HKIE CPD Training Course (II)

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Organization by
The Hong Kong Institution of Engineers – Fire Division
Co-organized by the Association of Registered Fire Services
Installation contractors of Hong Kong Ltd (FSICA)

Prescriptive Requirement for Smoke Control
1. Introduction

Smoke Control

Ventilation/Air Conditioning Control (VAC)

Staircase Pressurization System

Smoke extraction

2. Ventilation/Air Conditioning Control System (VAC)

An automatic control system, designed to stop mechanically induced air movement within a designated fire compartment, actuated by smoke detectors and provided with a central manually operated backup facility.
2.1 Purpose of VAC

To reduce air movement within the compartment on fire

i.e. to allow smoke to rise and form a layer at ceiling level which will not be disturbed by the introduction of air into that smoke layer.

2.2 Method of Control

Method A - Compartment/unit is provided with a smoke detector automatic fire alarm system, on activation of that system all fans serving that compartment shall be shut down.

Method B - Smoke detector is installed in the exhaust and/or re-circulated ductwork which on sensing smoke will shut down all the fans in the mechanical ventilation system.

Method C - All fans in the building shall be shut down by the building fire alarm.
2.3 Exemption

Mechanical Ventilation System forming part of the Fire Service Installations.

Individual, self contained or split type, direct expansion room cooling units.

Minor mechanical ventilation system (all air distribution ductwork systems are contained within the same compartment and the air flow rate does not exceed 1,000 litres/sec).

Mechanical ventilating system handling toxic gas or grease/air mixtures, fume cupboard ventilation.

Mechanical ventilating system where all air is supplied at low level and/or extracted (not re-circulated) at high level.

Individual plant rooms, and individual toilets which are mechanically ventilated directly to outside.
2.4 Other reference-


Dear Sirs/Madams,

FSD Circular Letter No. 2/2005 Ventilation/Air Conditioning (VAC) Control System

Ventilation/air conditioning control system is classified as fire service installation. The relevant specification is detailed in Section 5.25 of current Code of Practice for Minimum Fire Service Installations and Equipment.

In the past, there have been a lot of enquiries from the industry and trade in connection with how different configurations of air conditioning and mechanical ventilation (ACMV) system could meet the requirements of this control system. With a view to facilitating the industry and trade to understand the relevant requirements, in the more comprehensible approach, a set of schematic drawings appended to this Circular Letter is prepared for general reference. These drawings are the results of co-operation between the Industry and this Department after meticulous reviews and discussions on various possible scenarios. A summary of the requirements in table form for typical cases is also produced as Annex for easy reference.

The cases presented in these drawings basically cover different ACMV system layouts commonly encountered. However, should these be other cases requiring further clarifications, enquiry can be made to Fire Service Installations Division of this Department.

As this Circular Letter does not involve any change of current statutory requirements, it is effective immediately.

Yours sincerely,

[Signature]

G.K. Chang-hang
CASE 1/1 - PAU IN OPEN VENTILATED ROOM SERVING SINGLE COMPARTMENT

VAC control logic for four scenarios:

1. PAU (P) - VCU (1000) and P CU - VCU (1000)
   - Requirement: PAU and these FCUs should be shut down. (Note: FCUs = 1000 s within the compartment are not required to be shut down)

2. PAU (P) - VCU (1000) and P CU (P) (Note: P CU should be shut down, whereas PAU is taken to be serving the fire compartments including PAU Room)

3. PAU (P) - VCU (1000) and P CU (P) (Note: P CU should be shut down)

4. PAU (P) - VCU (1000) and P CU (P) (Note: FCUs = 1000 s within the compartment are not required to be shut down)

Please refer to "Notes" on drawing no. PS-701/1 for acceptable methods to install the VAC control system.

CASE 1/2 - PAU IN OPEN VENTILATED ROOM SERVING MULTI-COMPARTMENT SINGLE FLOOR

VAC control logic for four scenarios:

1. PAU (P) - VCU (1000) and P CU (P) (Note: P CU should be shut down. (Note: FCUs = 1000 s within the compartment are not required to be shut down)

2. PAU (P) - VCU (1000) and P CU (P) (Note: Only PAU should be shut down)

3. PAU (P) - VCU (1000) and P CU (P) (Note: Only PAU should be shut down)

4. PAU (P) - VCU (1000) and P CU (P) (Note: FCUs = 1000 s within the compartment are not required to be shut down)

Please refer to "Notes" on drawing no. PS-701/1 for acceptable methods to install the VAC control system.
2.5 Submission of Drawings
Building Plan submission

Working drawing submission

Method of control to be stated-
  Method A, B, or C
Layout -
  Air handling equipments to be shut down
  should be coloured.
  VAC control zones should be indicated.
Schematic
  Air side should be provided with air flow
  rate.

