



Technical Submittal

Smoke Extract Stairwell Ventilation

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Verified	T Fielding Fox			

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Executive Summary

The purpose of this technical submittal is to provide the reader with an overview of the smoke ventilation scheme to be provided at the below mentioned site. It also provides details of the system makeup and the equipment to be used to achieve the smoke ventilation solution.

Appendix A - Basis of Design

- NSE-MEE-NS-XX-TS-Z-008002, MCFC Redevelopment Mechanical & Public Health Services Specification, P01
- NSE-MEE-ZZ-XX-TS-E-008002, MCFC Redevelopment Electrical Services Specification P01

Appendix B - Manufacturers Details

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Appendix C - Technical Literature

As per technical data attached - see appendix H.

Appendix D - Compliance

In line with the mechanical specification and equipment schedule:

NSE-MEE-NS-XX-TS-Z-08001

NSE-MEE-NS-XX-LS-M-008312

Appendix E - Non -Compliance

N/A

Appendix F - Programme

Lead time of 12 - 20 weeks

The Purpose of this technical submission is to inform the Etihad client team and professional team of SES intent regards to procurement of systems and equipment to enable input into the MEP design and therefore complete the systems MEP design.

The Technical submission is by no means intended to show full systems design by the way of MEP design drawings and schematics.

Drawings and Schematics will follow once technical submissions have reached A or B status and the technical information from within the approved submission has been inputted into the MEP design.

Appendix G - Drawing Reference

NSE-SEE-NS-ZZ-DR-M-57ZZZZ

Appendix H - Attachments

Etihad Hotel SMOKE EXTRACT SYSTEM Technical Submission
Technical Submission NSE-SEE-HT-ZZ-TEC-M-001001-P01

NSE-SEE-HT-ZZ-TEC-M-601001 Revision P01 Etihad CFD
Proposal Hotel

Etihad North Stand SMOKE EXTRACT SYSTEM Technical
Submission Technical Submission NSE-SEE-NS-ZZ-TEC-M-
000001-P02

NSE-SEE-NS-ZZ-TEC-M-600001 Revision P02 Etihad CFD
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NSE-SEE-NS-ZZ-TEC-M-600001
Revision P02

Etihad

CFD Proposal

North Stand

Prepared For:
SES

28th June 2024

Gavin Walker
Colt International Limited

CFD PROPOSAL ACCEPTANCE SHEET	
Project Name:	Etihad
Colt Project Reference:	ANAC87
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Revision:	P02
Document Title:	CFD Proposal – North Stand

DOCUMENT STATUS <i>To be completed by the reviewer</i>		
Status	Description	Tick
A	All modelling parameters and acceptance criteria understood and agreed.	
B	Minor comments (e.g. typographical errors) that do not affect the modelling parameters and acceptance criteria.	
C	Comments that affect the acceptance criteria or input parameters.	
Comments: <div style="height: 150px; border: 1px solid black;"></div>		

REVIEWER DETAILS <i>To be completed by the reviewer</i>		
Signature:		Date of Review:
Print Name:	Position:	On behalf of:

CFD modelling will not be commenced until status A or B is achieved.

Any additional modelling requested after commencing CFD modelling may be treated as a variation.

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Issue	Date	Reason	By
P01	28 June 2024	Preliminary Issue	G. Walker
P02	24 July 2024	Role Code Changed	G. Walker

1. Introduction

This document outlines the proposed Computational Fluid Dynamics (CFD) analysis of the smoke control system to be installed within the North Stand fire-fighting lobbies in the Etihad development in Manchester. The development is a stadium to host sports and concert events. The North Stand building extends from ground to 5 upper floors.

Approved Document B (Fire Safety) to the Building Regulations (ADB) recommends that buildings with an occupied floor 18m or more above or 10m below fire service access level should be provided with a fire-fighting shaft [1]. In the event of a fire in the building, a fire-fighting shaft allows quick and safe access for firefighters to enter the building and conduct fire-fighting activities. Normal protocol is for the firefighters to set up a bridgehead, typically one or two floors below the fire floor, and tackle the fire from the fire-fighting lobby on the fire floor. The stair serves a floor that is greater than 18m above fire service access level and is therefore designated as a fire-fighting stair.

Further guidance within BS 9999:2017 recommends that measures are put in place to ensure that the use of fire-fighting shafts is not restricted by smoke [2]. Therefore, a smoke control system is required to provide protection against smoke entering the stairwell. Four types of smoke control system are described in BS 9999:2017; pressure differential systems, mechanical smoke ventilation systems, natural ventilation using shafts and natural ventilation using Automatic Opening Ventilators (AOVs). It is proposed to use a mechanical smoke ventilation system in this building. BS 9999:2017 recommends that the performance of mechanical smoke ventilation systems is proven through CFD analysis [2].

According to the Fire Strategy Report NSE-SHF-NS-XX-TR-O-000005_P02-MCFC North Stand Stage 4 Fire Safety Strategy, it was proposed that a mechanical smoke ventilation system would be required for the protection of the fire-fighting stairs.

The purpose of this proposal is to detail the parameters used in the CFD modelling and the acceptance criteria.

The CFD modelling will assess the temperature and visibility conditions in the stair and lobbies during the escape and fire-fighting phases. Acceptance criteria have been determined after review of guidance and recommendations contained within the ADB, British Standards, Smoke Control Association publications and project specific specification documents.

2. Modelling Approach

2.1 Acceptance Criteria

The performance requirements of mechanical smoke ventilation systems that are used to protect fire-fighting shafts are described within BS 9999:2017. It recommends that the mechanical smoke vent system should provide conditions that are as good as, if not better, than the conditions that would be provided by a natural shaft as described in BRE Project Report 79204 [3]. The Fire Strategy Report also states this as a requirement.

Therefore, the acceptance criterion for the system will be that the conditions provided by the mechanical smoke ventilation system should be at least equivalent to, if not better than, those provided by the natural shaft system.

Conditions will be measured in terms of visibility and temperature within the fire-fighting lobby and stairwell. Temperatures will be measured at 1.5m above floor level as recommended in the Smoke Control Association (SCA) guide [4].

To ensure that occupants of the building are still able to open doors to make their escape it is essential that door opening forces are kept to a suitable level. BS EN 12101-6:2005 recommends that the maximum door opening force for a pressure differential system is 100N [5]. This is based on systems where the maximum pressure differential across a door is 55Pa. Therefore, at no point during the simulation should the pressure differential between the fire compartment and the fire-fighting lobby or the pressure differential between the fire-fighting lobby and the stairwell should not exceed 55Pa.

2.2 Scenario Selection

In order to ensure that the simulation is representative of a real scenario that could occur within the building it is necessary to evaluate all possible scenarios to determine which are the 'worst case' scenarios. If the smoke control system can meet the acceptance criteria when subjected to the 'worst case' scenario it can be determined that it would meet the acceptance criteria in any other, less onerous scenario.

When considering a smoke control system that is used to provide protection to the fire-fighting stairwell, the 'worst case' scenario is the scenario in which it is most difficult to prevent smoke from entering the stairwell. There are a number of factors to be considered which may make a fire in a particular location more or less onerous than fires in other locations. Factors to be considered include;

- The location of fire compartment doors in relation to the stairwell door.
- The volume of the fire compartment.
- Proximity to the head of stairwell ventilator.

It is essential to ensure that the smoke control system can prevent smoke from entering the stairwell during the fire-fighting phase. When the firefighters open the door to the fire compartment smoke and heat that has built up in the compartment between the escape and fire-fighting phases is released into the corridor, often at high velocity. To prevent the heat and smoke from entering the stair the smoke control system must counter this before it reaches the stairwell. The 'worst case' scenario for protecting the stair will be a fire located in a compartment that is closest to the stairwell as it provides the least opportunity for the smoke control system to prevent smoke entering the stairwell.

The design fires used for CFD simulations of smoke control systems do not vary with compartment size, unless the compartment is too small to accommodate a fully developed fire. The volume of smoke and heat generated by the fire will be the same. This is to ensure repeatability and also to allow comparisons to be made between different scenarios. Smaller fire compartments will fill with smoke more rapidly than larger compartments and can result in larger volumes of smoke entering the corridor. It is therefore important to

consider fire compartment size as smaller fire compartments can provide more onerous conditions than larger fire compartments.

