

THE GRENFELL TOWER INQUIRY

EXHIBIT DPB/14

This is the Exhibit marked “DPB/14”
referred to in the witness statement
of David Paul Bradbury

Ph2 enhancement to make

Mech vent relates to MF Analysis
6-5-14 reviewed late by JSW

+ Rev B 13/5/14



TRUSTED TO PERFORM

J S Wright & Co Ltd
The Atlas Building
16 Portland Street
Aston
Birmingham
B6 5R

Quotation number
PSBUK1343/12/Mech

Handled by
Hugh Mahoney
Tel.nr. [REDACTED]
Fax nr. [REDACTED]
Mobile [REDACTED]

Date: 2nd February 2015

For the attention of: **Mr. David Bradbury**

Re: Grenfell Tower
Lobby Smoke Ventilation System
Phase 2 Change system to Mechanical Extract

Further to your e-mail of 5th January 2015 and please find attached details for the additional work required to convert the natural ventilation scheme (Phase1), to a full mechanical system (phase2).

Our proposal includes for the following:

- Duty standby smoke extract fan set.
- Single environmental supply fan
- Fan starter control panel incorporating inverter drives
- Pressure sensors for each ventilated lobby
- By pass dampers (5 number) in the roof top plant room
- Fire rated ductwork in plant room (budget only subject to site measure)

I have based my offer on the following documents:

Drawing numbers:

- PSB Plant room sketch 1243-2

Specification

- Smoke Ventilation Analysis Rev A dated 6th May 2014 (for smoke extract fan duty)
- Z(--)500 Mechanical Equipment (Rev T5 10.1.14) (for the environmental fan duty)

Quotation



Customer : J S Wright
Date : 2nd February 2015
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Project : Grenfell Tower Phase 2 Mechanical ventilation

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My proposal is based upon the following additional points

- The Plant room area will have all redundant materials removed by others.
- Internal wall openings are to be formed by others
- External wall openings are to be formed and weathered by others
- It is assumed that the Fans and ductwork are to be hung from the roof of the plant room and that the roof structure is structurally sound and can support the weight of these items.
- The fire rated ductwork within the plant room will be for stability and integrity only and not insulation.
- Lifting (crane) of the fans and ductwork to the roof will be the responsibility of others, we have not included for this item within in cost.
- The ductwork element of our offer is based upon a budgetary assessment and is subject to confirmation and or increase following a full site measurement.

The price quoted is fixed for 30 days and is for completion within 6 months of receipt of order. The tender, at this stage, has been prepared in accordance with PSB-UK's standard Terms and Conditions of sale a summary of which is attached and a full copy of which can be viewed on our website at www.psbuk.com

I trust that the above information and our attached proposal will be of interests to you and I look forward to being of further assistance to you on this project.

If you have any questions in connection with the attached proposals, please do not hesitate to contact the undersigned. We hope we will have the opportunity to talk to you soon.

Yours sincerely

A handwritten signature in black ink, appearing to read 'H. Mahoney', written over a light blue rectangular stamp.

Hugh Mahoney
Commercial Manager

Quotation



Customer : J S Wright
Date : 2nd February 2015
Projectnr. : PSBUK/1343/12/Mech
Project : Grenfell Tower Phase 2 Mechanical ventilation

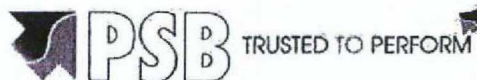
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Pos	Nr	Description	Total price
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Scope: Supply, Delivery, installation and commissioning of the mechanical Smoke ventilation components required to convert the already installed natural ventilation System to a full mechanical smoke extract system.

- A. 1 Delivery of PSB Smoke exhaust twin axial flow fan sets duct mounted horizontally with fans bolted together in series. (one set per smoke extract riser)
Type : 630 (indicative)
Motor power : 4.0kW (indicative)
Motor type : Single speed (frequency inverter)
Electr. Connection : 3x400V/50Hz
Temp. Rating : F300 (certified acc. EN 12101-3)
Tested at 300°C/120min
Accessories :
Flexible connection with duct spigots
Horizontal mounting feet
Vibration dampers
- B. 1 PSB smoke control fan starter panel on the roof and within 3.0m of the smoke extract fan set. Power supply to the panel should be in accordance with BS8519 for primary and secondary power supplies. Power supplies and associated changeover panel and manual by-pass switch to our panel are to be supplied and installed by others. (one per smoke extract riser) This panel will also provide DOL starting for the environmental fan and control of the plant room by pass dampers
- C. 5 Supply and install motorised duct mounted by pas dampers.
- D. 23 Supply and install PSB pressure sensors.
- E. 5 Supply and installation of fire rated ductwork connecting the two smoke extract risers in the plant room and discharging through the duty standby fan arrangement. Also to connect the environmental fan to the main ductwork arrangement.
- F. 1 Supply and Installation of power and control wiring systems to 3 number fans, 5 number dampers and 23 number pressure sensors.(excluding containment system).

Quotation



Customer : J S Wright
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- G. 1 Carriage to site during normal working hours.
- K. 1 Testing, commissioning and setting to work the complete lobby smoke control and environmental systems including a separate day to instruct the client.
- L. 1 Detailed System Design
The engineering design work will consist of the following
- Technical submission
 - Cause & Effect chart
 - Design of control system software (where applicable)
 - Control schematic & cabling selection
 - System Layout Plan Drawings

Total Price

£77173.00 nett

Seventy seven thousand one hundred and seventy three pounds nett.

Quotation



Customer : J S Wright
Date : 2nd February 2015
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Project : Grenfell Tower Phase 2 Mechanical ventilation

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Not Included in scope of supply

- Value Added Tax
- CFD Modelling
- Main contractors discount
- Builders work such as cutting and making good openings roof up stands etc.
- Activities not mentioned in this quotation.
- Activities outside normal working hours.
- General Smoke/Fire detection system.
- Interface wiring between fire alarm system and our controls
- Primary power supplies into our master control panel
- Containment for power and control wiring
- Site costs.
- Crane or any horizontal/vertical transport or lifting equipment.
- Maintenance or service.
- Stand-by facilities.
- Spares.

Quotation



Customer : J S Wright
Date : 2nd February 2015
Projectnr. : PSBUK/1343/12/Mech
Project : Grenfell Tower Phase 2 Mechanical ventilation

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Terms & Conditions

General Terms & Conditions

Final terms and conditions are to be agreed. These proposals are based on standard PSB-UK Ltd Terms and Conditions of sale (available on request, and on our web site).

The sum of 20% of the contract value will be charged on completion of detailed design work as detailed under equipment overview above.

Payment of all approved applications will be due within a maximum period of 28 days, overdue payments will be subject to interest charges equivalent to 5% above the bank rate ruling at the time of invoice.

System warranty will be 12 months from practical completion or 15 months from installation, whichever is the sooner, and from first handover in phased installations.

Validity

This quotation is valid for acceptance up to 30 days from the date of this tender, unless withdrawn in writing and is not transferable to a third party.

This quotation is valid for completion of supply and installation work within 6 months of order placement.

Delivery

Engineering and drawings, including the calculations of the electrical wiring will be available within 4 weeks of your firm order enabling us to proceed.

The supply, installation and commissioning of the equipment and system will be determined in conjunction with yourselves or other interested party to fit, wherever possible, into the build programme.

Drawings

It is a condition of this tender that full details of the building, in so far as that which affects the work undertaken by PSB-UK Ltd, are provided in AutoCAD Electronic format.

No information contained within this tender should be used for construction purposes. PSB-UK Ltd will provide construction issue drawings on receipt of an order. To save time, the detailed design/drawing work can proceed on the receipt of a letter of intent, but the drawings will only be released once an official order is received.

Validation of the System

Cold smoke generation will be used at the time of commissioning to prove the air and smoke paths within the car park.

Property Rights

The contents of this tender are exclusive to and remain the property of PSB-UK Ltd and must not be copied or divulged to any other party without the express permission of PSB-UK Ltd.

Tender Proposals

Please note that information contained in these proposals, such as fan and sensor quantities, are subject to confirmation at detail design stage and cannot be used for construction purposes.

Electrical Power Supply

It is assumed that a 110V electrical power supply will be provided free of charge for installation and commissioning work. It is also assumed that an essential power supply of adequate capacity will be provided to the PSB control panel.

Working Hours

The tender is based on two attendances on site for installation. Only normal working hours are allowed for in this tender, these hours being Monday to Friday, 8.00am to 4.30pm. Working outside these hours can be arranged at extra cost if required.

Removal of Rubbish

Allowance is made for ensuring that all rubbish created by PSB will be deposited into skips. However, it is assumed that suitable skips and removal of the rubbish will be provided free of charge.

Containment & Cabling Clarification

Please note that the cabling included within these proposals specifically excludes containment unless stated otherwise. Where containment is included, or is provided by others, it is based upon all fan cables being laid within cable trays. Should cables trays be inverted additional costs will be incurred due to the additional labour required, and we reserve the right to adjust our price accordingly.

Similarly our quotation includes for the running of cables via the most practical and shortest routes. Should the installed cable trays take diverse routes to the locations of the respective equipment then additional costs will be incurred due to the additional parts and labour required, and we reserve the right to adjust our price accordingly. Please note that we do NOT include for "clipping" cables directly to the soffit or walls.

Ph1 Upgrade of Dampers
& Control Panel.



TRUSTED TO PERFORM

J S Wright & Co Ltd
The Atlas Building
16 Portland Street
Aston
Birmingham
B6 5R

Quotation number
PSBUK1243/12

Handled by
Hugh Mahoney
Tel.nr. [REDACTED]
Fax nr. [REDACTED]
Mobile [REDACTED]

Date: 5th November 2014

For the attention of: **Mr. David Bradbury**

Re: **Grenfell Tower
Lobby Smoke Ventilation System**

Further to our meeting of the 3rd instant, and subsequent e-mail containing the revised information, please find attached my proposals for the temporary natural ventilation scheme, in line with our discussions.

Our proposal assumes:

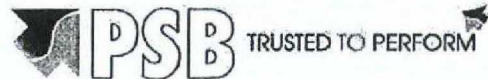
- All original dampers will be removed by others and that the original grilles will be retained and re-used.
- The existing wall openings are in good order and no allowance has been made for making good or re-decorating.
- Due to the grille and in duct face velocities it will be necessary to utilise all four of the existing damper openings in each of the ventilated lobbies.
- The large pressure drop across the grilles will be taken into consideration when selecting the fans for phase 2.
- The existing builderswork shafts are in good order and are of an airtight construction.
- Our offer is for the lobby smoke control system serving the stair core lobbies, as indicated above. All other smoke control measures are excluded from this offer.

As previously discussed, due to current work commitments, PSB Ltd will be unable to carry out these site activities prior to Christmas 2014 but we are prepared to assist you with technical advice to enable you to gain the necessary Building Control Approval for the system and associated products, which will enable you to undertake the work within this time scale.

PSBUK Limited Registered Office: WITT House, Brookwoods Industrial Estate, Burrwood Way, Holywell Green, Halifax HX4 9BH ENGLAND
Company Registration Number: 400 66 40

JSW000001929/8
JSW0000

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Customer : JS Wright
Date : 5th November 2014
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Project : Grenfell Tower Phase 1 Natural ventilation

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We are also able to offer the products within the time constraints subject to an order being placed within the next few days.

Due to the restrictive nature of the existing openings the only manufacturer who can provide the size of dampers with the maximum available free area is Gilberts of Blackpool using their 54 series damper.

I have spoken to the proposed damper manufacturer and assuming an order is place within the next few days they will be able to provide two deliveries of forty dampers during December 2014 w/c 08/12/2014 and w/c 15/12/2014.

I have based my offer on the following documents:

Drawing numbers:

9497/M/200 rev A, 9497/M/201 rev A, 9497/M/2002rev A, 9497/M/202 rev A, 9497/M/204 rev A, 9497/M/205 rev A, 9497/M/106 rev A

Specification

No specification issued at this stage

My proposal is based upon the following additional points

- This proposal is for the temporary measured required to provide a natural smoke ventilation system (Phase1) and does not include for a fully developed mechanical smoke extraction system. The system serves the lobbies on floor levels Walkway +1 up to level 20 (21 level in total)
The current ventilation shafts are to be utilised to form a natural smoke extract shaft with dual inlet at each storey level and a natural inlet shaft with dual inlet vents at each storey level.
- The system must be developed so that it can be converted to a combined mechanical smoke extraction system and mechanical environmental extraction system at a future date (phase 2)
- A PLC control system complete with battery backup is to be installed as part of phase1 and is to be compatible with the phase 2 i.e. will form part of the mechanical system.-
- An individual smoke control module is to be installed in the service riser located within the lobby at each ventilated level. The control module will have the facility to accept the pressure and temperature sensors which are to be installed as part of phase 2
- Each floor module will have a data and power cable daisy chain connected back to the master panel and battery backup unit.
- A Smoke detector is to be allowed for each lobby to activate the system should smoke enter the lobby. This detector will be hard wired back to the storey level control module (one per ventilated lobby) and only the smoke affected lobby will operate and all other lobby ventilators are to remain closed in order to maintain fire compartmentation.
- An override panel is to be located next to the fire alarm panel on the ground floor and is to incorporate a HMI screen.
- Each lobby will be provided with an individual fire override switch (auto/on) which will be mounted in the stairwell local to the stairwell/lobby door. This switch will be hard wired back to the control module.

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Customer : J S Wright
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Project : Grenfell Tower Phase 1 Natural ventilation

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- Each of the ventilated lobbies will have four number new motorised dampers fitted and this will be hard wired back to the floor control module for power.
- The wall openings are all of the same size, enabling a manufacturing production run of a single sized damper.
- The original press steel grilles are to be retained and re-used.
- All electrical and control wiring will be surface clipped and no allowance has been made for containment.
- The ductwork section required to connect the existing fresh air duct to an external will is to be provided by others.
- The existing fans are to be removed and replaced with a new section for ductwork. This activity and the ductwork is to be carried out by others.