Fire dampers, fire and smoke dampers should be shown.
VAC shut down table incorporating room names, equipment designations and zones.

Control Panel

Adjacent to FS main control panel.
Manual override to switch off each VAC control zone with fan running/shut off indicating lights.
3. Staircase Pressurization

3.1 Objective

i. To keep the protected staircase free of smoke for the people to escape in the event of fire.

ii. To provide a smoke free area for firemen to fight the fire.

3.2 Provision of Staircase Pressurization Requirement

General Building (e.g. commercial high bldg.) Required where:
- natural venting of Staircase is not provided;
- The aggregate area of openable windows of the room/unit of the building does not exceed 6.25% of the floor area of those room/units, calculated on floor to floor bases; and:
- the cubic content of the building > 28,000 cubic metres; and
- the design fire load of the building is likely to exceed 1,135 MJ/m².
Basement exceeding 230m²

SPS is required for basement of 3 or more level where:

- No open air access routes for firemen are provided; and
- the cubic content of the basement exceeds 7,000m³; and
- the designed fire load of the basement is likely to exceed 1135 MJ/m².

The no. of pressurized staircase to be provided shall be determined by the table stipulated under the definition of pressurization of staircase in Pt II of Code of Practice but shall not exceed that required by cod of Practice for Means of Escape.

The requirement of SPS should be sort out during the submission of Building Plan.
3.3 Design of Staircase Pressurization

Follow Code of Practice and B.S. Standards 5588 Pt 4-FSD circular letter 2/2006 refers.

For escape purpose- air flow velocity requirement shall be 0.75m/s on fire floor.

For fireman's access, air flow velocity requirement shall be 2m/s.
3.4 Drawing submission

Building Plan Submission

The staircase to be pressurized, type of pressurization should be stated clearly in the approved F. S notes. The area to be pressurized should be coloured.

Working Drawing submission
All working drawing shall be signed by Registered Professional Engineer on Building Services or Mechanical Engineering.

Calculation shall be submitted to show the air flow requirement during close door state, open door state and that the force to open the door does not exceed 100N. The air relief requirement and air release requirement design are supported by the calculation.

Layout drawings should show all pressurization fan, pressurization ductwork, air relief and air release ductwork. The fans and ductwork should be coloured as:
Fresh air - dark green
Exhaust air duct-light blue
FRP encl/duct- Yellow/red
Ductwork shall comply DW144
Fresh air intake at roof - 2 fresh air intakes facing different
directions complete with smoke detectors and fire &
smoke dampers.

**Schematic**
MOE- Class A system, 3 consecutive level door egress
velocity 0.75 m/s and with final exit door open
MOA-fire floor door air flow velocity 2m/s. The following
doors open between:
1. the stair and the lobby on the fire-affected storey;
2. The stair and the lobby on the adjacent storey;
3. The firefighting lift well and the lobby;
4. The stair and the final exit

Close door state
- 50 Pa at staircase,
- 45 Pa at lift lobby

Air release path
Pressure relief facilities

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**List Two - Clauses to be replaced by modified conditions**
(Schedule for the use of BS5588 : Part 4 : 1990 Incorporating
Amendment No. 1 and Corrigendum No. 1)

Appendix I

(Ta replace Figure 1 in page 9 of BS5588, part 4)
Compartmentation is top priority.

Normal, fire, no power mode.
Motorized fire and smoke dampers fail safe status.

Buildings overall height less than 30 m - single injection or multiple injection system. Building overall height of 30 m or more - multiple injection system with air supplies at no greater than 12m apart.