A fundamental operating principle of mechanical smoke extract systems is that fresh air is drawn from the stairwell when the door to the stairwell is opened. This is achieved by depressurising the corridor in relation to the stairwell so that when the door is opened fresh air can be drawn into the corridor via the stairwell and the AOV at the head of the stairwell. It is therefore necessary to consider the distance between the fire affected floor and the head of stairwell AOV. On floors which are more remote from the head of stairwell AOV the smoke control system will have to overcome greater resistance to airflow due to the stairwell than on floors which are closer to the head of stairwell AOV.

A study of the building has been carried out to assess the worst case scenario. One location has been identified.

- A fire located in the third floor telecommunications room shall be modelled because:
 - The majority of the rooms in the fire-fighting cores are sprinklered. This room is unsprinklered, therefore a larger theoretical fire is possible.
 - The third floor is the only floor with unsprinklered rooms.
 - The other unsprinklered rooms on the third floor are further away from the stair door, therefore posing less risk of smoke ingress into the fire-fighting stair.

The layout of the third floor is shown in Figure 1. The stairwell is shown in green, corridor in orange, fire-fighting lobby in blue, fire compartment in red and smoke extract shaft in pink.

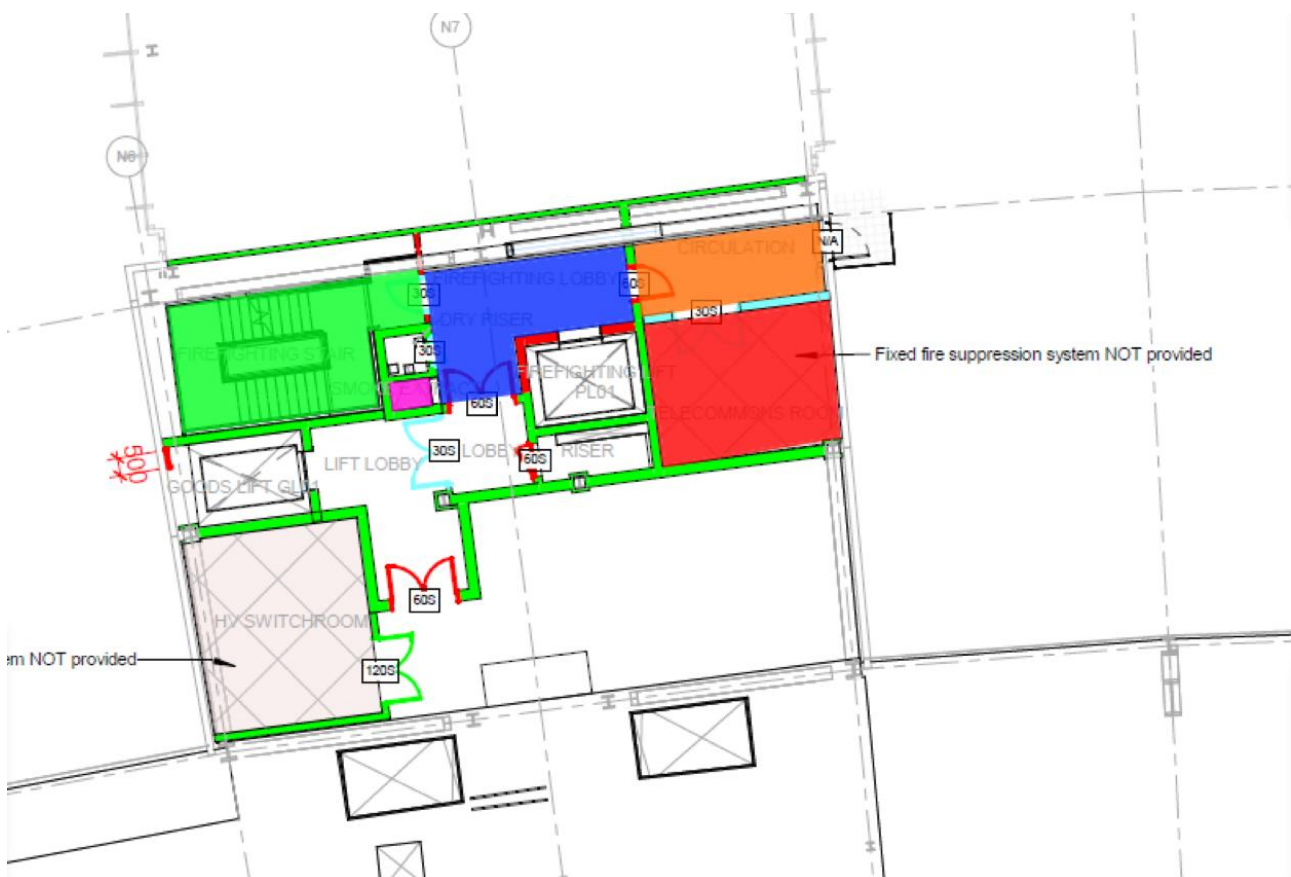


Figure 1: Third Floor, NW Stair

3. Model Details

3.1 Background Information

The simulation must be representative of a real scenario that could occur within the building. It is therefore important that the 3D model that is produced for the simulation reflects the geometry of the building that it is intended to represent. A number of sources of information will be used to obtain data for producing the 3D model, including architects layout drawings and sections and the project specific fire strategy. This information will then be incorporated into the 3D model which intends to reflect the actual geometry of the building following the interconnecting grids as a guide.

Information and details were obtained from the following sources:

- Ashton Fire:
 - Fire Strategy Report:
 - NSE-SHF-NS-XX-TR-O-000005_P02
- Populous:
 - General Arrangement Plan:
 - NSE-POP-NS-03-DP-A-001504_C01
 - Section:
 - NSE-POP-ZZ-ZZ-DS-A-000202_PROPOSED GRIDLINE N7 SECTION_S4 - (by LAP)_P00

3.2 Modelling Software

The CFD software used for this analysis will be Fire Dynamics Simulator (FDS 6.7.9) from the National Institute of Standards and Technology, United States Department of Commerce (See Appendix A).

The model will consist of a number of interconnecting grids which define the extent of the simulation domain. The grids will cover areas of the building which are key to the outcome of the simulation such as the stairwell, lobbies and smoke extract shafts. Additionally a single office area will be included as the location of the fire.

3.3 Mesh Resolution

It is widely acknowledged that mesh and cell sizes have a significant effect on the accuracy of the results of a CFD simulation. One that uses a finer mesh with a smaller cell size will produce more detailed results than a simulation that uses a much coarser mesh with a larger cells. It must also be recognised that using a smaller cell size increases the number of cells in the model so will increase the time taken to complete the simulation.

Therefore it is important that a cell size is used that allows for an appropriate level of detail within the results and also does not result in unnecessary long run times. A recommendation is made within the FDS User's Guide that a 100mm cell size may be "adequate" for assessing the spread of smoke through a building [6]. The suitability of cells of this size can be assessed using the calculations for Plume Resolution Index given within the FDS Validation guide [7].

$$Plume\ Resolution\ Index = \frac{D^*}{\delta x}$$

Where: D^* is the characteristic fire diameter in metres.
 δx is the cell size in metres.

The characteristic fire diameter is given by the equation in the FDS User's Guide [6]:

$$D^* = \left(\frac{\dot{Q}}{\rho_{\infty} c_p T_{\infty} \sqrt{g}} \right)^{\frac{2}{5}}$$

A range of values of D^*/dx between 4 and 16, where 4 represents a coarse mesh and 16 a fine mesh, are commonly regarded as acceptable.

When calculated based on a cell size of 100mm D^*/dx equals 4.174132, if the heat release rate of the fire is 125 kW. As the value D^* increases as the total heat output of the fire increases it can be concluded as long as the heat output of the fire is at least 125 kW a 100mm cell size is appropriate for the simulation.

In areas of the model that are remote from the fire and are less significant to the outcome of the simulation, a coarser cell size of 200mm shall be used.

3.4 Input Parameters

The building is fitted with a sprinkler system, however the telecommunications room is not sprinkler protected. Following the recommendations in CIBSE Guide E for industrial occupancies, which a telecommunications room/plantroom can be considered as, the fire will be modelled with a medium t^2 growth rate and a heat release rate per unit area of 260 kW/m². The maximum fire size will be determined by sensitivity analyses using a prescriptive low level ventilator as discussed in section 3.5.