I have provided two separate prices as follows:

1. Supply, install and commission
2. Supply and commission.

The price quoted is fixed for 30 days and is for completion within 6 months of receipt of order. The tender, at this stage, has been prepared in accordance with PSB-UK's standard Terms and Conditions of sale a summary of which is attached and a full copy of which can be viewed on our website at www.psbuk.com

I trust that the above information and our attached proposal will be of interests to you and I look forward to being of further assistance to you on this project.

If you have any questions in connection with the attached proposals, please do not hesitate to contact the undersigned. We hope we will have the opportunity to talk to you soon.

Yours sincerely

Hugh Mahoney
Commercial Manager

Quotation



Customer : J S Wright
Date : 5th November 2014
Projectnr. : PSBUK/1243/12
Project : Grenfell Tower Phase 1 Natural ventilation

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Pos	Nr	Description	Total price
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Price 1 Supply, Delivery, installation and Commissioning Of the Natural Smoke ventilation System Serving The lobbies

- | | | |
|----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A. | 1 | Supply and installation of PSB Master Smoke Control system panel located in the service riser within the lobby on the Walkway level. This panel is to be a 230vAC in and 24vDC output panel and to be complete with a battery backup pack. |
| B. | 1 | Supply and install PSB aluminium smoke vertically mounted louvred smoke ventilator with a measured free area of 1.0m ² . (inlet shaft) |
| C. | 1 | PSB Mimic override panel in ground floor complete with HMI Screen and mounted in separate protective steel enclosure. |
| D. | 21 | Supply and install PSB two zone interface modules, mounted on every floor level (these are connected to local override switches, smoke detector, and provide power to the motorised damper/AOV ventilators/stairwell ventilators etc.). Power and control cabling will be by PSB from master smoke control panel. The control modules will be located in local the electrical service riser within the ventilated lobbies. |
| E. | 3 | Supply and install PSB booster battery packs local to control module on every fifth floor |
| F. | 21 | Supply and install PSB Fire override switches |
| G. | 21 | Supply and install PSB smoke detectors |
| H. | 80 | Supply and install PSB AOV wall mounted damper ventilators fitted into existing openings and re-install existing grilles |
| I. | 1 | Supply and Installation of power and control wiring systems (excluding containment system) between the master control panel and the components of PSB supply, all other wiring by others. |
| J. | 1 | Carriage to site during normal working hours. |
| K. | 1 | Testing, commissioning and setting to work the complete corridor smoke control systems including a separate day to instruct the client. |

Quotation



Customer : J S Wright
Date : 5th November 2014
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Project : Grenfell Tower Phase 1 Natural ventilation

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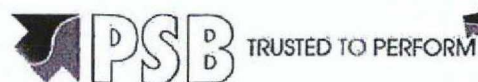
- L. 1 Detailed System Design
The engineering design work will consist of the following
- Technical submission
 - Cause & Effect chart
 - Design of control system software (where applicable)
 - Control schematic & cabling selection
 - System Layout Plan Drawings

Total Price

£115578.00 nett

One hundred and fifteen thousand five hundred and seventy eight pounds
nett.

Quotation



Customer : J S Wright
Date : 5th November 2014
Projectnr. : PSBUK/1243/12
Project : Grenfell Tower Phase 1 Natural ventilation

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Pos	Nr	Description	Total price
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Price 2 Supply, Delivery, and Commissioning of the Natural Smoke ventilation System Serving The lobbies (installation by others)

N.	1	Supply and deliver of PSB Master Smoke Control system panel located in the service riser within the lobby on the Walkway level. This panel is to be a 230vAC in and 24vDC output panel and to be complete with a battery backup pack.	
O.	1	Supply and deliver PSB aluminium smoke vertically mounted louvred smoke ventilator with a measured free area of 1.0m ² . (inlet shaft)	
P.	1	PSB Mimic override panel in ground floor complete with HMI Screen and mounted in separate protective steel enclosure.	
Q.	21	Supply and deliver PSB two zone interface modules, mounted on every floor level (these are connected to local override switches, smoke detector, and provide power to the motorised damper/AOV ventilators/stairwell ventilators etc.). Power and control cabling will be by PSB from master smoke control panel. The control modules will be located in local the electrical service riser within the ventilated lobbies.	
R.	3	Supply and deliver PSB booster battery packs local to control module on every fifth floor	
S.	21	Supply and deliver PSB Fire override switches	
T.	21	Supply and deliver PSB smoke detectors	
U.	80	Supply and deliver PSB AOV wall mounted damper ventilators	
V.	1	Carriage to site during normal working hours off loading and distribution by others.	
W.	1	Testing, commissioning and setting to work the complete corridor smoke control systems including a separate day to instruct the client.	

Quotation



Customer : J S Wright
Date : 5th November 2014
Projectnr. : PSBUK/1243/12
Project : Grenfell Tower Phase 1 Natural ventilation

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- X. 1 Detailed System Design
The engineering design work will consist of the following
- Technical submission
 - Cause & Effect chart
 - Design of control system software (where applicable)
 - Control schematic & cabling selection

Total Price

£61372.00 nett

Sixty one thousand three hundred and seventy two pounds nett.

Not included in scope of supply

PSBUK Limited Registered Office: WITT House, Brookwoods Industrial Estate, Burrwood Way, Holywell Green, Halifax HX4 9BH ENGLAND⁷
Company Registration Number: 400 66 40

JSW00001929/14

Quotation



Customer : J S Wright
Date : 5th November 2014
Projectnr. : PSBUK/1243/12
Project : Grenfell Tower Phase 1 Natural ventilation

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- Value Added Tax
 - CFD Modelling
 - Main contractors discount
 - Builders work such as cutting and making good openings roof up stands etc.
 - Activities not mentioned in this quotation.
 - Activities outside normal working hours.
 - General Smoke/Fire detection system.
 - AOV ventilation system shown on schematic drawings serving lower levels
 - Interface wiring between fire alarm system and our controls
 - Primary power supplies into our master control panel
 - Containment for power and control wiring
 - Site costs.
 - Crane or any horizontal/vertical transport or lifting equipment.
 - Maintenance or service.
 - Stand-by facilities.
 - Spares.

Quotation



Customer : J S Wright
Date : 5th November 2014
Projectnr. : PSBUK/1243/12
Project : Grenfell Tower Phase 1 Natural ventilation

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Terms & Conditions

General Terms & Conditions

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The sum of 20% of the contract value will be charged on completion of detailed design work as detailed under equipment overview above.

Payment of all approved applications will be due within a maximum period of 28 days, overdue payments will be subject to interest charges equivalent to 5% above the bank rate ruling at the time of invoice.

System warranty will be 12 months from practical completion or 15 months from installation, whichever is the sooner, and from first handover in phased installations.

Validity

This quotation is valid for acceptance up to 30 days from the date of this tender, unless withdrawn in writing and is not transferable to a third party.

This quotation is valid for completion of supply and installation work within 6 months of order placement.

Delivery

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Tender Proposals

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Working Hours

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Removal of Rubbish

Allowance is made for ensuring that all rubbish created by PSB will be deposited into skips. However, it is assumed that suitable skips and removal of the rubbish will be provided free of charge.

Containment & Cabling Clarification

Please note that the cabling included within these proposals specifically excludes containment unless stated otherwise. Where containment is included, or is provided by others, it is based upon all fan cables being laid within cable trays. Should cables trays be inverted additional costs will be incurred due to the additional labour required, and we reserve the right to adjust our price accordingly.

Similarly our quotation includes for the running of cables via the most practical and shortest routes. Should the installed cable trays take diverse routes to the locations of the respective equipment then additional costs will be incurred due to the additional parts and labour required, and we reserve the right to adjust our price accordingly. Please note that we do NOT include for "clipping" cables directly to the soffit or walls.

Summary of PSB costs
Ph1 & 2 together.

David Bradbury

From: Hugh Mahoney <hm@psbuk.com>
Sent: 02 February 2015 10:16
To: David Bradbury
Subject: RE: Grenfell Tower
Attachments: 1243-12 Grenfel Tower Mechanical Phase 2 Quote.pdf

Hi David,

Please find attached my quotation for the phase 2 Mechanical at the above project.
The price information you requested is detailed below against your original e-mail.

Should you require any additional information please do not hesitate to contact me.

Sorry it has taken so long to finalise all elements, I have only just received the fire rated ductwork price.

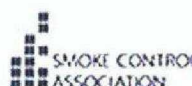
The current delivery for the ductwork element is as follows:

- | | |
|--------------------------------------------------------------------------------------|-----------------|
| • Production of working drawings from approval/acceptance of an order | 2 working weeks |
| • 1 st delivery of material from final approval of manufacturing drawings | 3 working weeks |
| • Minimum notice to commence work on site | 3 working weeks |

Could you also note our change of address and new contact number

Best regards
Hugh Mahoney
Commercial Manager- **PSB UK Ltd**

Witt UK Group
Witt House
Shelf Mills
Wade House Road
Shelf
Halifax
HX3 7BJ
Tel: [REDACTED]
Mobile: + [REDACTED]
Email: hm@psbuk.com
Website: www.wittukgroup.co.uk



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Please consider the environment before printing this email

PSB UK Ltd is a division of the **Witt UK Group**, which includes the following companies:

Fan Systems Group Limited
PSB UK Limited
Alldays Peacock
WITT&SON UK Limited

From: David Bradbury [mailto:DavidBradbury@jswright.co.uk]
Sent: 05 January 2015 11:43
To: Hugh Mahoney
Cc: Alan Whyte; Terence McLaughlin
Subject: RE: Grenfell Tower

Morning Hugh,

Hope you had a great Christmas break and new year.

Following a meeting with the client just before we broke up and to push things forward we are looking to collaborate the following information into the following breakdowns.

1. Cost for phase 1 and 2, supply, install and commissioning by PSB.
Phase 1 : £115578.00 Phase 2: £77173.00
2. Cost for all work to be done as one complete phase, supply, install and commissioning by PSB
Combined Price £178404.00
3. Cost for controls and commissioning by PSB, supply of equipment, wiring and installation by JSW (extent of work can be discussed, as to what's best suited in whose package)
£47270.00
4. Ground / Mess stand-alone AOV to be cost separately.
£11395.00

I've listed the above in priority order.

Also we have just received a call from the client asking regarding lead times etc, so would you be able to provide us with a timescale for each option, time from receiving an order from us to being on site and an installation time.

Any questions please do not hesitate to contact me.

Kind regards,

Dave Bradbury
Design Manager

Tel: [REDACTED] | Fax: [REDACTED] | Mob: [REDACTED] | Email: davidbradbury@jswright.co.uk | Web: www.jswright.co.uk

From: Hugh Mahoney [mailto:hm@psbuk.com]
Sent: 02 December 2014 11:19
To: David Bradbury
Cc: Lydia Noble
Subject: Grenfell Tower

Hi David,

Sorry for the delay.

Please find attached the technical submission and product data sheets.

I have incorporated phase 1 and phase 2 into the submission. The reason for still keeping them separate is that the controls philosophy will be different for each phase and I thought we should cover how they will be installed separately and then coming together to form the final complete and integrated control system.

Best regards

Hugh Mahoney

Commercial Manager- **PSB UK Ltd**

PSB UK Ltd.
Witt House,
Brookwoods Industrial Estate,
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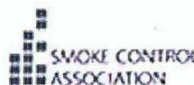
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Phil Leech

From: David Bradbury
Sent: 24 June 2015 16:39
To: Terence McLaughlin
Subject: FW: Grenfell Tower - AOV
Attachments: Z[--]500 Mechanical Equipment (Rev T5 10.1.14).pdf; 20140506 - Grenfell Tower - Smoke Extract Analysis.pdf; Grenfell Tower Tech Sub Lobby Smoke Control Systems Rev 1.pdf

*Forward of
Email of
5/2/15*

Kind regards,

Dave Bradbury
Design Manager
Head Office

Tel: [REDACTED] | Fax: [REDACTED] | Mob: [REDACTED] | Email: davidbradbury@jswright.co.uk | Web: www.jswright.co.uk

From: David Bradbury
Sent: 05 February 2015 17:27
To: Zak Maynard
Cc: Terence McLaughlin; Alan Whyte; Simon Lawrence
Subject: Grenfell Tower - AOV

Hi Zak, Further to your conversation this morning with Terence, I've detailed the AOV additional costs below and attached some additional information to help, but any problems please do not hesitate to give me a call.

Breakdown of AOV costs:

JSW Original costs (based on 0.42m³/s): **£80,984.58**

Client Change (Additional Floors): **£13,104.25**

- **Scope: Supply, Delivery, installation and commissioning of the smoke control components serving the lower three floors.**

- A. 3 Supply and installation only PSB single zone interface modules, mounted on every floor level (these are connected to local override switches, smoke detector, and provide power to the motorised damper/AOV ventilators/stairwell ventilators etc.). Power and control cabling will be by PSB from master smoke control panel. The control modules will be located in local the electrical service riser within the ventilated lobbies.
- B. 1 Supply and delivery only PSB booster battery packs local to control module on every fifth floor
- C. 3 Supply and delivery only PSB key operated Fire override switches
- D. 3 Supply and delivery only PSB smoke detectors
- E. 3 Supply and delivery only PSB room thermostats
- F. 6 Supply and install PSB 600mm wide x 1200mm high AOV wall mounted damper/grille assemblies. Ventilators fitted into new wall openings.
- F. 1 Carriage to site during normal working hours.
- G. 1 Installation of fire rated cable connecting all components to the control module.
- H. 1 commissioning on completion.

Required design change for Building Control approval (based on 5m³/s): **£112,032.33**

I've attached the consultant's report detailing the reasons for the increased performance, which has changed the controls, fire rated ductwork in plantroom, increased 'smoke' vent fans (original equipment schedule has been attached for information) and the overall design philosophy has changed and therefore we have attached the specialists technical submission which has been discussed with the consultant, Rydons and the building control officers in a meeting held at Grenfell Tower on the 24th November 2014. The re-design was verbally accepted by building control at this meeting and the technical submission was formally submitted for their written approval (written confirmation still outstanding).

