a proposed product, and its constituent components, is easily compared with the proposed alternative and, if agreed, it is recorded as a Technical Deviation

f) Validation of changes would include verifying that the new product met all the requirements for the application with no detriment to the overall design, the details of which should be recorded (Changes in the product may be made between design and procurement, procurement and installation, handover, and ongoing maintenance)

g) More onus needs to be on the client during the collation of Information Requirements and the updating of design models into 'as installed' content suitable for Asset/Facilities Management

h) Full Disclosure of the product is needed at handover so that after Work Stage 7, if a manufacturer goes out of business or products change the record is there in perpetuity

i) Asset database must be kept up to date with core data for new installs. Installation documents should be held in a centralised digital location. Once BIM/COBie level data is manageable within the asset management system then this will be used as the main source of data

j) BIM, CAFM, Asset and Housing management systems must inform the change management process

k) H&S files for each building (cradle to grave) must be supplied, recorded, and be updated with notification of changes and the implications

l) Warranty information of the existing and the proposed products should be provided to allow proper consideration to be made on the selection of an alternative or replacement. If a product has a shorter life than another, this information should be available to inform selection. Given some of the products will be in locations that are difficult to locate, the longevity of a product could have safety implications

m) Compliance systems should be informed with the information from the AIM (Asset Information Model)

n) Asset tagging (barcode) systems and processes should be considered as forming part of the change management process

o) Procurement should be included in the process, recording what was purchased and feeding that into the BIM process to locate where they were installed, or which products they are replacing

p) Specification or design brief for the business (performance and or product) should be recorded in a machine-readable format to enable validation against the Golden Thread

q) Record the compatibility and compliance of any ancillaries and confirm they comply with the test data? (Ironmongery, door access control systems, vision panels, vents)

r) Any adjustment, repair, addition to / removal of product, ironmongery or fittings must be recorded and should only be undertaken by a licensed / accredited contractor (this includes and modification to an existing asset)

s) The asset information needs to enable comparison but the original performance spec of the sprinkler and the related information such as Fire Strategy and Cause and Effect should form part of that Technical Deviation process. The FMs must be able to update the Asset Information Model with machine-readable data of the newly installed product

t) Recording who has worked on/replaced the component and their entitlement/competence to do so (an MEP consultant, for example, is not the designer and will sometimes get the rules confused)

u) Evidence that the component's performance in relation to the part it plays in the system has been considered and is warranted

v) Manufacturers must provide a component list (e.g., ironmongery on a door) so if anything breaks, a direct replacement can be used

w) Removal of certain products/materials must be undertaken by people who are on an approved list, certified by an accreditation body and should require advance notice to all certification holders, with signoff to ensure traceability

(See Appendix 2 for Additional Participant Input)