A polyurethane fire with a soot yield of 0.1 (10%) will be used. Visibility factors are based on distances to light reflective signage. By default, FDS assumes that soot is transported just like all other gaseous species. That is, the soot particles are small enough that their settling velocity is small compared to the fire-driven flows of the gas containing the soot. Deposition cannot be defined using the mixture fraction model.

Single-Step Mixing-Controlled Combustion will be enabled. This approach to combustion considers a single fuel species that is composed primarily of C,H,O, and N that reacts with oxygen in one or more mixing-controlled steps to form H₂O, CO₂ and soot.

3.5 Fire Compartment Ventilation

In order to sustain combustion within the CFD model it is necessary to provide ventilation to the fire compartment outside to ensure that combustion continues without the fire being completely starved of oxygen. As there are no windows provided to this room, the worst case scenario is for the door to have been propped open, so leakage to the fire compartment is provided when the stair door is opened.

It is proposed to carry out sensitivity analysis of the largest fire size that can be suitably ventilated with leakage from the stairs. When the doors are closed to the stairs, a low level opening will be introduced to the room to ensure the fire sustains its size, which will be turned off when the door is opened.

3.6 Leakage

It is expected that the lobbies on-site will not be perfectly sealed. There is likely to be leakage from a number of sources including other fire doors, lift doors and general leakage through the construction. To account for this, leakage areas will be specified for the fire doors and lift doors. Following the guidance within BS EN 12101-6:2005 [5], the following leakage areas will be set:

- Single leaf door opening outwards from a pressurised space – 0.02m²,
- Single leaf door opening into a pressurised space – 0.01m²,
- Double leaf doors – 0.03m²,
- Lift shaft doors – 0.06m².

3.7 Ventilation System

Two models will be presented, a model of a BRE natural smoke shaft representing the code compliant solution and a model of a Colt Shaft Variable representing the proposed mechanical solution.

BRE Natural Smoke Shaft – Code Compliant Smoke Control System

The BRE natural smoke shaft will consist of a single 3m^2 vertical shaft, connected to the fire-fighting lobbies on each floor via a 1.5m^2 free area lobby ventilator. The shaft will have a 2.0m^2 free area ventilator at the top. In event of a fire the lobby ventilator on the floor where the fire was detected will open as well as the ventilator at the top of the shaft. Fresh air will be drawn from the stairwell when the door to the stairwell is opened.

The stairwell is provided via a 1.0m^2 ventilator from the top storey to outside.

Colt Shaft Variable - Proposed Mechanical Smoke Control System

The proposed mechanical smoke control system will consist of a single vertical shaft, connected to the fire-fighting lobbies on each floor via a 0.6m^2 free area lobby ventilator. The shaft will have a set of run and standby axial fans to extract smoke from the lobbies. In event of a fire the lobby ventilator on the floor where the fire was detected will open and the fans will begin to ventilate the lobby. The proposed extract rate will be $3\text{m}^3/\text{s}$. This extract rate may be adjusted up or down depending on the results of the analysis. Fresh air will be drawn from the stairwell when the door to the stairwell is opened. To ensure that the lobby does not become over-depressurised the smoke extract fans will slow down when the door to the stairwell is closed. A differential pressure sensor monitors the pressure difference between the lobby and stairwell and adjusts the speed of the fan accordingly.

The stairwell is provided via a 1.0m^2 ventilator from the top storey to outside.

3.8 Simulation Timeline

From the initiation of the fire through to completion, the model will follow a set timeline. The events in the timeline, in summary, represent the ignition of the fire and evacuation of the occupants of the fire compartment. Guidance has been taken from PD 7974-6:2019 with respect to the travelling speed of occupants [9]. It has been assumed that occupants will travel at 1 m/s whilst escaping from the fire compartment.

The fire strategy report describes the expected staff occupancy of the back of house areas as 5% of the guest numbers. For Level 3, as 30 guests are expected, this strictly means there will be no staff occupancy according to the fire strategy. However, to provide a worst case scenario, it is assumed that the telecommunications room will be occupied when the fire starts. A typical occupancy is 1 occupant per 6m^2 floor area. The total floor area of the office on Level 2 is 21m^2 . Therefore a reasonable number of occupants is 4. It is expected that occupants will be evenly distributed throughout the space.

The door opening times have been calculated based on the maximum possible travel times of occupants from the office area. The occupants of the telecommunications room are likely to be awake and familiar with their surroundings, so a pre-movement time of 60 seconds has been allowed for. The first occupants to escape will open the doors between the telecommunications room and the lobby at this time. The distance between the office door and the door to the stairs is 8m, therefore the stair door will open 8 seconds after the telecommunications door opens. PD 7974-6:2019 suggests that the last occupants to begin their escape will do so after 3 minutes^[9], however, due to the small size of the room, it is assumed that all 4 occupants will have escaped quickly. Therefore, the telecommunications door will close after 60 seconds of being opened and the stair door will close behind them after a further 8 seconds.

During the fire-fighting phase it is expected that the firefighters will access the office from the stairwell and fire-fighting lobby closest to the fire. Where there are doors that consist of more than one leaf, only the single largest leaf is open during the firefighting phase, following the guidance within BS EN 12101-6:2005 [5].

The smoke control system will be initiated at the beginning of the escape phase of the simulation.

Phase	Time (S)	Action	Notes
Pre-movement	0	Fire Starts	t^2 medium growth rate
Escape	60	Telecommunications door opens, smoke control system initiated	First occupants escape into lobby
	65	Stairwell door opens	First occupants reach stairwell
	120	Telecommunications door closes	Last occupants reach lobby
	125	Stairwell door closes	Last occupants reach stairwell
Fire-fighting	600	Stairwell door opens and is held open	Firefighters enter fire-fighting lobby
	630	Office door opens and is held open	Firefighters enter telecommunications room
	900	Fire extinguished	
Clearance	1200	End of Simulation	

Table 1: Timeline for Models

4. Results

Results will be presented in two forms. Recorded temperatures and pressures will be presented in graphs to show the changes in temperature and pressure at various locations throughout the simulation.

Results for soot visibility will be presented as vertical slices on various planes throughout the simulation. Slices will be located, as a minimum, through the ventilation shaft, the stairwell door and the fire compartment door. The data on the visibility slices will be truncated above 10m visibility so that areas of greater than 10m visibility will show as clear.

5. References

- [1] HM Government, The Building Regulations 2010. Approved Document B: Fire Safety Volume 2: Buildings other than dwellings, London: HM Government, 2019.
- [2] British Standards Institution, BS 9999:2017 Fire safety in the design, management and use of buildings - Code of practice, London: BSI Standards Limited, 2017.
- [3] Building Research Establishment, PRJ 79204 Smoke shafts protecting fire fighting shafts: their performance and design, London: BRE, 2002.
- [4] Smoke Control Association, Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes), 3.1 ed., Reading: Federation of Environmental Trade Associations, 2020.
- [5] British Standards Institution, BS EN 12101-6:2005 Incorporating Corrigendum No. 1 Smoke and heat control systems - Part 6: Specification for pressure differential systems - Kits, London: BSI Standards Limited, 2006.
- [6] K. McGrattan, R. McDermott, M. Vanella, S. Hostikka and J. Floyd, NIST Special Publication 1019 Sixth Edition - Fire Dynamics Simulator User's Guide, Gaithersburg, MD, USA: National Institute of Standards and Technology, 2020.
- [7] K. McGrattan, S. Hostikka, J. Floyd, R. McDermott and M. Vanella, NIST Special Publication 1018-3 Sixth Edition - Fire Dynamics Simulator Technical Reference Guide Volume 3: Validation, Gaithersburg, MD, USA: National Institute for Standards and Technology, 2020.
- [8] Building Research Establishment, Design Methodologies for Smoke and Heat Exhaust Ventilation, London: BRE, 1999.
- [9] British Standards Institution, PD 7974-6:2019 Application of fire safety engineering principles to the design of buildings. Part 6: Human factors: Life safety strategies - Occupant evacuation, behaviour and condition, London: BSI Standards Limited, 2019.