Total VO: £125,136.58

Kind regards,

Dave Bradbury
Design Manager
Head Office

Tel: [REDACTED] | Fax: [REDACTED] | Mob: [REDACTED] | Email: davidbradbury@jswright.co.uk | Web: www.jswright.co.uk

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Grenfell Tower Refurbishment

Architect: **Studio E Architects**

Issue Status: Stage E Tender

PLEASE NOTE: ALL EQUIPMENT IS TO BE EQUAL OR APPROVED. NO ITEMS ARE UNIQUELY SPECIFIED.

REF	DESCRIPTION/TYPE	LOCATION	MANUFACTURER & REF	DUTY	NOTES / ACCESSORIES
LANDLORD'S MAIN MECHANICAL EQUIPMENT					
B1, 2 & 3	Gas-fired condensing heating boiler, central (landlord's) heating installation. Space & hot water heating boiler. Stainless steel heating exchanger.	Basement plantroom	Viessmann Vitocrossal 300 CT3B	Maximum output 225kW	See the Max Fordham T[90]12_000 plant room layout. Low NOx (<39ppm) See specification for flue requirements.
HPU1	Heating system pressurisation unit	Basement plantroom	Aquatech Pressmain Aquapack AP 3 Type	Cold fill pressure 1.3 bar g	Complete with 100 litre expansion vessel
HPU2	Heating system pressurisation unit	Basement plantroom	Aquatech Pressmain Aquapack AP 9 (Custom) Type	Cold fill pressure 7.3 bar g Working pressure 11.2 bar	Complete with 850 litre capacity expansion vessel(s)
P1	Main heating pump	Basement plantroom	Grundfos MAGNA/UPE	10 l/s @ ##	Twin pumps, run and standby. To include automatic switchover control arrangements. Variable speed pumps with variable speed control. With differential pressure control (proportional and constant pressure control) located at most remote HIU. Complete with integrated frequency converter, self-venting pump housing and stainless steel pump housing. Separate pumps – not twin-head.
P2	Boiler shunt pump	Basement plantroom	Grundfos MAGNA/UPS	To suit boilers	
P3	Buffer vessel shunt pump	Basement plantroom	Grundfos MAGNA/UPS		Variable speed
BV1	Heating buffer vessel	Basement plantroom	Ormandy Rycroft	3500 litre	Tap-offs as required by schematic Insulated Jacket Vertical cylinder – floor mounted
PHE1	Plate heat exchanger	Basement plantroom	Ormandy Rycroft HT-Breeze CP B-300	627kW	
DP1	Dosing pot	Basement plantroom	Arrow Valves DP5	5 litre	
DP2	Dosing pot	Basement plantroom	Arrow Valves DP15	15 litre	
DS1	Dirt & air separator	Basement plantroom	SpiroTech SpiroCombi BC/BD080		
DS2	Dirt & air separator	Basement plantroom	SpiroTech SpiroCombi BC/BD100		
CWBS	Cold water pressure booster set	Rooftop plantroom	Aquatech Pressmain Series AMV2 15-5	2.5/s @ 200KPa	Pressure booster set required to ensure adequate water pressure across the HIUs on upper three residential floors. Peak diversified water flow rate (based on non low-flow fittings): 2.5 l/s.
HIU1	Indirect twin heat exchanger heat interface unit for space	Heat interface unit cupboards	SAV Flatstation 7-D5-59-12	59 kW	For general layout and arrangement of heat interface units, see Max

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4614: Grenfell Tower Refurbishment
26 November 2013 / M5 / page 3 of 4
J1--500 Mechanical Equipment

Grenfell Tower Refurbishment

Architect: **Studio E Architects**

Issue Status: Stage E Tender

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REF	DESCRIPTION/TYPE	LOCATION	MANUFACTURER & REF	DUTY	NOTES / ACCESSORIES
	heating and domestic hot water generation.			Flow and return temperatures to be 70/40oC unless agreed otherwise by EA.	Fordham drawing T[-]01_251 Heat interface unit including cabinet and heat meter. Provide trickle by-pass.
HIU2	Indirect single heat exchanger heat interface unit for space heating.	Boxing club	SAV Flatstation 3-85-15-B	18 kW Flow and return temperatures to be 70/40oC unless agreed otherwise by EA.	For general layout and arrangement of heat interface units, see Max Fordham drawing T[-]01_251 Heat interface unit including cabinet and heat meter. Provide trickle by-pass.
HIU3	Indirect single heat exchanger heat interface unit for domestic hot water generation.	Boxing club	SAV Flatstation 5-85-90-20	85 kW Flow and return temperatures to be 70/40oC unless agreed otherwise by EA.	For general layout and arrangement of heat interface units, see Max Fordham drawing T[-]01_251 Heat interface unit including cabinet and heat meter. Provide trickle by-pass.
T1	Programmable room thermostat	All dwellings Nursery Boxing Club	Danfoss TP5000RF Si		Programmable thermostat, wireless model
T2	Wireless room thermostat	Offices	Honeywell Y6630D		Battery powered wireless room thermostat and mains powered receiver box.
LANDLORD'S MECHANICAL VENTILATION EQUIPMENT					
F1	Smoke extract fans	Roof top plant room	Flaktwoods / JM Aerofoil: 35JM/16/2/5/18	0.42 m3/s @ 70 Pa	High temperature rated run & standby fans for smoke extraction from lift lobbies.
F2	Smoke extract supply fans	Boxing club lobby ceiling void (Walkway level)	Flaktwoods / JM Aerofoil: 31JM/16/2/5/20	0.42 m3/s @ 184 Pa	Run & standby fans for smoke extraction make up air to lift lobbies.
F3	General ventilation extract fan	Roof top plant room	Flaktwoods / JM Aerofoil: 56JM/20/2/3/18	3.6 m3/s @ 200 Pa	Invertor controlled, linked to temperature sensors in lift lobbies.
F4	General ventilation supply fans	Boxing club lobby ceiling void (Walkway level)	Flaktwoods / JM Aerofoil: 56JM/20/2/3/18	3.6 m3/s @ 320 Pa	Invertor controlled, linked to temperature sensors in lift lobbies, attenuation by AT1.
D1	Smoke dampers	Lift lobbies from Walkway +1	Actionair / Smoke Shaft Ventilation System Series SSV		Automatic Smoke Release Dampers with 75mm x 0.5mm thick stainless steel aerodynamic interlocking blades incorporating synthetic seal, with steel blade end bearings and peripheral gasketing. Housed in a galvanised steel fully welded casing with either a flanged or flangeless sleeve for Grille connection. The control mode/damper connection shall be by means of the snaplock drive interface mechanism, which is reverse mounted so as not to obstruct installation into the builders opening. 3-position motor. As Actionair Series SSV.

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G1-500 Mechanical Equipment

JSW00001929/24

Grenfell Tower Refurbishment

Architect: Studio E Architects

Issue Status: Stage E Tender

REF	DESCRIPTION/TYPE	LOCATION	MANUFACTURER & REF	DUTY	NOTES / ACCESSORIES
F5	Basement supply fans	Basement plant room	JM Aerofoil: 100JM/25/4/5/18	11.2 m ³ /s @ 84 Pa	Run & standby in series, interlocked to boilers, ducted to low level from soffit within blanking section to existing duct. Attenuation by AT2.
F6	Basement extract fans	Basement plant room	JM Aerofoil: 63JM/20/6/6/26	3 m ³ /s @ 8Pa	Run & standby in series, interlocked to boilers, fitted to soffit within blanking section to existing duct.
AT1	Attenuator	Boxing club lobby ceiling void (Walkway level)	Trox CB100 1500mm long		1x in-line attenuator either side of fan (2x in total).
AT2	Attenuator	Basement plant room	Trox CB100 1500mm long		1x in-line attenuator either side of fan (2x in total).
RADIATOR SCHEDULE					
R1	Double panel, 1000 x 600 mm	Residential floors 1-20	Stelrad Elite P+	726 W	Sized on 60/35 °C
R2	Single panel, 500 x 300 mm	Ground floor	Stelrad Elite K1	133W	Sized on 60/35 °C
R3	Double panel, 700 x 600 mm	Residential mezzanine floor	Stelrad Elite P+	508 W	Sized on 60/35 °C
R4	Single panel, 1500 x 300 mm	Residential mezzanine floor	Stelrad Elite K1	400 W	Sized on 60/35 °C
R5	Double panel, 800 x 600 mm	Residential mezzanine floor	Stelrad Elite P+	580 W	Sized on 60/35 °C
R6	Single panel, 1400 x 450 mm	Residential Walkway +1 floor	Stelrad Elite K1	554 W	Sized on 60/35 °C
R7	Single panel, 1200 x 450 mm	Residential Walkway +1 floor	Stelrad Elite K1	475 W	Sized on 60/35 °C
R8	Double panel, 1200 x 650 mm	Ground floor	Myson LST Super Plus	594 W	Sized on 60/35 °C
R9	Double panel, 1800 x 600 mm	Walkway	Stelrad Elite P+	1306 W	Sized on 60/35 °C
R10	Single panel, 900 x 450 mm	Ground floor	Stelrad Elite K1	356 W	Sized on 60/35 °C
R11	Double panel, 2000 x 450 mm	Residential floors 1-20	Stelrad Elite K2	1451 W	Sized on 60/35 °C. To be costed for alternative arrangement in the living room of 2-bed flats in the existing residential areas.
UNDERFLOOR HEATING					
UF1	Underfloor heating manifold, available with up to 6 ports. Maximum manifold flow 0.54l/s.	Main Lobby and Boxing Club Lobby	SAV Systems/ SAV FloCon – 501 – UFH Heating Manifold	Total Heat Load 5.2 kW	The specified manifold comes with a circulating pump.
FLAT MAIN MECHANICAL EQUIPMENT					
KEF1	Kitchen extract fan	Existing flats	Nuaire Cyfan, Xpelair or similar	60 l/s intermittent Part F compliant	Through the wall domestic kitchen extract fan to connect to louvre in curtain wall and with internal grille.
FEF	Flat mechanical extract unit.	New flats, Nursery & Boxing Club.	Nuaire EP-OPUSDC Extract Fan		Fitted in ceiling void or at high level within kitchen cupboard. Connected to flat plastic ductwork run in the ceiling void or bulkhead as indicated on the Max Fordham T[90]12" series typical mechanical layouts. Provide backdraught damper.
MISC. MECHANICAL EQUIPMENT					
SSF 1	Slipstream Filter	Boiler Room			Contractor to propose model and manufacturer to satisfy filtration requirements of HIU manufacturer, boiler manufacturer and all other elements of the new heating system.
HD	Hand dryer	Boxing Club, Nursery, Office WCs	Xlerator XL-BW	500 W	Hand dryers located in WCs according to T[90] layouts.

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Grenfell Tower Refurbishment

Architect: Studio E Architects

Issue Status: Stage E Tender

Notes

1. This schedule reflects the design generally in accordance with Stage E for Design & Build, and as such represents design development at this stage and does not contain all the information required to form a fully working installation without further design development.
2. All sizes and duties stated are approximate and are for tender purposes only. The contractor shall make final selections of plant based on their fully developed design. Any alternative equipment proposed by the contractor must be approved by the Employer's Agent.
3. Contractor to ensure that the catalogue number is consistent with the description prior to order.
4. All variable speed fans to be inverter controlled. Manufacturer to provide individual inverters for each and shall be from same manufacturer.
5. All equipment to be selected to ensure that the total harmonic distortion is less than 15%.
6. To be read in conjunction with MFLP specifications and all relevant drawings.

Rev	Date	Status	Description	Engineer	Project Leader
T5	10.01.14	Stage E Tender Issue	Addition of PHE & Associated Components	MJS	DC
T4	29.11.13	Stage E Tender Issue	Design & Build Tender	MJS	DC
T3	26.11.13	Stage E Tender Issue	Design & Build Tender	MJS	DC
T2	19.11.13	Stage E Tender Issue	Design & Build Tender	MJS	DC
T1	01.11.13	Stage E Tender Issue	Design & Build Tender	MJS	DC

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21-000 Mechanical Equipment

JSW00001929/26

Grenfell Tower
Smoke Ventilation Analysis

Rev A

6th May 2014

Matt Smith

MAX FORDHAM

GRENfell TOWER – SMOKE VENTILATION ANALYSIS

1 Summary

This report has been prepared in order to compare the design performance of the existing smoke extract ventilation system in Grenfell Tower with the design performance of the new system proposed as part of the refurbishment works.

It has been found that the proposed upgrade to the system should result in a considerable performance increase:

Existing System 1.1 – 1.2 m³/s

Proposed System 5.0 m³/s

Note: Please note that this report should be read in conjunction with attached Max Fordham drawing U[14]01_200 (rev T2) 'Core Services Smoke Ventilation Schematic'.

2 Existing System

The existing smoke extract system in Grenfell Tower consists of the following elements:

- 2x natural ventilation supply shafts of 0.24 m² area each, with 2x low level smoke dampers of 0.18 m² area each. These serve floors 1-20 (residential floors only). Inlet at Walkway +1 level.
- 2x natural ventilation extract shafts of 0.24 m² area each, with 2x high level smoke dampers of 0.18 m² area each. These serve floors 1-20 (residential floors only). Outlet at roof level.
- Manual fireman's override switch located in dry riser inlet cupboard on ground floor allowing control of mechanical supply and extract run and standby fans. Supply fans located at Walkway +1 level, extract fans located in roof top plant room.

The existing system operates in the following manner on detection of smoke within a communal lobby:

- Actuators open supply and extract dampers on fire floor upon receiving signal from smoke detector outstation. All dampers on other floors remain in closed position.
- Smoke is cleared by the stack effect in the extract shaft caused by the pressure differential arising from the temperature difference between the hot smoke and cooler external air temperature.
- Make-up air is drawn through the low level supply shaft.
- The supply and extract fans do not operate unless the manual override switch is operated by the fire brigade upon their arrival. This switch opens smoke dampers local to both fan sets and activates the fans to enable mechanical ventilation to aid smoke removal. This switch is located on the ground floor adjacent to the dry riser inlet breaching valve and controls the fans only.

The existing shaft dimensions are considerably less than those demanded for a natural smoke extract system in a new building by Approved Document B:

	Existing System	Approved Document B
Vent between lobby and shaft free area (m ²)	0.36	1.00
Shaft free area (m ²)	0.48	1.50

Table 1 - Comparison of Existing Free Area with Approved Document B

3 Proposed System

The proposed new smoke extract system will provide automated mechanical smoke ventilation in the event of a fire, as well as providing general ventilation to the communal lobbies in day to day use.