Sleeping accommodation with single pressurization stair- duplicate fans and motors.
More than 1 pressurization staircase- single fan with duplicate motors.
Essential power supply.
Power supply cable to BS6387 cat. CWZ or BS6207 or BS EN60702 or other international standards acceptable to FSD.
### Minimum Fire Resisting Cable Requirements for Fire Service Installations

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<tr>
<th>Item</th>
<th>Type of Fire Service Installations</th>
<th>Minimum Cable Requirements</th>
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<tr>
<td>1.</td>
<td>Audible/visual advisory systems</td>
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<td>2.</td>
<td>Automatic fire-fighting systems (other than sprinkler systems) using water</td>
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<td>3.</td>
<td>Deluge systems</td>
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<td>4.</td>
<td>Drencher systems</td>
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<td>5.</td>
<td>Fire alarm systems</td>
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<td>6.</td>
<td>Fire hydrant/pump systems</td>
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<td>7.</td>
<td>Fire extinguishing systems</td>
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<td>8.</td>
<td>Ring main systems with fixed pumps</td>
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<tr>
<td>9.</td>
<td>Water spray system</td>
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<td>10.</td>
<td>Emergency generators</td>
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<td>11.</td>
<td>Fireman’s lifts</td>
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<tr>
<td>12.</td>
<td>Pressurization of stairwells</td>
<td></td>
</tr>
</tbody>
</table>

Power supply cables from emergency generator to main switchboard to conform with:
- BS 6387 Part 1
- BS 6207 or BS EN 60702
- Other international standards acceptable to the Director of Fire Services.

Control

Actuation of system shall be by smoke detectors in accommodation area.

For building or that portion of a building without smoke detection system, smoke detectors shall be installed at a distance not exceeding 1 m from and outside the access doors to activate the system.

System shall achieve 90% - 110% of the new volumetric requirements within 5 seconds of a door being opened or closed.

Sail switch, pressure switch shall be industrial grade to BS EN60654 part 1.

Switchboard, type test cubicle form to BS5486 (BS EN60439 part 1) with 2mm thick steel located in 2 hr FRP room containing no other equipment.
Control panel

• Adjacent to FS main control panel.

• Manual override with manually reset including facilities:

  • On-off switches for each pressurization fan, fan running indicating lights.

  • Schematic air flow diagram.

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4. Smoke Extraction System

The purpose of the smoke extraction system is to assist in the provision of a clear egress for escaping persons and to assist fire-fighting in attacking & controlling a fire.
4.1 Classification

(a) Static system

(b) Dynamic smoke extraction system

4.2 Static system

A smoke extraction system utilizing smoke reservoirs, localized ducting; and permanent openings and/or automatic opening of windows, panels or external louvers actuated by smoke detectors; to remove, on the principles of natural ventilation, smoke and products of combustion from a designated fire compartment.

Smoke zoning area should not exceed 500 square metres per zone.

Smoke barrier should be permanently fixed or operates only when activated. It shall be with FRP of not less than 1 hour.
Smoke discharge area:

Free area > 2% of the floor area served by the system. Not less than half shall be permanently open or automatically actuated.

Permanent openings-signs shall permanently displayed on or adjacent to the opening.

Operating devices shall be to approval of Fire Services Department.

Mass flow rate of vented smoke (ref. CIBSE Guide E)

\[
M_{\text{out}} = \frac{C_d A_{vo} P_o (2g(h-z)(T_s-T_o)T_o)^{1/2}}{T_s^{1/2}(T_s + (A_{vo}/A_v)^2T_o)^{1/2}}
\]

4.3 Dynamic System

General requirement
- 8 air change per hour for the whole compartment for general occupation. The design volume is to be 7,000 m\(^3\) for compartment of 7,000 m\(^3\) or less.
- System design shall be 'fail safe' to ensure a free passage of smoke.
- Systems shall be automatically activated.

Specific requirement for Basement
- Separate system shall be provided for each compartment.
- Each system shall comprise at least two independent plants and ductwork.
- Emergency electrical supplies shall be capable of operating simultaneously all system relevant to Smoke Extraction Systems in the two adjacent compartments having the highest total electrical load.
4.4 Drawing Submission
Building Plan-Area to be provided with smoke extraction should be stated clearly in F.S. notes.

Working Drawing Submission
All drawings and calculation shall be signed by designer who shall be Register Professional Engineer on Building Services or Mechanical Engineering.

Layout Drawing:
• Ductwork shall be coloured:
  Smoke extraction - brown
  Make up air - light green
  FRP enclosure - yellow/red
• Smoke travel distance – not more than 30m.
• At least 1 extraction point per 500m$^2$.
• Make-up air 80% minimum of smoke extraction.

Maximum air velocity
| Natural make-up air inlets (at low level) | 3 m/s |
| Mechanical make-up air (at low level)    | 6 m/s |
| At extract grilles                      | 6 m/s |

• Horizontal/upward smoke discharge-3m above finished floor level.
• Downward smoke discharge-6m above finished floor level.
• Smoke shaft shall contain no other services.