Appendix A: CFD Modelling

Convectional Computational Fluid Dynamics (CFD) software programs operate by computing the Reynolds-averaged formulation of the Navier-Stokes Equations (RANS) over a discretised domain. The decomposition of the governing equations into a mean and fluctuating part leads to a closure problem. This is overcome by the introduction of turbulence models. The limitation of such time-averaged solutions is that they cannot show the development of the flow field over time. To obtain such solutions Large Eddy Simulations (LES) are usually employed. These solvers solve the unsteady Navier-Stokes equations directly at large scales of motion, while modelling the smaller eddies.

The CFD software that will be used for this analysis is Fire Dynamics Simulator (FDS) from the National Institute of Standards and Technology, United States Department of Commerce. Whilst FDS was developed primarily for fire and smoke modelling in buildings, it is also applicable to air movement and ventilation studies. It is well-documented with a substantial quantity of testing and validation data available.

FDS is a structured mesh CFD code that uses an explicit time-marching solution procedure and incorporates LES. Geometric shapes are defined and represented in Cartesian coordinate system by blocking cell-volumes or cell-faces.

Steady state fire results can be obtained through continuing time-dependent simulation, but because of non-linearity's in the equation-set the calculations take many hours to reach a meaningful solution. However, the advantage of a CFD analysis is that of generating detailed predictions of likely flow conditions based on rigorous numerical analysis techniques.

The default mixture-fraction combustion model will be used for the simulation.

FDS operates only in transient mode and solves an explicit formulation of the governing equations (the X, Y & Z components of velocity, pressure, and temperature etc.). The time-step is automatically selected within FDS based on the CFL stability condition. A direct solver for the pressure equation is employed solving mass continuity within each grid to machine accuracy at each time step.



Technical Submission

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ANAC87

Etihad

North Stand

SMOKE EXTRACT SYSTEM

Technical Submission

NSE-SEE-NS-ZZ-TEC-M-000001-P02

CONFIDENTIAL

Revision Record

Issue	Date	Reasons	Created By
P01	24 June 2024	First issue	J. Figueras
P02	24 July 2024	Role Code Changed	J. Figueras



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1. INTRODUCTION

The purpose of this technical submittal is to provide the reader with an overview of the smoke ventilation scheme to be provided at the below mentioned site. It also provides details of the system makeup and the equipment to be used to achieve the smoke ventilation solution.

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Project Name: Etihad - North Stand
Project Reference: ANAC87

Basic Scheme Design: Colt Shaft Variable
Ventilation Method: Mechanical
Quantity of Shafts: 2
Quantity of Levels: 6

2. SYSTEMS DESCRIPTION

2.1. Ventilation of a residential common escape route or a fire-fighting core using a Colt shaft variable

PDS:500-4

The Colt shaft variable is designed to provide equivalence to the Building Research Establishment (BRE) shaft and hence meet the recommendations of Approved Document B (ADB), BS 5588-5: 2004 and BS 9999 for ventilation of fire-fighting shafts. Both BS 5588-5 and BS 9999 explicitly mention the BRE shaft as a suitable method of ventilation. It therefore also provides better than equivalence with the smaller natural shaft for residential buildings described in Approved Document B.

Mechanical shaft systems in residential buildings are described comprehensively in BS 9991 and the Smoke Control Association document 'Guidance on Smoke Control to Common Escape Routes in Apartment Buildings, (Flats and Maisonettes).

Under design conditions with the lobby doors open the Colt shaft variable provides a ventilation rate similar to that of an equivalent natural (BRE) shaft. When the lobby doors are closed the ventilation rate is automatically reduced to avoid excess depressurisation of the lobby, mimicking the operation of the natural shaft.

The Colt shaft variable, if installed in accordance with this specification, has been accepted by the London Fire Brigade and London District Surveyors Association (LDSA) as being ADB compliant.

The Colt shaft variable is suitable for protection of fire-fighting cores of commercial buildings with sprinkler protection or common escape routes in residential buildings, with compliant (or near compliant) travel distance.

The system comprises:

- A run & standby fan system to be CE marked to BS EN 12101-3, Class F300
- Lobby ventilators to each level served by the shaft. The top of the lobby ventilator should be located at least 75mm from the finished ceiling level
- Pressure Sensors
- Fan Control Panel
- Head of stairwell ventilator to be CE marked to BS EN 12101-2
- OPV Control System
- Manual Control Point

The shaft passing through the building must be smooth internally and well-sealed. Maximum permissible leakage for the shaft is $3.8\text{m}^3/\text{h}/\text{m}^2$ at 50Pa. Failure to meet this performance could result in a shortfall in the smoke extract volume flow rate.

2.2. System Operation

In the event of a fire, it is accepted that smoke could migrate into the protected area. This smoke would be picked up by the smoke detectors, setting the system into fire mode. The principal objective of the system is to provide protection to the staircase by preventing smoke from entering. This is achieved by providing a high level of smoke extract when the stair door is open.

The system prevents over-depressurising the fighting lobbies by using a pressure sensor to control the fan speed when the stair door closes. With the stair door open, the fan operates at full speed. With the stair door closed, the fan slows down so that doors do not become difficult to open, or are pulled open inadvertently by the system.

Detection of smoke in any one of the protected areas will:

- Open the shaft/lobby ventilator on the level where smoke has been detected.
- Open the required adjacent head of stairwell ventilator.
- Start the extract fan, the running speed of the extract fan will be regulated by the pressure sensor.
- On detection of a build-up of negative pressure in the staircase, the system will control the fan speed so that the pressure does not exceed a nominal pressure and in any case, not more than -25Pa.
- When the pressure equalises i.e. the stair door is open, the fan will run at full speed.
- On activation of the Fire Override Switch (Auto/Full Speed) only available on the level where smoke has been detected, the pressure sensor will be bypassed and the system will run at full speed, regardless of the pressure in the protected area.
- Duty fan operation will be monitored electronically within the fan control panel. On detection of duty fan failure, the duty fan will shut down and the standby fan will run.

The system can be overridden by use of the fire override switches on the OPV panel, located within the Fire fighters entrance.



3. SHAFT DETAILS

The shaft/riser passing through the building must be smooth internally, well-sealed, have a cross-sectional area of at least 0.6m^2 and an aspect ratio of no more than 2:1. Maximum permissible leakage for the shaft is $3.8\text{m}^3/\text{hr}/\text{m}^2$ at 50Pa. Failure to meet this performance could result in a shortfall in the smoke extract volume flow rate.

4. FAN/SHAFT VENTILATOR SIZING

Colt ventilators and fans are sized to meet the requirements of the individual systems. The size of the shaft and ventilator will dictate the overall resistance of the system which in turn will affect the fan requirements

The required nominal extract rate at each shaft ventilator is to be determined by CFD analysis. This will be the minimum duty to be achieved at each extract point. Higher figures are acceptable, providing the maximum door opening forces to or from the area being ventilated do not exceed 100N at the door handle.

The sizing calculations have been based on a 0.6m^2 shaft. Additional leakage has been taken into account based on the number of ventilators within the shafts. The estimated fan duty is provided in section 6.11.

Fans will be run and standby in series.

Note:

Final fan selection will be based on pressure drop calculation for the final client approved drawings, as well as final approval of the CFD analysis. The current selection is therefore liable to change.

5. EQUIPMENT CONTROLS

This section details the controls philosophy for the smoke ventilation system; including controls voltages and control methods.

The ventilators forming part of this system are 230Vac and receive a maintained 230Vac supply from a Colt fan control panel.

Fans are 400Vac, 3 phase and are powered from a Colt fan control panel.

The ventilators utilise the Colt OPV network for control and operation. The OPV system gives individual control, status and fault indication of equipment on the *Apollo* addressable network. The networks include a number of manual call points (for remotely opening the head of stair vents) and Fire-fighters override switches (for overriding the pressure sensors and ramping the fans to full speed) to provide a signal to bring the smoke ventilation system into action. The network then relays signals back to individual equipment to open / close, start / stop as prescribed by the pre-programmed cause and effect.

Any Colt fan control panel receives an adequately rated, 400Vac, 3 phase power supply. A dual supply will be provided by the client to the Colt ATS (Automatic Transfer Switch), located adjacent to the Colt fan control panel. The ATS switches between primary and secondary supplies, providing a maintained supply.

All power supplies should be in accordance with the relevant British Standard.

5.1. Cable Types

Control Cables: Class PH120 to BS EN 50200.

Power Cables to Main Extract Fans: Class F120 to BS 7846.

The section: "Equipment in Detail" provides a more in-depth technical look at the individual components that make up the smoke ventilation scheme.