The system is constrained by the existing shaft dimensions. For this reason an automated mechanical system has been chosen in order to protect the escape route through the lobby to a higher standard than currently provided by the natural ventilation based system.

The proposed system will consist of the following elements:

- Retention of existing supply and extract shafts, and openings between the shaft and lift lobbies.
- New automated motored smoke dampers for supply and extract shafts.
- New smoke detectors and associated control outstations.
- New uprated 600 mm diameter supply and extract fans for smoke clearance sized to provide a balanced flow rate of 5 m³/s.
- New general ventilation supply and extract fans separated from the smoke shafts in the event of a fire by new smoke dampers.

The proposed system will operate in the following manner on detection of smoke within a communal lobby:

- General supply and extract fans switched off, motored smoke dampers local to these close.
- Motored smoke dampers on supply and extract shafts on fire floor fully open.
- Smoke dampers on all other floors motor closed.
- Smoke clearance supply and extract fans operate autonomously to maintain safety of the escape route.
- Fireman's override switches will be provided within each lobby to control the fans on/off and the local smoke dampers open/closed.

4 Performance Comparison of Existing System versus Proposed System

The system currently installed in Grenfell Tower is by default a natural ventilation system. It can be overridden by the fire brigade to provide mechanical assistance if required but this involves a manual intervention.

Natural Ventilation Mode

Natural ventilation based smoke clearance systems depend on the stack effect caused in the extract shaft due to the pressure differential arising from the temperature difference between the hot smoke and cooler external air temperature. The flow rate achieved depends on the following factors;

- The height of the stack; i.e. the distance from the lobby extract vent to the roof top vent.
- The temperature of the external air.
- The temperature of the extracted air; i.e. smoke in the case of a fire.
- The cross sectional area of the shaft.

These factors can be used to calculate the flow rate as follows;

$$Q = CA \sqrt{2gh \frac{T_i - T_o}{T_i}}$$

Where;

Q	Flow rate	m ³ /s
C	Discharge coefficient	0.61 (based on a sharp edged rectangular opening)
A	Flow area (shaft area)	0.48 m ²
g	Gravitational acceleration	9.81 m s ⁻²
h	Stack height (shaft length)	5.0 m
T _i	Internal temperature	473.15 K or 353.15 K
T _o	Outside temperature	301.15 K

For the purposes of this comparison the worst case condition is to be considered. This would be where the temperature differential between the smoke to be extracted and the external air is at its lowest and the height of the stack is the shortest possible distance. In this case, this occurs when the fire is at the highest floor during a summer's day of 28 °C.

Two smoke layer conditions are to be considered; the first is a high temperature layer of 200 °C, the maximum allowable temperature above an escape route. The second is perhaps the more typical case of a lower temperature smoke layer of 80 °C associated with the dispersal of smoke from a fire in an adjacent space.

The results are;

$$Q = 1.75 \text{ m}^3/\text{s} @ 200^\circ\text{C} (473.15 \text{ K})$$

$$Q = 1.11 \text{ m}^3/\text{s} @ 80^\circ\text{C} (353.15 \text{ K})$$

Manual Override Mode

Although this is not the default mode of operation upon detecting a fire, a comparison between the existing mechanical system and the proposed automated system will ensure that smoke clearance conducted by the fire brigade is not impaired.

The mechanical smoke ventilation as it is installed currently is a balanced 'push-pull' system. This means that an extract fan operates to remove smoke from the fire floor with make-up fresh air provided at the same rate of flow by a mechanical supply fan. This principle is to be retained but automated in the proposed new system.

The existing bifurcated extract fans (run and standby) were supplied by Victoria Fans Limited in 1993. Although no data of their duty was available from the manufacturer, they were able to provide the following specifications of the units:

Diameter: 400 mm

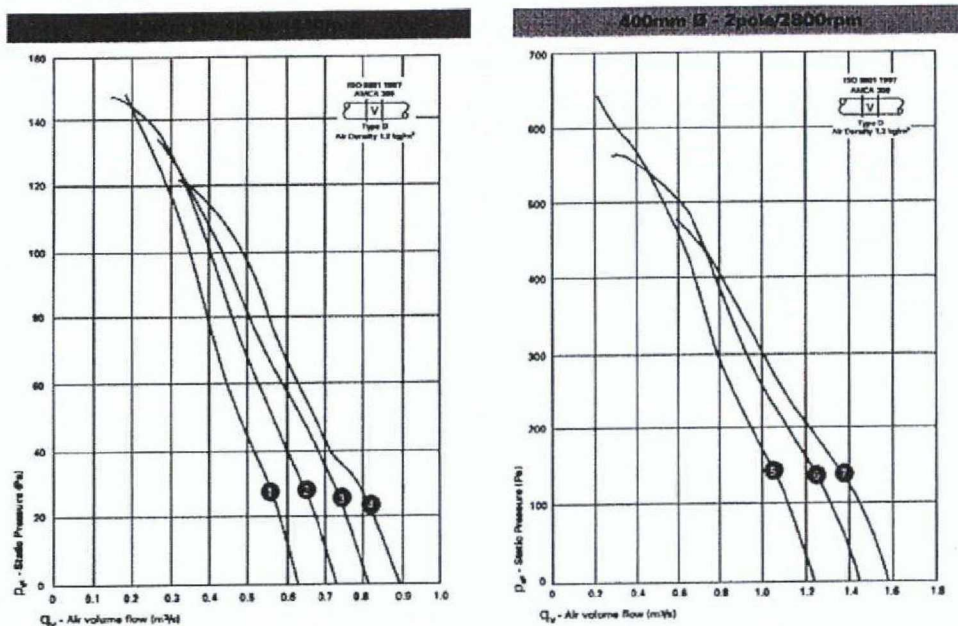
Blade Pitch: 8°

Motor: 0.55 kW

Motor Speed: 2850 rpm

This data is sufficient to allow comparison with fans of a similar specification to ascertain the flow rate at the calculated pressure drop of the extract shaft. For this purpose the fan curve data is to be taken from curve 5 of the following extract from Nuaire's catalogue on the following page:

Bifurcated Axial Flow - 400mm ø



General						Electrical/Motor						Noise/Sound							
Curve No	Unit Code	Blade Angle	Speed RPM	Unit kg	A.V. frame Set	Motor size	1 Phase (230V/50Hz) Motor flc kW	sc amps	2 Phase (400V/50Hz) Motor flc kW	sc amps		In-duct sound power levels dB re 1pW inlet Octave band mid frequency Hz							
1	AXB40M-411A*	20°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	85	79	76	74	68	60	60	
2	AXB40M-421A*	25°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	85	81	75	76	70	61	52	
3	AXB40M-431A*	30°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	85	81	77	76	71	64	56	
4	AXB40F-431A*	35°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	85	83	78	76	71	63	56	
5	AXB40M-211A*	20°	2700	31	NAV2	LS90L	1.1	7.5	35	1.1	2.5	88	80	82	84	87	79	72	
6	AXB40M-22A*	25°	2700	31	NAV2	LS90L	1.1	7.5	35	1.1	2.5	87	86	83	83	87	80	74	
7	AXB40M-23A*	30°	2700	31	NAV2	LS90L	1.1	7.5	35	1.1	2.5	90	85	84	84	88	81	75	

Figure 1 - Nuaire Comparable Fan Curves - <http://www.nuaire.info/catalogue/Axial-AXB.pdf>

The worst case condition to be calculated in this case would be a fire on the lowest residential floor as this would be the index run for the system, i.e. would incur the largest pressure drop.

For the purposes of this comparison it can be modelled simplistically as a smoke damper in the lobby, a 90° bend into the shaft, a 60 m length of smoke extract shaft and a smoke damper prior to the extract fan. The following pressure drops have been applied to these components:

Lobby smoke damper:	10 Pa
90° bend:	8.3 Pa
Extract shaft:	0.3 Pa/m
Fan smoke damper:	7.88 Pa

This gives a total pressure drop in the system of 44.2 Pa.

When the total pressure drop calculated previously is applied to the relevant comparison fan curve, curve 5, it can be seen that:

$$Q = 1.2 \text{ m}^3/\text{s} @ 44.2 \text{ Pa}$$

5 Performance Comparison Results

Method	Flow Rate – Worst Case (m^3/s)
Existing Natural Ventilation	1.1
Existing Mechanical Ventilation (manual override)	1.2
Proposed Mechanical Ventilation (automated)	5.0

Table 2 - Performance Comparison of Existing and New Systems

From the table above it can clearly be seen that the performance of the smoke ventilation system in Grenfell Tower will be considerably improved as part of the refurbishment works. The fans will be sized in order to provide a minimum of $5 \text{ m}^3/\text{s}$ flow rate at the furthest point from the fans. This is line with current best practice for balanced 'push-pull' type smoke ventilation systems, with the figure arising from a $3.5 \text{ m}^3/\text{s}$ flow rate through an open door to prevent smoke ingress from the lobby to the escape stair during escape plus an additional $1.5 \text{ m}^3/\text{s}$ allowance for leakage from the builder's work shafts and remaining dampers.

NOTES:

1. DO NOT SCALE FROM THIS DRAWING
2. READ IN CONJUNCTION WITH THE MF TENDER DOCUMENTATION.
3. READ IN CONJUNCTION WITH THE T(90)01 SERIES COMBINED MECHANICAL LAYOUTS.
4. ONLY HALF THE DAMPERS & DUCTS SHOWN FOR CLARITY, EACH FLOOR HAS TWO SUPPLY AND TWO EXTRACT DUCTS SERVICING EACH LOBBY, EACH MOTORISED DAMPER IS TO BE NORMALLY OPEN, WITH ALL DAMPERS EXCEPT THOSE ON THE FIRE FLOOR CLOSING IN THE EVENT OF A FIRE.
5. EXISTING SMOKE EXTRACT SYSTEM SUPPLY AIR FANS LOCATED IN CEILING VOID OF WALKWAY+1. THESE FANS WILL BE REMOVED. PROPOSAL IS TO INSTALL NEW FANS IN LOCATION SHOWN ON T(90)01_102.

T2	20/11/13	STAGE E TENDER ISSUE	MJS
T1	01/11/13	STAGE E TENDER ISSUE	MJS
rev	date	description	eng

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job title

GRENfell TOWER
REGENERATION

project leader date scale (at A3)

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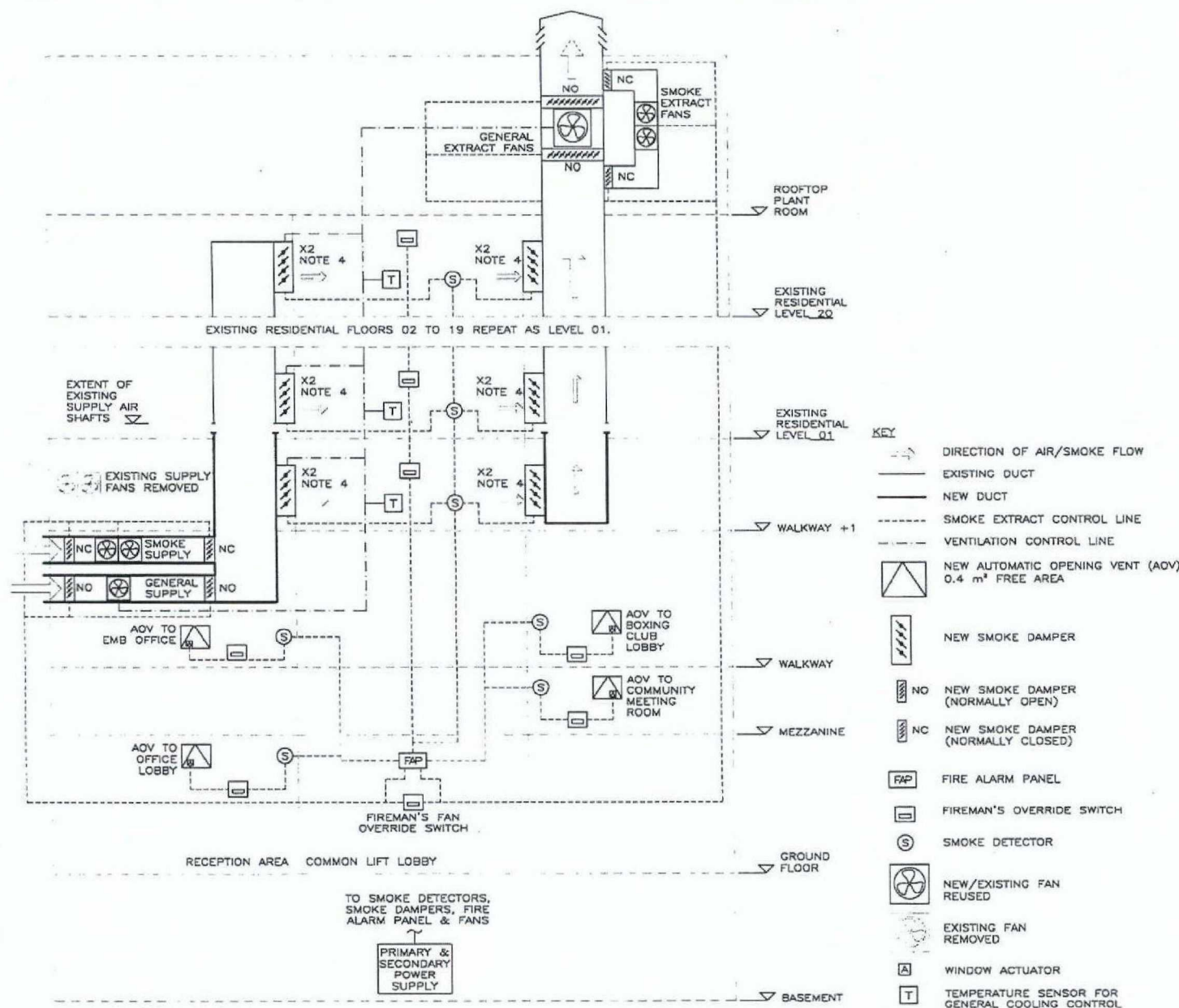
drawing title