• Ductwork shall comply with DW144 and pressure test to DW143.

• Ductwork outside service compartment shall be insulated for 30min to BS476 part 24, and FRP to BS476 part 20 same as service or contained compartment whichever is the larger.

• Smoke curtain shall comply with BS7346 part 3 and BS12101 Part 1.
Schematic

• Fire compartmentation to be ensure all the time.
• There shall be no fire & smoke dampers except multi-zone system.
• Dampers shall be fail safe open to ensure free passage of smoke and mode table shall be submitted with normal & no power mode.
• Equipment handling smoke shall be suitable for continuous operation at 250°C for not less than 1 hour. The equipment includes fans, motors, drives, damper operators, ductwork, flexible ducts etc.
• Duplicate plants are required for sleeping accommodation and dual purposes.

• Essential power supply to be provided.

• Power supply cable to BS6387 cat. CWZ or BS6207 or BS EN60702 or other international standards acceptable to FSD.

• Control cables to BS6387 cat. AWX or SWX or BS 6207 or BSEN60702 or other international standards acceptable to FSD.
### Control

- Actuation of system shall be by smoke detectors.
- Sprinkler system operation shall cause the actuation as well.
- No. of zone operations (e.g. Commercial bldg. 1 above ground in addition to any requirement for Basement and Atria).

- Sail switch, pressure switch shall be industrial grade to BS EN60654 part 1.

- Switchboard, type test, cubicle form to BS5486 (BSEN60439 Part 1) with 2mm thick panel steel located in 2 hour FRP room containing no other equipment.

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Remarks:

Cables under any of the following conditions may be exempted from the above minimum requirements:

- Cables installed and terminated in switch/plant room;
- Cables inside concealed metallic or PVC conduits which are embedded by plaster/concrete to a depth of at least 12 mm;
- Cables inside underground cable ducts or reinforced concrete cable trenches;
- Cables embedded in the soil to a depth of at least 300 mm;
- Cables within fire resisting cable ducts and are not mixed with other services (e.g. switchgear etc.) the fire resistance of cable ducts to be not less than that of the building.
Control Panel

• Adjacent to FS main control panel.

• Label indicating authorized personnel operation.

• Manual override with manually reset including:

  On-off switches for each smoke fan, fan running indicating lights.

  Schematic air flow diagram provided adjacent to control panel.

5. Inspection and Testing

• Application for initial inspection and testing for smoke control should be made via the prescribed form (FS501) at the same time as for other FSI installation. The form shall be signed by both registered fire service installation contractor and the Authorized Persons.

• Equipment list together with certificate and/or approval from DFS should be submitted.

• Signed testing reports should be submitted.
• For staircase and smoke extraction system, certificates shall be signed by the designer certifying on behalf of the design company/organization that the installations are operating in accordance with his design and to requirement of Fire Services Department.

• Instruments for testing purpose shall be provided in duplicate and be calibrated not more than 3 months prior to the test.

• Complete testing records shall be taken.

6. Common mistakes

General

Application for inspection of smoke control system should be submitted at the same time as that for other FSI installation.

VAC
• Tripping of ventilation fan is not by smoke detector.
• Manual override switch for ventilation is not provided.
• VAC grouping or VAC control mode - no fire rated wall to separate the compartment (this includes the fire separation at ceiling void as well).
• Incorrect VAC control zone.
Staircase Pressurization

• The air flow requirement could not be achieved within 5 seconds at changed from close door state

• The pressure differential requirement could not be achieved from open door state—i.e. open door force exceed 100N.

• Installation of FR enclosure not completed.

• SPS supervisory panel without audio alarm when activated under manual condition.

• Provision of duplicate fans complete with motor for air release system where the extract air/smoke from the accommodation area is the sole means of creating the pressure differential.

Smoke extraction system

• Smoke discharge outlet being not separated by 5m in any direction from other opening into the building.

• Smoke discharge is less than 3m AFFL.

• Make up air data for being at least 80% of smoke extraction is lacked.

• Smoke extraction should be from high level near the ceiling.

• Testing of ductwork to DW 143 record.

• FRP separation to the smoke extraction system from other ventilation/air conditional system inside the plant rooms.
• Skylight and framework of smoke reservoir should comply with Code’s requirement.

• Smoke extraction duct fan & associated control are lack of label.

• Local control panel should comply with BS5486 (or equivalent).

• Smoke extraction points were not evenly distributed.