6. SCHEDULE OF EQUIPMENT

This section details equipment locations within the smoke ventilation scheme.

Type	Description	Location	Quantity
OPV Heart Module	Control Panel	Electrical Riser	2
OPV Display Panel	Control Panel	Ground Floor Entrance	2
MCC Variable Internal	Control Panel	Plant Room	2
ATS	Control Panel	Plant Room	2
CSIO-AC L	Control Equipment	Electrical Riser	2
DPIO	Control Equipment	Electrical Riser	12
Manual Call Point(Add)	Control Equipment	Ground Floor Entrance	2
Defender	Shaft Ventilators	Corridor / Lobby	12
K Fixed Grille	Shaft Ventilators	Corridor / Lobby	12
Seefire	Natural Ventilators	Roof	4
Smoke Fans	Fans	Roof	2
Attenuation	Fans	Roof	2

Note:

- Volt Free Contact (VFC) for each level required to OPV Heart Module.
- Containment is not in Colt's scope of works.
- Smoke detection is not in Colt's scope of works.

6.1. Colt OPV Heart Module

PDS: 308-2

The Colt OPV Heart Module control the overall OPV system. The module connects to the user interfaces such as the Display Panel, Display Expansion Panel and Firefighter's Override Panel across an RS485 network. It is a central input and output signalling point as communicates, via an Apollo network to various field devices, which may include CSIOs, smoke detectors, manual control points or temperature sensors and which provides a signal to bring the smoke ventilation system into action. The Heart Module is programmed to operate the overall smoke control scheme using a cause and effect matrix, which commands the devices to operate depending on which sensors have been triggered.

Materials

- The enclosure is made from ABS plastic coloured grey
- Mounting
- Wall mounted with four fixing holes through the back of the unit. Fix using two screws in diagonal corners

Technical data

- Dimensions: 396mm(W) x 316mm(H) x 128mm(D)
- Weight: 5kg
- IP56
- Temperature range: 0 - 50°C in normal operation conditions
- Limited to one per OPV system
- Back-up batteries: 2 x 3.6AH 12V batteries in series
- Battery standby time: Up to 72 Hours depending on the system
- Programmed using USB connection

Operation

- 230Vac/1ph/50Hz/1.1A power supply required
- 12 VFC Inputs
- 4 x Single relay contact outputs (30VAC/DC 3A resistive & 1A Inductive Load)
- 1 x Apollo network spur is available to control up to 126 devices, further network spurs can be fitted to provide another 126 devices
- 1 x RS485 output for display panel, display extension and firefighter override panel connection
- 1 x RS485 output for VFC extension module (maximum of 10 extension supported)
- Limited to a total of 32 RS485 devices
- Status LED
- Mains failure detection

Maintenance

- Isolate electrical supply before maintenance. Note: This panel has a 24V battery backup and potentially voltages from other sources
- Clean exterior of module. Do NOT use water
- Open the panel and clean any accumulated dust carefully
- Check connections for security
- Carry out functional test using smoke control display panel
- With batteries check battery voltage. Reconnect after test
- Batteries must be recycled at the end of their life in accordance with local and national laws/regulations

Standards

- The Colt OPV Heart Module is CE marked
- Low Voltage Directive (LVD) 2006/95/EC
- EMC EN 61000-6-1:2007 - Generic Immunity For Residential, Commercial & Light-Industrial Environments
- EMC EN 61000-6-3:2007 +A1:2011 Generic Emissions For Residential, Commercial & Light-Industrial Environments



6.2. Colt OPV Smoke Control Display Panel

PDS: 305-2

The Colt Smoke Control Display Panel is the user interface for the Colt OPV system. This panel provides individual control, status and fault indication of devices connected to the OPV Heart Module unit via an Apollo network.

Materials

- The main body of the casing is manufactured from plastic, off white RAL 9002

Mounting

- Wall mounted with four fixing holes through the back of the unit. The fixing holes can be access by removing the side panels. Fix using two screws in diagonal corners

Technical Data

- Dimensions: 270mm(W) x 200mm (H) x 48mm (D)
- Weight: 0.5kg
- IP40
- Temperature range: 0 - 50°C in normal operation conditions
- Limited to one per OPV 2015 Heart Module
- Fault warning alarm: Louder than 50dB at 1m for 0.5 sec every 5 sec
- LCD display 4 lines of 19 characters each
- Up to 12 Zones indicators
- Status LED
 - Fire Condition – Red
 - Test – Amber
 - Healthy – Green
 - Flashing LED indicates fault
- 12 zone LEDs
 - Fire or Override Active – Red
 - Override Inactive – Amber
 - Auto Inactive – Green
 - Flashing LED indicates fault
- LCD screen providing:-
 - Firefighter's Override
 - Fire Reset
 - Status of Devices & Sensors
 - Control of devices
 - Diagnostics
 - Configuration



Operation

- Fire-fighter's control is enabled/disabled via a key-switch on the front fascia
- Operation of all zones via screen control using membrane touch panel buttons
- Some operations are password protected (i.e. time & date settings)

Cabling & Connections

- 4 core + Screen RS485 daisy chain connection from Colt OPV 2015 Heart Module
- Connections are spring clamp type
- Maximum cable connection 2.5mm²

Maintenance

- Isolate electrical supply at OPV Heart Module before maintenance
- Clean exterior of module. Do NOT use water
- Check connections for security
- Check indication lamps
- Navigate from the menu to Configure – Lamp test
- Carry out functional test

Standards

- The Colt OPV Display Module is CE marked
- Low Voltage Directive (LVD) 2006/95/EC
- EMC EN 61000-6-1:2007 - Generic Immunity For Residential, Commercial & Light-Industrial Environments
- EMC EN 61000-6-3:2007 +A1:2011 Generic Emissions For Residential, Commercial & Light-Industrial Environment



6.3. Fan Control (MCC) Panel Variable Internal

PDS: 310-2

The Colt MCC control panel is the panel which distributes the power supply for the Colt system. Typically it will provide switching and power to the Colt fans and associated Colt ventilators, dampers, etc. Typically MCC panels are double door panels with an interlocked isolator.

Materials

- Panel enclosures that are designed for internal use will be constructed from sheet steel
- Internal panels are polyester powder coated in RAL 7035

Technical data

- Approved Enclosure dimensions: W: 1000 x H: 1200 x D: 300
- Weight: 105kg
- Rating: 3KW – 7.5KW
- Protection rating: IP54
- Supply: 400Vac 3ph + N (4 wire) 50Hz via
- maintained supply from the client or a dual
- supply from the client via a Colt ATS unit.
- Maximum incoming cable size 16mm
- Cable entry top

Maintenance

- Clean exterior of panel
- Check for signs of corrosion, clean and touch-up as necessary
- Isolate electrical supply
- Open the panel and clean any accumulated dust
- Check connections for security
- Carry out functional test

Standards

- All panels are tested before they are dispatched from Colt.
- Panels conform to the low voltage directive, are built to Form 2 and use BS7671 as a guide for wiring standards.



6.4. Automatic Transfer Switch

PDS: 314-2

Colt Automatic Transfer Switches (ATS) are available for switching supplies up to 160A. The unit will detect the loss of the primary supply and automatically break the primary switch before making the secondary switch when transferring between three phase sources. It comprises two mechanical and one electrical interlock as well as control relays, timers and test functions to manage the switching operation. The switch can be locked in “zero” position to isolate the supply and aid maintenance.

Materials

- The enclosure is made from 1.2mm thick steel sheet
- The finish is polyester powder coated in RAL 7035 (grey)

Technical data

- Dimensions: 400mm(W) x 600mm(H) x 210(D) (excluding 75mm wall brackets)
- Weight: 20kg
- Available as 40A, 63A, 100A, 125A & 160A (size based on full load current)
- Cabling via a bottom gland plate
- 4 x wall mounted brackets
- Locking system: 3 mm double-bar key
- Selection between two grid supplies or one grid and one generator supply
- Generator start/stop bi-stable output 30VDC 2A max
- External option also available in a GRP enclosure
- 4 pole with switched neutral isolators
- Dip switch selection
- Ingress protection rating: IP55

Operation

- Primary source failure detected
- Delay to allow primary source to recover
- Output to generator start (If secondary source is from generator)
- Secondary source available
- Switch to secondary source
- Primary source available
- Delay to check that primary source is stable
- Switch over to primary source
- Output to generator stop (If secondary source is from generator)

Maintenance

- Isolate both incoming electrical supplies.
- Clean exterior of panel with a soft cloth or brush
- Check for corrosion. Repair and touch up as necessary
- Check electrical connections
- Clean interior of panel with a soft brush
- Reinstate power and check switch over by isolating primary supply
- Repair any faults found.