CORE SERVICES
SMOKE VENTILATION
SCHEMATIC

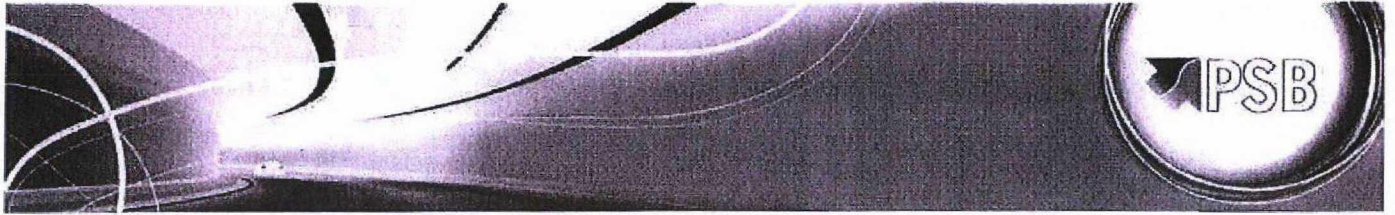
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JSW00001929/34



Smoke Ventilation Technical submission

For

Lobby Smoke Control Systems

at

Grenfell Tower Apartments, London

Revision History

Rev	Details	Author	Date	Appr
0	Issued for Approval	HMM	12/11/2014	HMM
1	Incorporation of Phase 2 details	HMM	1/12/2014	HMM

Technical Specification for PSB Lobby Smoke Control

Relation : J S Wright & Co Limited
Date : 1st December 2014
Reference : PSBUK1143-12 rev 1
Project : Grenfell Tower Appertments

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1.0 Lobby Smoke Control Systems

1.1 Base Documents

This Technical Submission is based in part upon the following documentation:

- Drawing Numbers
 1. 1279 (04) 101 Revision 05, 1279 (04) 102 Revision 05, 1279 (04) 103 Revision 05, 1279 (04) 105 Revision 01, 11279(08)100, Revision 01 279(08)101Revision 01
- Specification
 1. Max Fordham Employers Requirements for MEP Services Document J4350 dated 16th October 2013.
 2. Max Fordham Grenfell Tower Smoke Ventilation Analysis Rev A dated 6th May 2014

1.1.1 Description of the Project

The building is an existing tower block with 20 storeys of residential accommodation on top of a podium containing new residential accommodation, offices, a nursery and a boxing club.

The general scope of the project is:

- Recladding of the façade
- Reconfiguration of the podium levels to provide additional residential accommodation
- Relocation and refurbishment of the nursery
- Relocation and refurbishment of the boxing club
- Provision of new office space and meeting rooms
- Modifications to the MEP systems.

It is noted that a key factor for this for this project is that the tenants will remain in occupation throughout the installation and it is essential for all basic services to remain functional at all times apart from pre-agreed interruptions.

1.1.2 Smoke Control Proposals

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. The system has been designed to provide an average open door velocity, across an open lobby/stairwell door of 2.0m/s. This velocity is in accordance with the recommendation for a Class B pressure differential system as defined in Code of Practice BSEN12101 Part 6: Specification for pressure differential systems — Kits. (bsen12101-6)

It should be noted that as the system is designed to extract air from the lobby, via the open stairwell door, the system is not designed to comply with all the requirements of the aforementioned Code of Practice.

The smoke control measures in the lobby areas will be implemented in two phases. Phase 1 will be to re-instate the natural smoke ventilation system consisting, of two natural smoke extract shafts and two natural air inlet shafts, with new motorised dampers in each lobby complete with a Programmable Logic Control System (PLC)

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The PLC control system will have links to the new fire alarm system to provide an initiating signal (one signal per floor). Once a signal is received all the dampers (extract and inlet air) in the smoke affected lobby will open and all dampers on other floors are to remain closed.

A human Mechanical Interface Panel (HMI) will be located within the entrance area to provide the fire and rescue service with a central override facility to close all dampers in a single operation.

Each ventilated lobby will be provided with a key override, switch located within the stairwell, at each storey level providing the Fire and Rescue service with a local override facility to open the dampers on any one floor.

Once one switch has been activated to open the dampers on a given floor then all other floor switches will be locked out. Once the activated switch is returned to its original position another floor can be activated.

Phase 2 will include ductwork alterations to connect all the existing supply air and smoke extract ducts into one extract section into which will be incorporate a pair of smoke extract fans mounted, in series, to provide a duty and standby mechanical smoke extract facility.

The control system will also have pressure sensors added into each ventilated lobby to control the speed of the fans 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

- **Phase 1 Natural Smoke**

The existing fresh air and extract shafts are to be retained and converted to provide a natural low level air inlet and high level natural smoke extract.

Both the inlet air and smoke extract shafts will utilise the existing dual openings at each storey level. i.e. there will be two high level smoke extract ventilator openings and two low level fresh air ventilators, opening into the respective shafts.

Each of the four openings will be provided with a motorised damper grille assembly utilising a new damper unit and re-using the existing steel grille.

Each lobby will have a smoke detector linked back to the control system to provide an automatic initiating signal.

When smoke is detected within a lobby area only the ventilators within the lobby area are to operate and the ventilators on the other storey levels are all to remain closed.

Each lobby will have a local key operated two position fire override switch (auto/open) this will be mounted within the stairwell at each storey landing.

The system will have a PLC driven central control system with an individual control outstation module located at each storey level. All control and power cabling will be taken to and from the outstation to the smoke control system components on the individual floor.

A data and power cable will be daisy chain linked throughout the height of the building to link all the control modules to form an integrated system.

An HMI override panel will be installed in a position agreed with the approving authority which will enable the Fire and Rescue service to turn the system off. Once the system has been turned off the individual floor override switches can be used to open the dampers on any one floor. Once the key switch has been activated on one floor it will not be possible to open the dampers on another floor until the first activated

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switch is returned to the auto position i.e. once one floor is activated all other floors are locked out and all other dampers will remain closed.

All cables are to be run in fire rated cables.

A battery backup module will provide 72 hours secondary power supply to the system.

The existing smoke extract fans are to be removed and a new section of ductwork installed.

The existing fresh air shaft is to be extended through the plant room to an external wall and an automatic opening smoke ventilator will be fitted as a weathered discharge.

On completion of all works the system will be fully tested, commissioned and left in standby auto-position, ready for operation.

2. Phase 2 Mechanical Smoke Extract

At a pre-determined date phase two will be implemented to convert the system into a fully mechanical extract system with a new smoke extract run and standby fan set and fan starter panel with inverter drives to vary the speed of the extract fans. Pressure sensors will be fitted on each storey level to measure the pressure differential across the stair/lobby door. The system will be designed to provide low speed trickle ventilation when the lobby doors are closed and to provide high speed ventilation when the door is open.

The speed of the fans will be varied in accordance with the pressure readings so that the opening force on the closed lobby door does not exceed 100N and when the door is open air will be drawn through the open door at an average rate of 2.0m/s to provide smoke control protection of the stairwell.

A by-pass damper arrangement to allow a separate environmental fan system to be linked to the smoke shafts to provided day to day ventilation of the lobbies.

The method for testing the open door velocity and the opening forces on the door will be as detailed in BSEN12101-6 code of practice for pressure differential systems.

The new mechanical system will incorporate the phase 1 dampers and controls and the PLC control will be re-programmed to work as an integrated part of the mechanical system.

All of the works associated with the mechanical system will be completed, tested and proven prior to the final link being made to the natural smoke shaft so that the building is left unprotected for the minimum time period.

Once the final link has been made the fully integrated system will be commissioned, including re-testing of the original damper assemblies.

It should be noted that the mechanical systems will operate as follows:

- Smoke Extract mode: the by-pass damper assembly will shut off the connection to the environmental fan system and all four dampers in the lobby open, to extract air from the lobby through all four openings. Make up air will be provided via the open lobby door.
- Environmental Mode: the by-pass damper assembly will open and shut off the smoke extract fan set and isolate the two shafts. One shaft will act as an environmental extract shaft and the other will act as a fresh air make up shaft.

The newly installed vertical fresh air make up inlet ventilator within the plant room wall will be removed and the ductwork opening blanked off. The existing fresh air riser and smoke extract builderswork risers will be connected together using galvanised smoke ductwork and fed to a single extract fan set as described above. i.e. all four existing builderswork shafts will all be used as part of the smoke control extraction system.

A separate technical submission will be provided for phase 2 environmental systems which are linked to the smoke control system.

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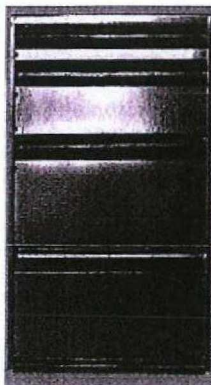
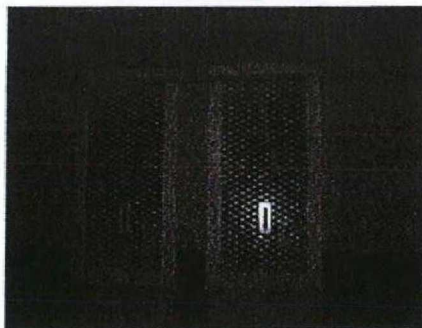
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2.0 Phase 1 Equipment and Controls

2.1 Automatic Lobby Ventilators

Product: Gilberts Series 54 Damper

Location: Existing Lobbies

QTY	CODE	CONSTRUCTION	FLANGE LENGTH	FLANGE WIDTH	OPENING LENGTH	OPENING WIDTH	FLANGE TYPE	CONTROLS	
80	SSE	GALVANISED STEEL	637	337	600MM (L)	300MM (W)	SELF	24V	
Damper Type: SSE 300 X 600 Number of Blades: N/A Construction of Blades: Galvanisd steel Opening Height: 600 Opening width: 300 Flange length: 637 Flange width: 337 Flange Type: Self Base Type: N/A Controls: MS Control 24v									
Grille Type Existing Construction Punched Steel									
Colour: Existing Certification: Damper section tested to EN1366 Pt2 Fire resistance test for service installtions Part 2 Fire Dampers									

Note: the damper motor is accessed for maintenance by removing the grille.

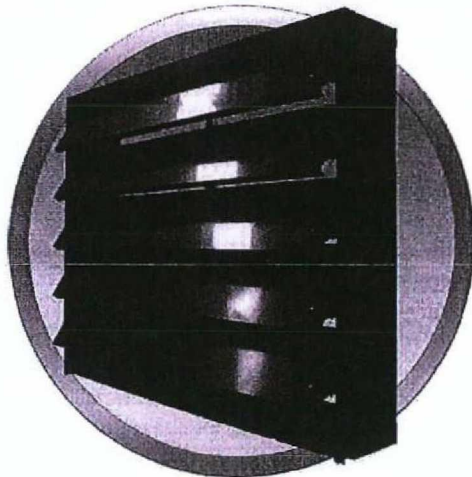
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2.2 Natural Air Inlet Ventilator

Product: Powrmatic OSR aluminium roof Ventilator with a measured free area of 1.0m².

Location: Roof Plant Room, External Wall

QTY	CODE	CONSTRUCTION	FLANGE HEIGHT	FLANGE WIDTH	THROAT OPENING HEIGHT	THROAT OPENING WIDTH	FLANGE TYPE	CONTROLS	WINDSHIELD
1	OSRW 12-06	ALUMINIUM	1065	1200	945	1080	CURB	24V	NO
Type: OSR Number of Blades: 7 Construction of Blades: Alu-1 Construction of Frame: Alu-1 Opening height: 945 Opening width: 1080 Flange height: 1060 Flange width: 1200 Mounting Flange Type: Wall Base Type: Wall Actuators: Motor Control 24v Certification: BSEN12101-2 specification For powered heat and Smoke exhaust ventilators									

The opening dimensions are the opening sizes taken for the purposes of calculating the measured free area and are not builderswork opening dimensions.

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2.3 Control System

2.3.1 Control System Philosophy Statement

The control system will be an intelligent PLC based modular control system using a network for operation of filed hardware and Ethernet communications network for the HMI user interfaces.

The control system will consist of the following components:

- Master smoke control panel with PLC
- HMI override panel
- Outstation module panels (one per ventilated lobby)
- Smoke detector (one per ventilated lobby)
- Override switch, configured auto/open (one per ventilated lobby, located within the stairwell)

The control philosophy is as follows:-

Upon smoke being detected in any of a firefighting lobby the following events shall occur:-

- The AOV's into the natural extract shafts serving the lobby in which the smoke was detected shall open.
- The AOV's into the natural air supply shafts serving the lobby in which the smoke was detected shall open.
- The wall mounted fresh air damper in the external wall opens.
- All other floors will be electrically isolated to prevent them from being opened to maintain separation and smoke contamination of the other floors.
- In the event of failure of the primary supply the battery backup panel will provide a power secondary supply.
- Indication on the mimic repeater panel and main control panels shall indicate the core & floor on which the alarm has been triggered.
- If the HMI override is activated i.e. shut system down all open dampers will close. The dampers on any given floor can be then opened using the local key override switch. Once a single switch has been turned to open all other switches, on the other floors, will be locked out.
- The above sequence shall also be executed if the manual overrides are operated on any level or by the master control panel.

Upon reset of the fire alarm or by override selection:-

- The AOV's into the builders work extract shaft serving the lobby shall close automatically.
- The AOV's into the builders work inlet air shaft serving the lobby shall close automatically
- The status on the indication panels shall return to normal.

2.3.2 Activation Mechanism

The system is triggered by smoke detectors supplied and installed by PSB. Detection within the lobby shall be provided by ceiling mounted smoke detectors. Signals from the smoke detectors will be relayed direct to the relevant smoke control systems via the local floor outstation.