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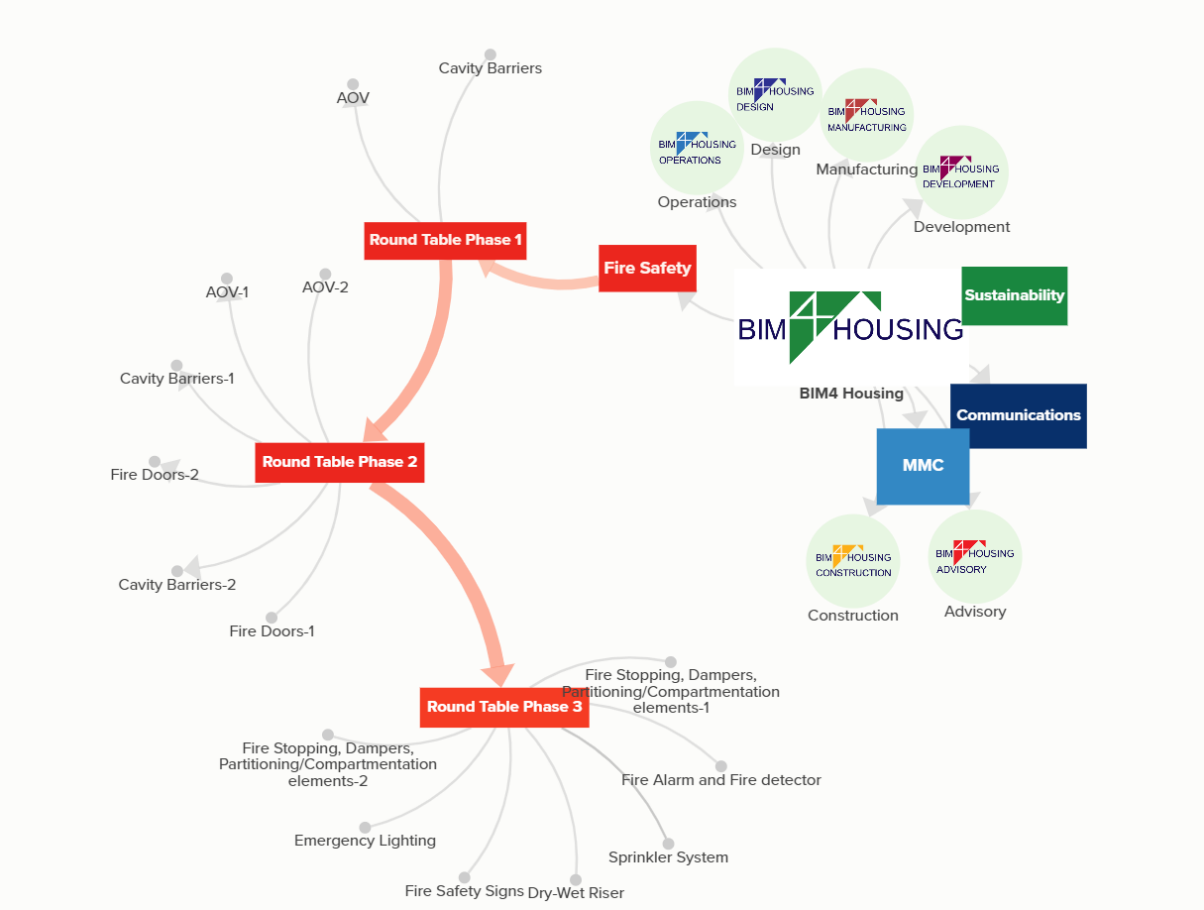
APPENDIX 1

BIM4Housing Structure



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APPENDIX 2

Additional Participant Input Question 5

Notes: from the PCSA

We have found that the MEP Consultant will have drawn an allowance for the Sprinkler System for the system to be tendered to the market. However, this will not sufficiently resolve the design to avoid negatively effecting the architectural or structural design at a very late stage. The information typically does not take in to account the following items:

- The correct sprinkler head space allocations and setting out so RCPs can be fixed.
- Coordination with other services as the allowances are indicative rather than actual.
- The correct riser size allocations for the drain and isolation valves arrangements
- The correct system high/low rise hydraulic design
- The correct water storage requirements
- The correct embedded ground floor slab drainage locations and size.
- The correct incoming water utility size because of the storage
- The correct wet or dry system requirements
- Design approval from Building Control is achieved very late.

These items are not sufficiently developed on the MEP Consultants drawings, as only the sprinkler specialists, generally have the expert knowledge of all the relevant Technical Bulletins issued by Fire Protection Association (FPA) in order to achieve a clean certificate under the Loss Prevention Council Boards, Loss Prevention Scheme 1048 (LPS 1048)

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APPENDIX 3

Participants

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Bex Gibson	Livewest
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David Peacock	TÜV SÜD
David Poat	Notting Hill Genesis
George Stevenson	ActivePlan
Joanna Harris	Sodexo
John Morrow	Origin Housing
John Newman	RSP sprinkler systems
Martin Baines	Camden
Neville Tomblin	Southampton City Council
Paul Bray	Plymouth Community Homes
Paul McSoley	Mace
Paul Oakley	ActivePlan
Paul Wooldridge	Haringey
Pauline Tuitt	L&Q
Pencho Studenkov	Origin Housing
Ranie Goolcharan	Origin Housing
Richard Michael	Camden
Sarah Stevenson-Jones	Swan Housing
Stephen Cleavely	Alliance Homes Group
Stewart Kidd	BAFSA
ThomasRoche	FM Global
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