Standards

- IEC 60947-3
Low-voltage switchgear and control gear. Switches, disconnectors, switch-disconnectors and fuse-combination units
- IEC 60947-6-1
Low-voltage switchgear and control gear. Multiple function equipment. Transfer switching equipment
- IEC 60439-1
Low-voltage switchgear and control gear assemblies. Type-tested and partially type-tested assemblies



6.5. Colt Standard Input/Output unit (CSIO)

PDS: 303-3

The Colt CSIO is an individually addressable relay/IO that forms part of the Colt OPV control system. Once signalled by the OPV panel, via the Apollo network, the unit will switch to actuate the controlled equipment. Typically one CSIO is supplied per floor or piece of equipment, depending upon the layout, to allow individual and accurate control of the smoke ventilation scheme. The unit is mounted inside an ABS plastic enclosure to protect it from the risks of mechanical damage, unauthorised modification or interference and exposure to moisture, dust and foreign bodies.

Materials

- The enclosure is made from ABS plastic coloured grey

Technical data

- Dimensions: 200mm(W) x 245mm(H) x 95mm(D)
- Weight: 1kg
- Individually addressable on the Apollo network

Operation

- Available for 230Vac and 24Vdc systems

Maintenance

- Isolate electrical supply
- Clean exterior of enclosure
- Check for signs of corrosion, clean and touch-up as necessary
- Open the enclosure and clean any accumulated dust
- Check connections for security



6.6. Differential Pressure Input/Output unit (DPIO)

PDS: 304-3

The Colt DPIO is an individually addressable relay/IO combined with a differential pressure transmitter, which forms part of the Colt OPV control system. Once signalled by the OPV panel, via the Apollo network, the unit will switch to actuate the controlled equipment. Typically one DPIO is supplied per lobby to allow individual and accurate control of the smoke ventilation scheme.

The Colt Differential Pressure Transmitter is used for measuring differential pressure, positive pressure and vacuum. Its normal use within the Colt control scheme is to measure pressure differences between the stair and lobby on a Colt Shaft Variable system. The transmitter is to be located out of the fire zone (typically within the stair or electrical riser) and will signal the Colt fan control panel to adjust the speed of the fans extracting from the adjacent lobby (via an inverter), preventing over depressurisation.

The entire unit is mounted inside an ABS plastic enclosure to protect it from the risks of mechanical damage, unauthorised modification or interference and exposure to moisture, dust and foreign bodies.



Materials

- The enclosure is made from ABS plastic coloured grey

Technical data

- Dimensions: 200mm(W) x 245mm(H) x 95mm(D)
- Cover cap size: 80mm(W) x 80mm(H) x 20mm(D)
- Weight: 1kg
- Individually addressable on the Apollo network

Operation

- Available for 230Vac and 24Vdc systems
- Programmable to the Colt OPV network
- The transmitter is equipped with an integrated piezo-resistive pressure transducer designed so that the pressure difference to be measured is applied to a thin membrane made of mono-silicon, thus deflecting it. The semi-conductor resistors on the membrane detect this mechanical deflection and generate an electrical output signal.
- Pressure connections to the transmitter are made using Ø6mm copper tubing, with the open end(s) protected by the supplied cover plate(s)



Maintenance

- Isolate electrical supply
- Clean exterior of enclosure
- Check for signs of corrosion, clean and touch-up as necessary
- Open the enclosure and clean any accumulated dust
- Check connections for security
- Check operation

6.7. Manual Call Point (Addressable Breakglass) Switch

PDS: 336-2

Colt Switches are designed as localised controls for the Colt system and equipment. A variety of different switches are available depending on the system type and the equipment used. These include firefighter's override switches, reset switches, roof access hatch switches and manual control points.

A manual call point is installed within a colt control system to allow occupants to signal that fire or smoke exists within the building. Manual call points are connected to the Colt OPV panel via the Apollo network. Each manual call point (MCP) is individually addressable and the address of each call point is pre-set at commissioning stage.

When activated, the MCP not only interrupts the polling cycle to indicate to the control panel that it has been operated, but also reports its address and thus location.

A single bi-coloured LED is provided on the MCP. This LED is controlled, independently of the MCP, by the control panel. The red LED is lit when the MCP has been activated, and an amber/yellow LED indicates a fault.

Materials

- All Colt switches are made from ABS plastic

Technical data

- Dimensions: 90mm(W) x 90mm(H) x 57mm(D)
- Weight: 0.18kg
- Operating temperature: -10°C - +55°C
- Ingress Protection rating: IP24

Switch type

- Manual Call Point (Addressable Breakglass):-
 - Colour: orange (RAL 2011)
 - Operation: deformable element switch
 - Location: stairwell at ground floor level

Maintenance

- Check for visible damage
- Check incoming power supply
- Check operation of switch
- Clean the switch and ensure it is clearly visible

Standards

- Colt manual control points and firefighter's override switches are colour orange (RAL 2011) in accordance with BS EN12101



6.8. Defender

PDS: 050-3

The Defender is a 26SSD series smoke control damper. It is a motorised smoke damper suitable for use in mechanical and natural smoke control systems. It has been designed to prevent the passage of fire and smoke from one area to another while in the closed position and to allow efficient smoke ventilation when open. Suitable for many industrial, commercial and residential buildings where smoke ventilation is required.

The damper can be provided with a K15 (15° deflection) or K40 (40° deflection) grille.

Materials

- Blades, Sleeve & Frame: Galvanised mild steel.

Finishes

- Grille: RAL 9010 (Pure White) 20% gloss.
- Damper (front face): RAL 9005 (Jet Black) 30% gloss.
- Damper (other areas): Mill finish.

Fixing Options

- Suitable for any EI120 rated construction in accordance with BS EN 1363-1.
- Plasterboard (flexible) wall construction:
 - 2x 15mm thickness EN 520 Type F Gypsum Boards.
 - 62 to 100mm steel stud & 85 to 115 kg/m³ mineral wool insulation.
 - 2x 15mm thickness EN 520 Type F Gypsum Boards
- Blockwork, masonry or homogenous concrete (high density rigid) wall construction:
 - Overall density ≥ 850 kg/m³, minimum thickness 122mm.
- Aerated concrete block (low density rigid) wall construction:
 - Overall density 650 ± 200 kg/m³, minimum thickness 122mm.
- Damper and sleeve supplied separately for installation on site.

Sizing Information

- Structural opening dimensions for a single unit:
 - Width: 523mm (minimum) to 1013mm (maximum)
 - Height: 600mm (minimum) to 1998mm (maximum)
- Unit Depth: 204mm
- Weight: Up to 120kg

Operation

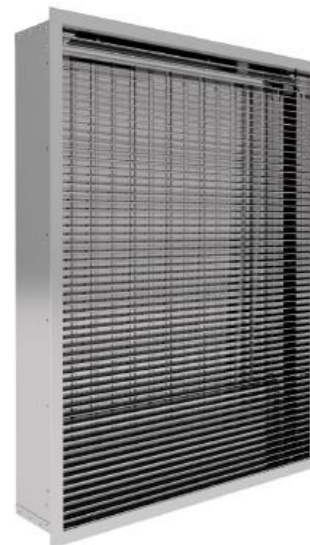
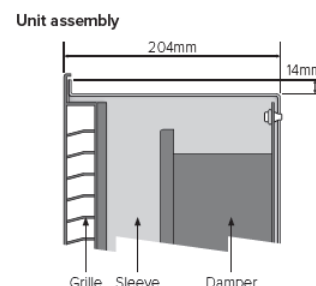
- 230Vac or 24Vdc electric actuator, drive open/drive closed operation.
- Actuators include micro switches for position monitoring.

Maintenance

- Isolate the electrical supply before working on the damper.
- Check for visible damage.
- Check damper fixing.
- Clean damper with a soft brush or damp cloth.
- Clean and lubricate all bearings and pivots.
- Check operating mechanism for wear, chafing, damage, loose fixings and leakage.
- Check incoming power supply.
- Check operation of the damper.
- Adjust limit switches or restrictors if necessary.
- Repair any faults found.