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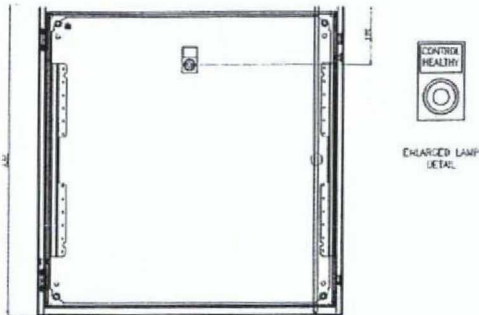
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2.3.3 Control Panels

2.3.3.1 Master Smoke Control Panel

Product: PSB Right Choice Control panel size 600mm wide x 600mm high x 400mm deep

Location: Service Riser Level 1 Existing Lobby

QTY	CODE	CONSTRUCTION	HEIGHT	WIDTH	DEPTH		CONTROLS	
1	MCP	STEEL BOX	600	600	400		240VAC IN 24VDC OUT	
Type:		SMCP Master smoke control panel incorporating PLC Control system						
Construction:		Steel cabinet						
Height:		600						
width:		600						
Mounting Type:		Surface wall mounted						

The master smoke control panel will be a steel wall mounted unit. The dimension of the panel will be 600mm High x 600mm Wide x 400 Deep with full PLC driven control system. The panel will be wall mounted in the electrical riser on the first floor.

The panel will have control interface wiring to the:

- Mimic HMI panel on the ground floor
- Outstation panels in electrical riser located in the lobby on each level served by the smoke control system.
- Battery backup panel one on every fifth floor

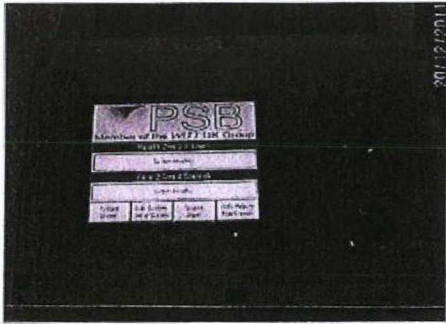
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2.3.3.2 HMI Mimic Override Control Panel

Product: PSB Right Choice mimic HMI panels

Location: Local To Fire Alarm Panel (Final Location to be Agreed)

QTY	CODE	CONSTRUCTION	LENGTH	HEIGHT				CONTROLS	
1	MIMIC	PLASTIC BOX	400	300				24V	
Type: HMI Mimic / Override panel Construction: Plastic cabinet with HMI Screen width: 400 Height: 300 Mounting Type: SURFACE									

The smoke mimic control panel will be a HMI Touch screen and shall comprise of an operator dialogue terminal housed in a plastic wall mounted enclosure. The dimension of the repeater panel will be 400mm Wide x 300mm High x 150 Deep. User facilities will allow the operator to access system configuration, maintenance and testing functions and provide Fireman's override facilities through the menu driven touch screen control interface. The master mimic will communicate with each core master control panel over an Ethernet TCP/IP protocol displaying in full graphical representation status of each core with event recording accessed through the menu system.

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2.3.3.3 Outstation Modular Control Panel

Product: PSB Right Choice Outstation Panel

Location: Service Riser Existing Lobbies

QTY	CODE	CONSTRUCTION	LENGTH	HEIGHT				CONTROLS	
20	OUTSTATION	METAL BOX	400	300				24V	
Type: Otstation Control Module Construction: Plastic cabinet with HMI Screen width: 400 Height: 300 Mounting Type: SURFACE									

The outstation modular smoke control panel will be a steel wall mounted unit. The dimension of the panel will be 300mm High x 400mm Wide x 200 Deep. The panel will be wall mounted in the electrical riser in each of the ventilated lobbies.

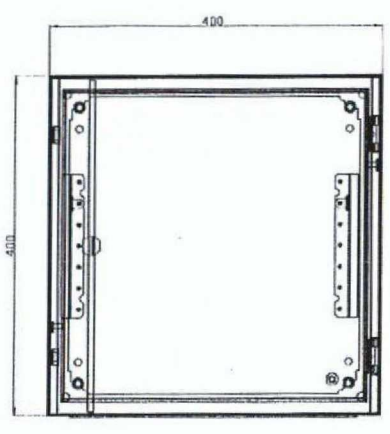
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2.3.3.4 Modular Battery Backup Panel

Product: PSB Right Choice Battery Backup Panel

Location: Service Riser Existing Lobbies every 5th Floor

QTY	CODE	CONSTRUCTION	LENGTH	HEIGHT				CONTROLS	
5	BATTERY BACKUP MODULE	STEEL BOX	400	400				240VAC IN 24V DC OUT	
<p>Type: Otstation Control Module</p> <p>Construction: steel cabinet with H</p> <p>width: 400</p> <p>Height: 400</p> <p>Mounting Type: SURFACE</p>									

The battery backup smoke control panel will be a plastic wall mounted unit. The dimension of the panel will be 400mm High x 400mm Wide x 300 Deep. The panel will be wall mounted in the electrical riser on every fifth floor level within the ventilated lobbies.


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2.3.3.5 Floor Override Switches

Product: KAC Ltd Right Choice Control Override Switches

Location: Stairwell at each storey level served by the ventilation system


QTY	CODE	CONSTRUCTION					CONTROLS	
80	FOC FIRE OVERRIDE SWITCH	PLASTIC					VIA INTERFACE MODULE	
Type: FOC Construction : Plastic Mounting Flange Type: Base fixing Base Type: Plastic Colour: Yellow								

A Key operated fire override switch will be located within the stairwell for each ventilated lobby, local to the automatic lobby ventilator, these switches will be in a normal auto position allowing the ventilator to be opened when the system operates. Once the fire override switch on the mimic override panel has been activated the floor override switch will allow the fire and rescue service the facility to open the dampers.

2.3.3.6 Smoke Detector Heads

Product: Apollo Right Choice smoke detector heads

Location: Existing Lobbies

QTY	CODE	CONSTRUCTION					CONTROLS	
20	XP95	PLASTIC					VIA INTERFACE MODULE	
Type: Apollo Optical with relay base Construction : Plastic Mounting Flange Type: Base fixing Base Type: Plastic Colour: white								

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2.4 Power Supplies Electrical & Control Wiring

2.4.1: Power and Control

The master control panel incorporates a facility to connect the incoming 230v Ac incoming mains supply to power the smoke control systems. (Supplied and installed as part of the electrical contractors contract).
Should the mains power fail there is provision for 72 hour power supply via battery a battery backup system.

2.4.2: Power and Control cables

The electrical wiring for the system shall be provided in fireproof cable with a CWZ classification.

Power/Controls wiring – FP200 Enhanced or equivalent.

ASI Network – FP200 Enhanced or Equivalent.

Fan Cables – FP400 Enhanced or equivalent.

COMMS – Firetuf or Equivalent.

And installed in accordance with the Electrical Wiring Regulations and BS8519.

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3.0 Phase 2 Equipment and Controls

3.1. Run & Standby Extract Fan Arrangement

Product: Elta Fan Type LCS063K2-A5/19

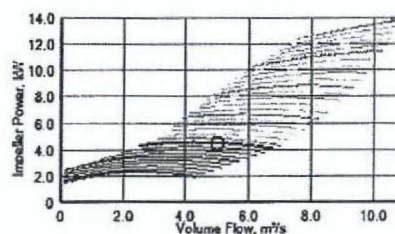
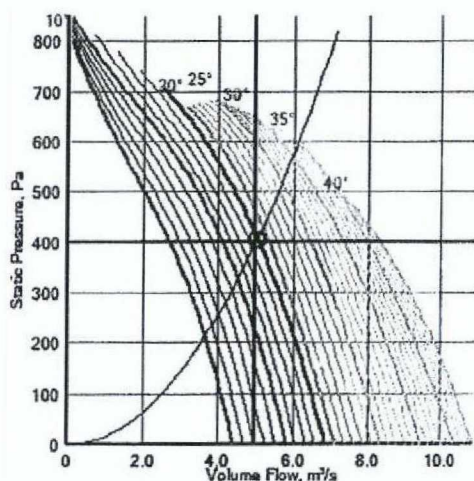
Location: Roof Top Plant Room

Fans will be mounted in series in the roof top plantroom and connect via ductwork to the builders work shafts. Motorised shut off dampers will be installed in the ductwork to provide a positive shut off of the system. All dampers will be fitted 24v DC motors.

All fans are tested to the latest internationally recognised standard ISO5801 Part 1, installation category D for aerodynamic performance and BS848 Part 2 (1985) for acoustic performance. The adjustable pitch Aerofoil impeller gives the exact performance required, with a non overloading fan characteristic.

The impellers are all high pressure die cast to offer thin aerofoil sections for low generation of noise. The maximum pitch angles allow for speed control by frequency inverter. The motors are suitable for inverter speed control down to 20% of full speed. Fans are tested in compliance with high temperature test standard directive 89/106/EEC to EN 12101-3 and are rated to one off emergency operation at 300°C for 2 hour.

Fan Performance Data: Elta Fan Type LCS063K2-A5/19



Sound Data

Spectrum (Hz):	63	125	250	500	1K	2K	4K	8K	dBW	dB(A) @ 3m
Inlet (dB):	99	96	96	94	95	92	87	82	104	78
Outlet (dB):	94	96	99	96	96	95	87	81	104	80

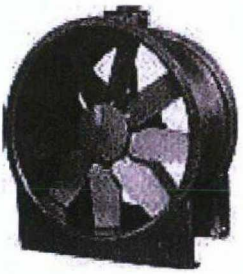
Sound levels are quoted as in-duct values. dB(A) values are average spherical free-field for comparative use only.

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3.1. Run & Standby Extract Fan Arrangement (cont.)

Fan Performance Data: Elta Fan Type LCS063K2-A5/19

QTY	CODE	CONSTRUCTION	FLANGE LENGTH	FLANGE WIDTH	OPENING LENGTH	OPENING WIDTH	FLANGE TYPE	CONTROLS	WINDSHIELD
2	AS BELOW	STEEL/ALUMINIUM	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Description of product / remarks: Fan Type: LCS630K2-A5/19 Fan diameter: 630mm Electrical Supply: 380-420volts 50Hz 3 phase Rated Motor Power: 4.0kW Full Load Current: 10.21 A Starting Current: Invertor soft start Start type: Invertor Absorbed Power: 4.47kW Peak Power: 4.52 kW Certification: BSEN12101-3 specification For powered heat and Smoke exhaust ventilators									


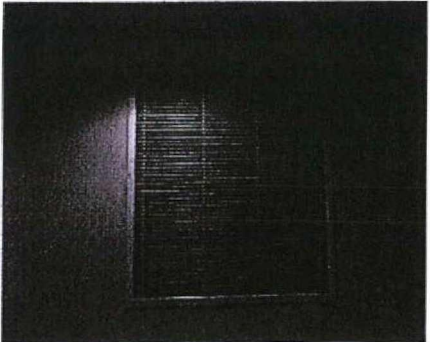
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Relation : J S Wright & Co Limited
 Date : 1st December 2014
 Reference : PSBUK1143-12 rev 1
 Project : Grenfell Tower Appertments

3.2 Automatic Lobby Ventilators

Product: Gilberts Series 54

Location: Lobbies to Ground Floor, Walkway & Walkway Mezzanine

QTY	CODE	CONSTRUCTION	FLANGE LENGTH	FLANGE WIDTH	OPENING LENGTH	OPENING WIDTH	FLANGE TYPE	CONTROLS	
6		GALVANISED STEEL	837	637	800MM (L)	600MM (W)	SELF	24V	
<p>Damper</p> <p>Type: SSE 600 X 800</p> <p>Number of Blades: N/A</p> <p>Construction of Blades: Galvanisd steel(black)</p> <p>Opening Height: 800</p> <p>Opening width: 600</p> <p>Flange length: 837</p> <p>Flange width: 637</p> <p>Flange Type: Self</p> <p>Base Type: N/A</p> <p>Controls: MS Control 24v</p>									
									
<p>Grille</p> <p>Type: Gilberts K15</p> <p>Construction: Extruded Aluminium</p>									
									
<p>Colour: RAL9010</p> <p>Certification: Damper section tested to EN1366 Pt2 Fire resistance test for service installtions Part 2 Fire Dampers</p>									

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3.3 Mechanical Control System

The mechanical fan set will be provided with a fan starter panel incorporating inverter speed drives to control the speed of the fans between low speed (all doors closed) and high speed (door on fire floor open). The open/closed door condition will be monitored by a pressure sensor (see details below) which will measure the pressure differential between the lobby and the stairwell. The system is designed to maintain -25Pa in the lobby with all doors closed and will maintain the fans at low speed setting. Once a door to the smoke affected lobby, and only the smoke affected lobby, the pressure differential will be lost and the fans will automatically ramp up to full speed to extract air from the lobby at a rate which will provide an average face velocity of 2m/s across the open lobby / stairwell door.

The master control panel will be provided with a primary and secondary power supply in accordance with BS519 and the power supplies are to include an auto changeover panel and a bypass switch arrangement with a single mains feed connection to the fan control panel.

The panel will be linked to the master PLC control panel via a data cable taken from the top floor outstation module in the service riser within the lobby area and will therefore seamlessly link into the existing natural smoke ventilation system installed in phase 1.

The pressure sensors will be fitted at each storey level and will monitor the pressure differential between the stairwell and lobby.

The pressure sensor will have a link to the control outstations fitted at each storey level and will link back to the master control panel via the data link between each outstation.

Once the system has been initiated by the smoke detection system only the smoke affected floor will operate and all floors will be linked out. Only the pressure sensor within the smoke affected lobby can operate the system.

As the smoke shafts are to be used to provide a route for fresh air and extract air for the environmental system a set of by-pass dampers will be incorporated into the ductwork system.

During normal environmental activities the system damper to the smoke ventilation fan set will be closed and the dampers to the environmental fan sets will be open.

On receipt of a fire alarm signal the environmental system dampers will close and the damper to the smoke ventilation system will open.

On receipt of a signal from the fire alarm system all environmental controls will be overridden by the smoke control system.

The mechanical system will operate as described above for the natural system as follows:

- On alarm signal all dampers in the smoke affected lobby open (four dampers per lobby on the existing twenty floors and two dampers on the ground floor, walkway and walkway mezzanine areas)
- All other floor are locked out
- Environmental controls are locked out
- Bypass dampers to environmental systems close

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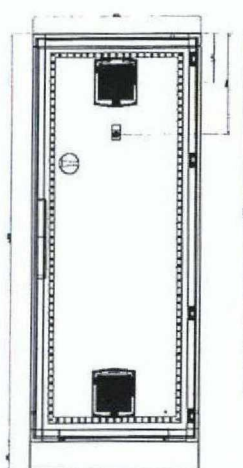
3.3 Mechanical Control System (cont.)