Standards

- The unit is tested and certified in accordance with BS EN 12101-8.
- Classification to BS EN 13501-4:
 - E120 ($V_{ew} i \rightarrow o$) S500 C₁₀₀₀₀ AA multi
 - E90 ($V_{ew} i \leftrightarrow o$) S500 C₁₀₀₀₀ AA multi
- The Defender can be used without a grille or either the K15 or K40 grilles supplied with the unit. The use of other grilles will void the certification to BS EN 12101-8. Any other covering must be at least 200mm in front of the unit.



6.9. K Fixed Blade Grille

PDS:026-2

Standard duty fixed blade grille comprising of a series of fineline blades within a frame. K Grilles are suitable for use with the Colt Smoke, Fire and Environmental dampers. The grilles are front fixed through the flanges direct into structure. Grilles are available as standard in white (RAL 9010) or in a standard Colt RAL colour.

K15 grilles are the normal choice as they provide the optimum balance of limiting vision through and resistance to air flow.

Materials

All grilles are constructed from extruded aluminium

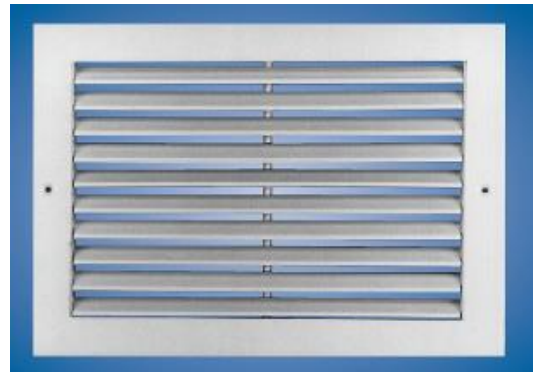
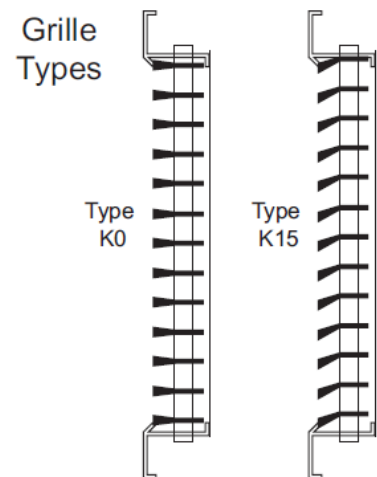
Technical data

- Standard sizes: 100mm(W) x 100mm(H) to 1200mm(W) x 1200mm(H)
- Available with blades at 0° or 15°
- Free area of grille:
 - K0 - 87%
 - K15 - 87%
- Blade thickness: 3mm
- Blade pitch: 19mm

Maintenance

- Check for visible damage
- Check grille fixings
- Clean grille if necessary

Project specific dimensions will be shown on the construction issue drawings.



6.10. Seefire

PDS: 001-2

The Seefire is a louvered natural ventilator, available in a wide range of sizes, louver and control options. Suitable for many industrial, commercial and residential buildings where day-to-day ventilation and/or smoke ventilation is required. For day to day ventilation a rain detection system can be added to close the louvres automatically during precipitation. There is also an option of a fusible link. In case of fire the link will melt at a pre-selected temperature (68°C to 182°C) and permit the ventilator to open or close automatically. Installation angle of 0° to 90°. The option of polycarbonate or glass louvres permits daylight entry. Available in mill finish or polyester powder coated to a standard Colt RAL colour.



Materials

- Principal components are manufactured from corrosion resistant aluminium alloy grade 3005 in accordance with EN573-3, with stainless steel fixings.
- The use of polypropylene pile weather seal on aluminium louvres, or EPDM rubber flipper weather seal on polycarbonate and glass louvres, reduces the loss of warm air when the louvres are closed.

Louvre Types / U Values

- Single skin aluminium louver, with or without pile weather seals / 5.42W/m²K
- Double skin aluminium louver, with or without pile weather seals / 3.49W/m²K
- Double skin polycarbonate louver (clear or opaque), with rubber weather seals / 3.2W/m²K
- Glass louver (wired, toughened or toughened and laminated) with rubber weather seals / 5.4W/m²K



Fixing Options

- Glazing
- Sheeting
- Curbs / Upstands
- Brickwork

Technical Data

- Air permeability with pile or rubber seals is 130-230m³/h/m² at 50Pa, depending on width of unit
- Aerodynamic coefficient (Cv) 0.65 – 0.68, depending on size of unit
- Acoustic rating (closed) up to 13dB (Rw) (double skin with pile weather seals)
- For dimensional data please see table

Operation

- Hand Control – External cable, internal cable or internal cable with latch or winch
- Electric Motor – 230Vac (0.15Amps) or 24Vdc (0.65 Amps), two actuators are required for larger sized vents
- Pneumatic controls, two actuators are required for larger sized vents

Maintenance

- Check for visible damage
- Check ventilator fixing and weathering
- Clean ventilator, paying special attention to drain and weathering channels
- Wash polypropylene pile weather seal (if fitted)
- Clean and lubricate all bearings, pivots and hinges
- Check operating mechanism for wear, chafing, damage, loose fixings and leakage
- Check incoming power supply
- Check operation of the ventilator
- Adjust limit switches or restrictors if necessary
- Repair any faults found

Note: where ventilators are subjected to a high level of debris it may be necessary to clean channels more often to maintain performance and weather resistance.

Standards

- Ventilators used as smoke and heat exhaust ventilators are CE marked in accordance with EN 12101-2: 2003.
- The Seefire is manufactured under the ISO 9001 quality standard. Each unit is given a functional test before despatch.

Project specific sizes will be shown on construction issue drawings.



6.11. Smoke Extract Fans

PDS: 101-2

Colt Smoke Extract fans are long case axial fans that have been designed and tested in accordance with EN12101-3. A central metric foot mounted motor, totally enclosed, is wired via a flexible cable system to an externally located IP55 protected terminal box on the fan casing. The fan motors have 'sealed for life' bearings and have a standard industrial paint finish.

Materials

- Outer casing is constructed from heavy gauge steel sheet, roll formed and welded and hot dipped galvanised after fabrication
- Blades are pressure die cast aluminium (natural finish)

Technical Data

- Sizes from Ø315mm – Ø1250mm
- Volume flow rates up to 30m³/s
- Motor protection IP55
- Temperature rated at 300°C for 2 hours
- Project specific data will be shown on the construction issue drawings
- The following ancillaries are available, dependant on application:
 - Feet for free standing fan arrangements
 - Anti-Vibration mountings
 - Flexible connections for reducing vibration to structure/ ductwork
 - Wire guards
 - Non-return dampers
 - Attenuators

Operation

- Electric – 400Vac, 3 phase, 50Hz

Maintenance

- Isolate using the local isolator switch prior to any maintenance works
- Ensure the impeller is at rest prior to any maintenance
- Check for visible damage
- Check fan fixings
- Check all electrical connections and interfaces
- Check all current/voltage/frequency are as stated on the nameplate
- Check for and remove any dirt and/or debris
- Bearings are 'sealed for life' and do not need a detailed inspection
- Check, clean and replace components as necessary
- Check for wear, chafing, damage, loose fixings and leakage
- Check operation of the fan
- Repair any faults found

Standards

- Fans providing extract of hot smoke are high temperature rated at a minimum of 300°C for 2 hours and are CE marked in accordance with EN 12101-3:2002 (F300 Classification)
- All accessories comply with the same EN 12101-3:2002 standard

Fans are tested to ISO 5801:1997 (Airside Performance) and BS 848-2:1985 (Sound Performance)