- By pass damper to the smoke extract fan set opens
- Smoke Ventilator in the stairwell opens to provide make up air path
- Smoke Extract Fans are initiated.
- Pressure sensor in smoke affected lobby active to regulate fan speed
- HMI override available
- If HMI override activated the Fan system shuts down and all dampers and stairwell ventilator will close
- If floor Override switch, in the stairwell, is turned to the on position, (when the HMI override has been activated) then the dampers on that floor will open, the stairwell ventilator will open and the fans will be initiated. Note: the override switch can be used on any one floor once the HMI override is initiated. However only one floor at a time can be activated via the override switches located in the stairwell.

3.3.1 Fan Starter Control Panel

Product: PSB Right Choice Smart Control panel size 600mm wide x 1400mm high x 600mm deep

Location: Roof top plant room local to fan set

QTY	CODE	CONSTRUCTION	HEIGHT	WIDTH	DEPTH				
1	FSP	STEEL BOX	1400	600	600				
Type:			FSP Fan starter control panel incorporating inverter fan drives						
Construction:			Steel cabinet						
Height:			1400						
width:			600						
Mounting Type:			Surface wall mounted						

The fan starter control panel will be a steel wall mounted. The dimension of the panel will be 600mm High x 1400mm Wide x 600 Deep with Macon MR5 inverter drives.

The panel will be provided with a 3 phase power supply (supplied and installed by others).


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3.3.2 Pressure Sensor

Product: Control Pressure Transmitter

Location: Stairwell at every floor level piped into lobby

QTY	CODE	CONSTRUCTION						CONTROLS	
83	PA-DPS-8X	PLASTIC						VIA INTERFACE MODULE	
Type:			PA-DPS-8x Sontay Pressure sensor						
Construction :			Plastic						
Mounting Flange Type:			Base fixing						
Base Type:			Plastic						
									

A Pressure transmitter will be fitted within the stairwell, at high level on each storey level, and will measure the pressure differential between the stair and the smoke affected lobby. If the pre-set pressure differential is maintain the fan will run at low speed (doors closed) Should a lobby door open then pre-set pressure differential will not be able to be maintained and the fan will ramp up to full speed via inverter drive in the master control panel (open door condition) to extract a higher volumetric rate from the lobby.

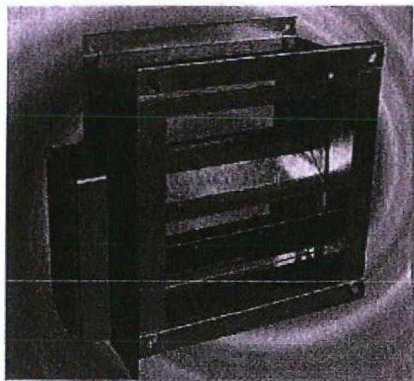
Technical Specification for PSB Lobby Smoke Control

Relation : J S Wright & Co Limited
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3.4 By-pass Dampers

Product: BSB SC Series

Location: Walkway Environmental Fan Set and Plant Room Smoke Extract Fan Set

QTY	CODE	CONSTRUCTION	FLANGE LENGTH	FLANGE WIDTH	OPENING LENGTH	OPENING WIDTH	FLANGE TYPE	CONTROLS	
3		GALVANISED STEEL	TBA	TBA	TBA	TBA	TBA	24V	
Damper Type: SC TBA Number of Blades: TBA Construction of Blades: Galvanisd Opening Height: TBA Opening width: TBA Flange length: TBA Flange width: TBA Flange Type: Self Base Type: N/A Controls: MS Control 24v									

The environmental fan sets and the smoke extract fan sets will each have a shut off/ bypass damper fitted to isolate the fan sets. The damper sizes will be provided once the final ductwork sizing and arrangement has been agreed.

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4.0 Testing and Maintenance Schedule

4.1 Maintenance Statement

It is a requirement under the Regulatory Reform Order of 2005 that a person shall be responsible for the maintenance of the smoke control system and this has to be tested and maintained in accordance with the schedules contained in BS9999 as detailed below in the extracts for the mechanical smoke control system and associated smoke detection. It is also necessary to carry out maintenance in accordance with manufacturers recommendations for each component.

4.2 Testing and Maintenance Schedule From BS9999

BRITISH STANDARD BS 9999:2008

Annex V (normative) Routine inspection and maintenance of fire safety installations

V.1 General

NOTE Fire safety installations comprise the items and elements of which examples are listed in Annex J.

It is essential for the safety of the occupants of a building that fire safety equipment (including passive fire protection provisions) is inspected frequently. Although much of the inspection can be undertaken by suitably trained personnel, a formal agreement should be made with the installer or the installer's representative to provide the regular inspection and testing described in the relevant British Standards for individual fire safety installations. Unless temporary alternative fire safety systems can be put in place, it might be appropriate for certain of the inspections carried out at three-monthly or longer intervals to be done outside normal working hours.

V.2 Daily inspections

V.2.1 General

The checks described in V.2.2 to V.2.6 should be undertaken daily. For premises with defined opening times such as shops, theatres and cinemas, these checks should be undertaken prior to members of the public entering the building.

V.2.2 Fire detection and alarm systems

All fire detection and alarm systems should be inspected daily. In particular, it should be ensured that:

- a) the control panel indicates normal operation or, if any fault is indicated, that it has been logged and the appropriate action(s) taken;
- b) any fault recorded the previous day has received attention.

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V.3 Weekly

V.3.1 General

In addition to the checks recommended in V.2, the checks described in V.3.3 to V.3.7 should be undertaken once a week.

V.3.2 Fire detection and alarm systems

All fire detection and alarm systems should be inspected weekly. In particular, it should be ensured that:

- a) the control equipment is able to receive a fire signal and to initiate the evacuation procedure, recording which trigger device has been used, in accordance with BS 5839-1;
- b) any standby batteries are in good condition and the fuel, oil and coolant levels of any standby generators are correct, topping up as necessary;
- c) the reserves of paper and ink or ribbon for any printer are adequate for two weeks' normal usage.
- f) *the mode monitoring system for stop valves in life safety installations is operating correctly;*
- g) *there is continuity of connection between the alarm switch and the control unit and between the control unit and the fire and rescue service (usually via a remote manned centre) for automatically monitored connections;*
- h) *trace heating systems provided to prevent freezing in the sprinkler system are functioning correctly.*

V.3.5 Smoke control systems for means of escape

Actuation of the system should be simulated once a week. It should be ensured that any fans and powered exhaust ventilators operate correctly, smoke dampers close (or open in some systems), natural exhaust ventilators open, automatic smoke curtains move into position, etc.

V.4 Monthly

V.4.1 General

In addition to the checks recommended in V.2 and V.3, the checks described in V.4.2 to V.4.9 should be undertaken once a month.

V.4.2 Fire detection and alarm systems

Any standby generator should be started up once a month by simulating failure of the normal power supply, and allowed to energize the system for at least 1 h, while the system is monitored for any malfunctioning caused by the use of the generator. After restoring the normal supply, the charging arrangements for the generator starting battery should be tested, and the appropriate action should be taken if they are found not to be functioning correctly. In addition, the oil and coolant levels should be topped up and the fuel tanks filled.

V.5 Three-monthly

In addition to the checks recommended in V.2, V.3 and V.4, the actuation of all smoke control systems should be simulated once every three months. All zones should be

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separately tested and it should be ensured that any fans and powered exhaust ventilators operate correctly, smoke dampers close (or open in some systems), etc.

V.6 Six-monthly

V.6.1 General

In addition to the checks recommended in V.2, V.3, V.4 and V.5, the checks described in V.6.2 and V.6.3 should be undertaken once every six months. Arrangements should be made for six-monthly inspections and tests to be carried out by competent persons on the fire detection and alarm systems, the sprinkler systems, any extinguishing systems, the emergency and escape lighting systems and the fire-fighting lift, for any defects found to be logged and the necessary action taken, and for certificates of testing to be obtained.

V.7 Yearly

NOTE Attention is drawn to the testing and inspection requirements of BS 7671.

In addition to the checks recommended in V.2, V.3, V.4, V.5 and V.6, arrangements should be made for annual inspections and tests of the following to be carried out by competent persons, for any defects to be logged and the necessary action taken, and for certificates of testing to be obtained:

- a) fire detection and alarm systems;
- b) self-contained luminaires with sealed batteries, if more than 3 years old;
- c) sprinkler and drencher systems;
- d) smoke ventilators and smoke control systems;
- e) evacuation lifts;
- f) fire-fighting lift installations;
- g) fire hydrants;
- h) fire mains;
- i) portable fire extinguishers;
- j) hose reels.

Stocks of foam concentrate or solution should be checked annually and replenished as necessary.

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5.0 Appendices

5.1 Product data sheets

- Gilberts Series 54 Data Sheet
- Powrmatic OSR Data Sheet
- KAC Override Switch Data Sheet
- Apollo Smoke Detectors
- Pressure sensors
- Elta Smoke Extract Fans
- BSB Bypass dampers

Grenfell Tower

Smoke Ventilation Analysis

Rev B

13th May 2014

Matt Smith

MAX FORDHAM

GRENFELL TOWER – SMOKE VENTILATION ANALYSIS

1 Summary

This report has been prepared in order to compare the design performance of the existing smoke extract ventilation system in Grenfell Tower with the design performance of the new system proposed as part of the refurbishment works.

Parts of the existing system are now approximately 40 years old, with various components updated in an ad-hoc manner during this period. As a whole, the installation is approaching the end of its serviceable life. It is proposed to upgrade and improve the installation as part of the refurbishment works to Grenfell Tower by replacing the system with one of an equivalent design with greatly improved performance and control.

It has been found that the proposed upgrade to the system should result in a considerable performance increase:

Flow rate of existing system 1.1 – 1.2 m³/s

Flow rate of proposed system 5.0 m³/s

Note: Please note that this report should be read in conjunction with attached Max Fordham drawing U[14]01_200 (rev T2) 'Core Services Smoke Ventilation Schematic'.

2 Existing System

The existing smoke extract system in Grenfell Tower consists of the following elements:

- 2x natural ventilation supply shafts of 0.24 m² area each, with 2x low level smoke dampers of 0.18 m² area each. These serve floors 1-20 (residential floors only). Inlet at Walkway +1 level.
- 2x natural ventilation extract shafts of 0.24 m² area each, with 2x high level smoke dampers of 0.18 m² area each. These serve floors 1-20 (residential floors only). Outlet at roof level.
- Manual fireman's override switch located in dry riser inlet cupboard on ground floor allowing control of mechanical supply and extract run and standby fans. Supply fans located at Walkway +1 level, extract fans located in roof top plant room.

The existing system operates in the following manner on detection of smoke within a communal lobby:

- Actuators open supply and extract dampers on fire floor upon receiving signal from smoke detector outstation. All dampers on other floors remain in closed position.
- Smoke is cleared by the stack effect in the extract shaft caused by the pressure differential arising from the temperature difference between the hot smoke and cooler external air temperature.
- Make-up air is drawn through the low level supply shaft.
- The supply and extract fans do not operate unless the manual override switch is operated by the fire brigade upon their arrival. This switch opens smoke dampers local to both fan sets and activates the fans to enable mechanical ventilation to aid smoke removal. This switch is located on the ground floor adjacent to the dry riser inlet breaching valve and controls the fans only.

The existing shaft dimensions are considerably less than those demanded for a natural smoke extract system in a new building by Approved Document B:

	Existing System	Approved Document B
Vent between lobby and shaft free area (m ²)	0.36	1.00
Shaft free area (m ²)	0.48	1.50

Table 1 - Comparison of Existing Free Area with Approved Document B

3 Proposed System

The proposed new smoke extract system will provide automated mechanical smoke ventilation in the event of a fire, as well as providing general ventilation to the communal lobbies in day to day use.

The system is constrained by the existing shaft dimensions. For this reason an automated mechanical system has been chosen in order to protect the escape route through the lobby to a higher standard than currently provided by the natural ventilation based system.

The proposed system will consist of the following elements:

- Retention of existing supply and extract shafts, and openings between the shaft and lift lobbies.
- New automated motored smoke dampers for supply and extract shafts.
- New smoke detectors and associated control outstations.
- New uprated 600 mm diameter supply and extract fans for smoke clearance sized to provide a balanced flow rate of 5 m³/s.
- New general ventilation supply and extract fans separated from the smoke shafts in the event of a fire by new smoke dampers.

The proposed system will operate in the following manner on detection of smoke within a communal lobby:

- General supply and extract fans switched off, motored smoke dampers local to these close.
- Motored smoke dampers on supply and extract shafts on fire floor fully open.
- Smoke dampers on all other floors motor closed.
- Smoke clearance supply and extract fans operate upon activation of the smoke detector to maintain safety of the escape route.
- Fireman's override switches will be provided within each lobby to control the fans on/off and the local smoke dampers open/closed.

The provision of a second set of supply and extract fans to provide general ventilation will greatly improve the comfort of the lift lobbies by extracting unwanted heat gains caused by the new communal heating pipework installed in these areas. The control of these general ventilation fans and operation of the smoke dampers which this system will share with the smoke extract system will be such that in the case of a fire, the smoke extract system immediately takes precedence and operates as outlined above. A further advantage of this strategy is that the smoke dampers at each lobby will be operated on a

regular basis, resulting in the possibility of deficiencies being picked up earlier and maintenance reduced when compared to a system that is operated only for safety tests.

4 Performance Analysis of Existing System

The system currently installed in Grenfell Tower is by default a natural ventilation system. It can be overridden by the fire brigade to provide mechanical assistance if required but this involves a manual intervention.

Natural Ventilation Mode

Natural ventilation based smoke clearance systems depend on the stack effect caused in the extract shaft due to the pressure differential arising from the temperature difference between the hot smoke and cooler external air temperature. The flow rate achieved depends on the following factors;

- The height of the stack; i.e. the distance from the lobby extract vent to the roof top vent.
- The temperature of the external air.
- The temperature of the extracted air; i.e. smoke in the case of a fire.
- The cross sectional area of the shaft.

These factors can be used to calculate the flow rate as follows;

$$Q = CA \sqrt{2gh \frac{T_i - T_o}{T_i}}$$

Where;

Q	Flow rate	m ³ /s
C	Discharge coefficient	0.55 (based on a rough edged rectangular opening)
A	Flow area (shaft area)	0.48 m ²
g	Gravitational acceleration	9.81 m s ⁻²
h	Stack height (shaft length)	5.0 m (based on top floor worst case)
T _i	Internal temperature	473 K or 353 K
T _o	Outside temperature	301 K

For the purposes of this comparison the worst case condition is to be considered. This would be where the temperature differential between the smoke to be extracted and the external air is at its lowest and the height of the stack is the shortest possible distance. In this case, this occurs when the fire is at the highest floor during a summer's day of 28 °C.

Two smoke layer conditions are to be considered; the first is a high temperature layer of 200 °C, the maximum allowable temperature above an escape route.

The second is perhaps the more typical case of a lower temperature smoke layer of 80 °C associated with the dispersal of smoke from a fire in an adjacent space, for example in the event of a fire within a flat rather than in the common area.

The results are;

$$Q = 1.6 \text{ m}^3/\text{s} @ 200^\circ\text{C} (473 \text{ K})$$

$$Q = 1.0 \text{ m}^3/\text{s} @ 80^\circ\text{C} (353 \text{ K})$$

Manual Override Mode

The default operation of the system upon activation of a smoke detector is to open the smoke dampers on the fire floor and rely on natural ventilation as outlined previously to extract the smoke. There is, however, a manual override switch located on the ground floor adjacent to the dry riser inlet breaching valve which can be accessed by the fire brigade to operate the mechanical supply and extract fans in order to clear smoke.

Although this is not the default mode of operation upon detecting a fire, a comparison between the existing manually operated mechanical ventilation system and the proposed automated mechanical ventilation system will ensure that new system performs better than existing system in this manual operation mode.

The mechanical smoke ventilation as it is installed currently is a balanced 'push-pull' system. This means that an extract fan operates to remove smoke from the fire floor with make-up fresh air provided at the same rate of flow by a mechanical supply fan. This principle is to be retained but automated in the proposed new system.

The existing bifurcated extract fans (run and standby) were supplied by Victoria Fans Limited in 1993. Although no data of their duty was available from the manufacturer, they were able to provide the following specifications of the units:

Diameter: 400 mm

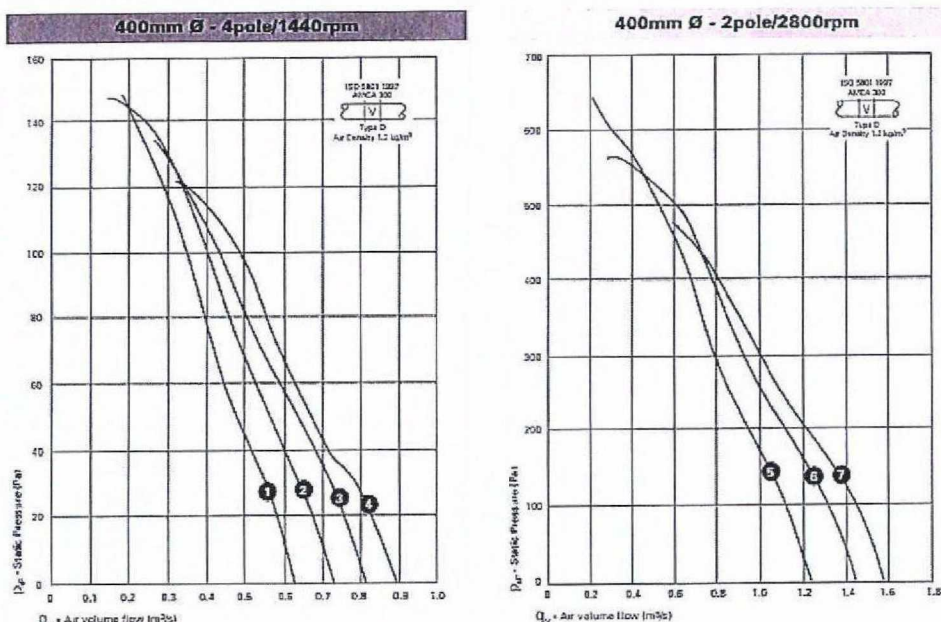
Blade Pitch: 8°

Motor: 0.55 kW

Motor Speed: 2850 rpm

This data is sufficient to allow comparison with fans of a similar specification to ascertain the flow rate at the calculated pressure drop of the extract shaft. For this purpose the fan curve data is to be taken from curve 5 of the extract from Nuaire's catalogue on the following page:

Bifurcated Axial Flow - 400mm ø



General							Electrical/Motor						Noise/Sound In-duct sound power levels dB re 1pW Inlet							
Curve No	Unit Code	Blade Angle	Speed RPM	Unit kg	A.V. Set	Motor frame size	1 Phase (230V-50Hz)			3 Phase (400V-50Hz)			Octave band mid frequency Hz							
							Motor kW	flc amps	sc amps	Motor kW	flc amps	sc amps	125	250	500	1k	2k	4k	8k	
400mm Ø - 4pole/1440rpm																				
1	AXB40M-411A*	20°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	-	85	79	76	74	68	60	50	
2	AXB40M-421A*	25°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	-	85	81	75	75	70	61	52	
3	AXB40M-431A*	30°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	-	85	81	77	76	71	64	55	
4	AXB40F-431A*	35°	1410	28	NAV2	LS71L	0.37	2.9	11.6	-	-	-	85	83	78	76	71	63	56	
400mm Ø - 2 pole/2800rpm																				
5	AXB40M-211A*	20°	2700	31	NAV2	LS80L	1.1	7.5	35	1.1	2.5	14	86	90	92	94	87	79	72	
6	AXB40M-221A*	25°	2700	31	NAV2	LS80L	1.1	7.5	35	1.1	2.5	14	87	96	93	93	87	80	74	
7	AXB40M-231A*	30°	2700	31	NAV2	LS80L	1.1	7.5	35	1.1	2.5	14	90	95	94	94	88	81	75	

Figure 1 - Nuair Comparible Fan Curves - <http://www.nuair.info/catalogue/Axial-AXB.pdf>

The worst case condition to be calculated in this case would be a fire on the lowest residential floor as this would be the index run for the system, i.e. would incur the largest pressure drop.

For the purposes of this comparison it can be modelled simplistically as a smoke damper in the lobby, a 90° bend into the shaft, a 55 m length of smoke extract shaft and a smoke damper prior to the extract fan. The following pressure drops have been applied to these components:

Lobby smoke damper:	10 Pa
90° bend:	8.3 Pa
Extract shaft:	0.3 Pa/m
Fan smoke damper:	7 Pa

This gives a total pressure drop in the system of 42 Pa.

When the total pressure drop calculated previously is applied to the relevant comparison fan curve, curve 5, it can be seen that:

$$Q = 1.2 \text{ m}^3/\text{s} @ 42 \text{ Pa}$$

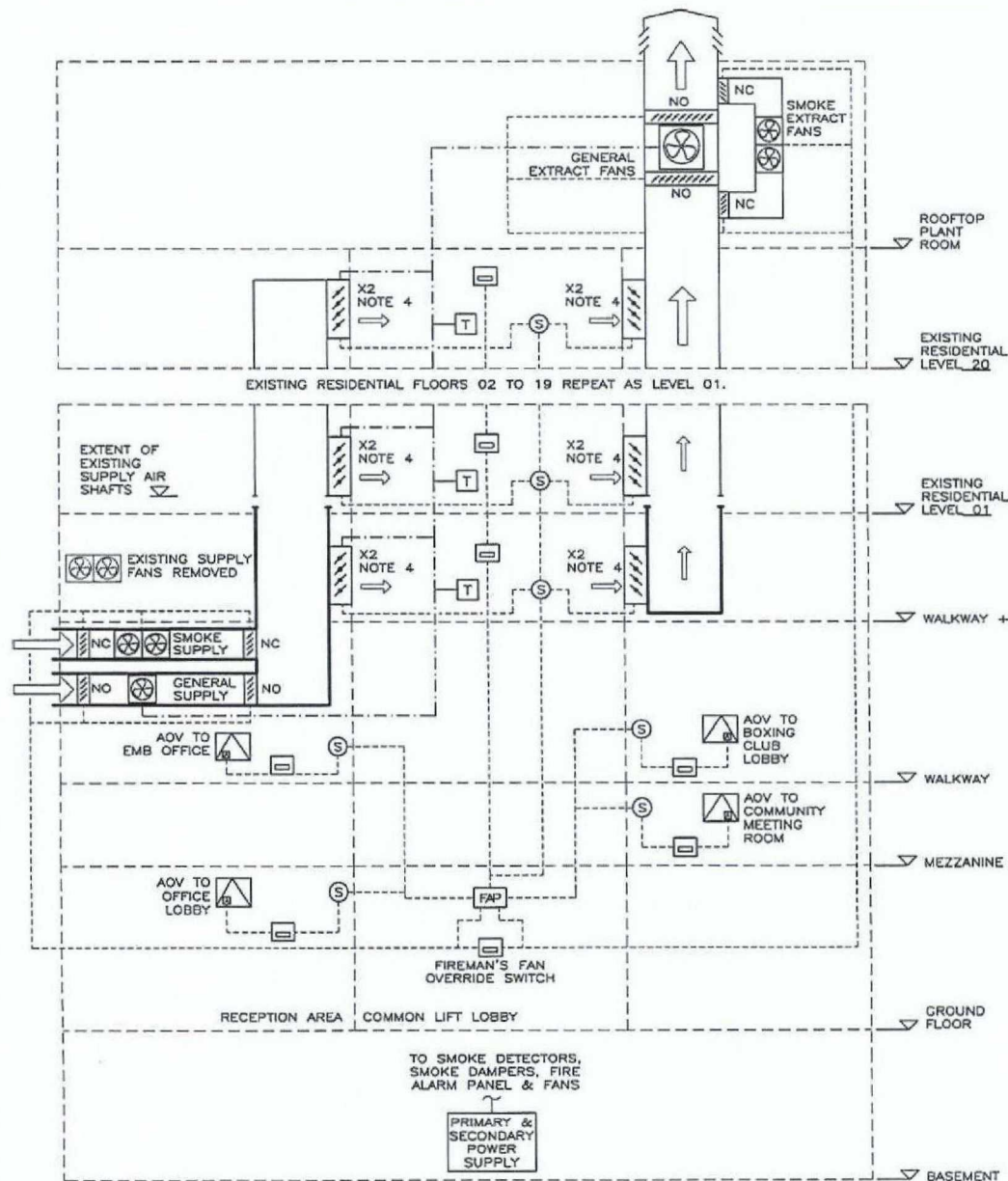
5 Comparison of Existing Calculated Performance with Proposed New System

The new fans will be sized to provide a minimum of $5 \text{ m}^3/\text{s}$ flow rate at the furthest point from the fans. This is line with current best practice for balanced 'push-pull' type smoke ventilation systems, with the figure arising from a $3.5 \text{ m}^3/\text{s}$ flow rate through an open door to prevent smoke ingress from the lobby to the escape stair during escape plus an additional $1.5 \text{ m}^3/\text{s}$ allowance for leakage from the existing unlined builder's work shafts and remaining dampers on other floors.

Method	Flow Rate – Worst Case (m^3/s)
Existing Natural Ventilation	1.0
Existing Mechanical Ventilation (manual override)	1.2
Proposed Mechanical Ventilation (automated)	5.0

Table 2 - Performance Comparison of Existing and New Systems

From the table above it can clearly be seen that the performance of the smoke ventilation system in Grenfell Tower will be considerably improved as part of the refurbishment works. In addition, the new system will also be significantly more reliable and easier to maintain than the current system.



NOTES:

- DO NOT SCALE FROM THIS DRAWING
- READ IN CONJUNCTION WITH THE MF TENDER DOCUMENTATION.
- READ IN CONJUNCTION WITH THE T(90)01 SERIES COMBINED MECHANICAL LAYOUTS.
- ONLY HALF THE DAMPERS & DUCTS SHOWN FOR CLARITY. EACH FLOOR HAS TWO SUPPLY AND TWO EXTRACT DUCTS SERVING EACH LOBBY. EACH MOTORISED DAMPER IS TO BE NORMALLY OPEN, WITH ALL DAMPERS EXCEPT THOSE ON THE FIRE FLOOR CLOSING IN THE EVENT OF A FIRE.
- EXISTING SMOKE EXTRACT SYSTEM SUPPLY AIR FANS LOCATED IN CEILING VOID OF WALKWAY+1. THESE FANS WILL BE REMOVED. PROPOSAL IS TO INSTALL NEW FANS IN LOCATION SHOWN ON T(90)01_102.

T2	20/11/13	STAGE E TENDER ISSUE	MJS
T1	01/11/13	STAGE E TENDER ISSUE	MJS
rev	date	description	eng

KEY	
	DIRECTION OF AIR/SMOKE FLOW
	EXISTING DUCT
	NEW DUCT
	SMOKE EXTRACT CONTROL LINE
	VENTILATION CONTROL LINE
	NEW AUTOMATIC OPENING VENT (AOV) 0.4 m ² FREE AREA
	NEW SMOKE DAMPER
	NEW SMOKE DAMPER (NORMALLY OPEN)
	NEW SMOKE DAMPER (NORMALLY CLOSED)
	FIRE ALARM PANEL
	FIREMAN'S OVERRIDE SWITCH
	SMOKE DETECTOR
	NEW/EXISTING FAN REUSED
	EXISTING FAN REMOVED
	WINDOW ACTUATOR
	TEMPERATURE SENSOR FOR GENERAL COOLING CONTROL

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STUDIO E LLP

job title

GRENFELL TOWER

REGENERATION

project leader	date	scale (at A3)
DC	NOV' 2013	NTS

drawing title

CORE SERVICES

SMOKE VENTILATION

SCHEMATIC

job no	dwg no	rev
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