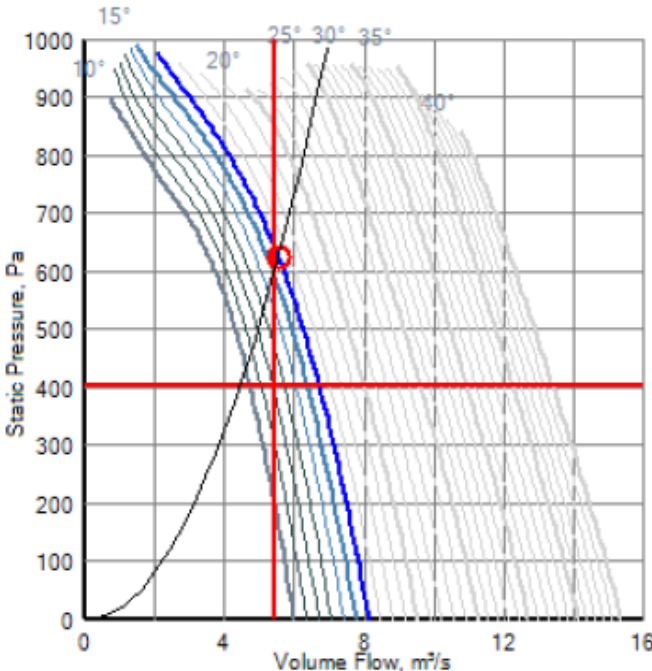
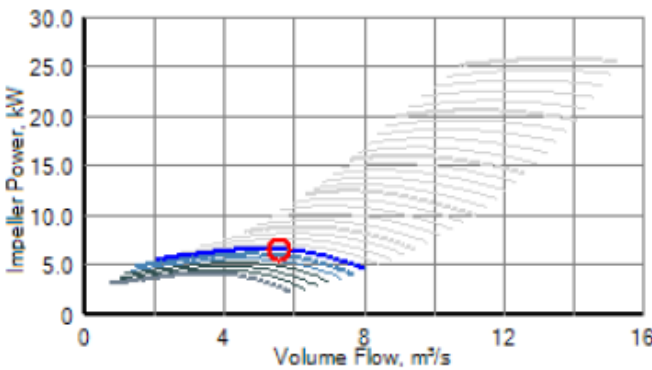


Typical "Colt Shaft" fan set



Typical car park extract fan system



Smoke Extract Fans Fan Ref: EF01 & 02									
Air Volume	5.45m³/s		<div><div>Fan Curve</div></div> <div><div>Impeller Power</div></div>						
Static Pressure	405Pa								
Nominal Diameter	710mm								
Number of Blades	6								
Pitch Angle	16°								
Speed	2880RPM								
Motor Frame	132S								
Motor Power	6.60kW								
Electrical Supply	400/50/3ph								
Casing Type	Long								
Full Load Current	12.24A								
Starting Current	12.24A (VSD)								
Classification	F300 (300°C / 120min)								
Sound Power Level Spectrum									
Frequency (Hz)	63	125	250	500	1K	2K	4K	8K	dB(A) @ 3m
Inlet (dB) with 2DENP	90	91	89	84	83	90	86	84	73
Outlet (dB) with 2DENP	91	92	88	83	82	89	86	83	73
Breakout (dB)	85	83	76	78	76	73	60	61	60

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

6.12. Attenuation

PDS: 211-2

Colt can provide a wide variety of attenuator types and attenuation methods depending upon the application and noise source. Large splitter attenuators are typically used for attenuation of fan noise, although 'pod' types may be sufficient for smaller, quieter fans. Attenuated louvres and plenum boxes are also available.

Materials

- Attenuator 'sound absorbing material' is non-combustible, non-hygroscopic and chemically inert. Attenuators have a standard high temperature construction (non-certified).
- Attenuator cases are constructed from galvanised steel

Technical data

- Splitter attenuators are stiffened and fitted with proprietary Doby flanges
- Circular attenuators are fitted with flanges to match fan units and their ancillaries
- All attenuators are suitable for both internal and external use
- Infill materials are faced with glass cloth and perforated steel

Maintenance

- Check for visible damage
- Check attenuator fixings
- Check attenuator is clear of any blockages
- Check for damage, loose fixings and leakage
- Repair any faults found

Standards

- All attenuators are constructed to DW144

Project specific information for the attenuators will be shown on the construction issue drawings.



7. MCC SHAFT VARIABLE SYSTEM LED INDICATORS

7.1. Supply Status LED Panel

- Mains Healthy three phase supply LED light Green and constantly illuminated whilst three phase supply healthy.
- 24VDC Healthy LED light Green and constantly illuminated whilst internal 24VDC supply healthy.

7.2. Smoke Control Status LED Panel

- When Fire Condition activated LED light illuminated Red.
- System fault or if any of the remote pressure sensors are faulty the LED light illuminated Red.

7.3. Extract Fan Status LED Panel

- When Duty Fan Running LED light illuminated Red.
- When Duty Fan Fault LED light illuminated Yellow.
- When Standby Fan Running LED light illuminated Red

Note if the LED lights are not illuminated as described above there may be a fault with the system, please contact Colt Services whose details are provided within this document.

Appendix A: Colt Technical Specifications

This section details the Colt technical specifications for electrical site wiring and control panel specification.

COLT CTS 1947 Specification for Electrical Site Wiring

	Colt Technical Specification				No: 1947	
	Title:	Electrical Site Wiring			Mod.	Issue
Category X	Owner R. Diaper	Checked T. Waters	Accepted R. Diaper	Date 22/09/2020	-	09

1.0 Description

- 1.1 This specification covers on site electrical wiring and installation of Colt electrical equipment by Colt staff or Colt electrical sub-contractors.
- 1.2 Compliance with the relevant sections of this specification for electrical wiring and installation of Colt electrical equipment by the electrical contractor is strongly recommended where on site wiring is not part of the Colt contract.

2.0 Standards

- 2.1 All installations shall be carried out to a standard no less than that laid down in the current edition of BS 7671 and any other standards and regulations which may be applicable to the building in which the installation is carried out.
- 2.2 All equipment shall meet appropriate British or IEC standards and be CE marked as appropriate.
- 2.3 All life safety and firefighting Installations should meet the requirements of BS 8519 where relevant
- 2.4 Installations in apartment buildings shall conform to the requirements of Approved Document P.

3.0 Personnel

- 3.1 All Colt or sub-contractor's staff carrying out electrical installations shall be suitably qualified. The supervisor should understand the requirements of BS7671 and this specification and a copy of both documents shall be available to the installers.
- 3.2 The supervisor shall be the on-site contact with the client's engineer. It is his/her responsibility to obtain and disseminate any special site safety or other requirements requested by the client and in particular methods of isolating any electrical equipment interconnected to the Colt system. This will be in accordance with the Colt Electrical System of Work.

4.0 Materials and Components

- 4.1 Where the temperature of air round the installed cable does not exceed 600°C under service conditions, the installation shall be carried out in accordance with BS7671 using one of the following systems:
 - a. LSOH/SWA/LSOH copper cable;
 - b. LSOH insulated copper cable including separate earth conductor, all in HFT conduit;
 - c. LSOH insulated copper cable in steel conduit (normally only when requested by client);
 - d. LSOH Insulated LSOH sheathed copper cable may be used for extra low voltage circuits (max50Vac, 100Vdc), clipped directly to the wall, subject to client's agreement;
 - e. LSOH/SWA/LSOH or LSOH insulated copper cable in cable tray.
- 4.2 For installations which need to continue to operate under high temperature conditions, such as smoke ventilation systems, fire resisting cable must be used to the relevant category. Suitable cable types are:
 - a. MICC to EN 60702-1;

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- b. cables to relevant category of BS 7846 or BS EN 50200;
- c. lower rated fire resisting cables where routed through an area providing protection against exposure to any significant fire risk, as permitted in BS 9999.

NOTE 1: LS0H cable in HFT plastic or steel conduit or LS0H/SWA/LS0H cable is not suitable when fire resistance is required.

NOTE 2: Current Colt practice is to use cables to the following minimum categories of BS 7846 or BS EN 50200:

NOTE 3: Where the cables are installed within a car park, this must be routed to avoid locations above parking places as far as is practicable in accordance to BS 7346, 6.10.2.

System	Control & Single Phase	Three Phase
Shaft systems	PH120 ¹	F60 ⁴ + protection or F120 ⁵
Car park smoke clearance	PH60 ²	F60 ⁴
Car park smoke control	PH120 ¹	F120 ⁵
Natural SHEVS (failsafe)	PH30 ³	
Natural SHEVS (non-failsafe)	PH60 ² or PH120 ¹ (for fire fighters)	
Powered SHEVS	PH60 ² or PH120 ¹ (for fire fighters)	F60 ⁴ + protection or F120 ⁵

¹ control cables meeting the PH120 classification when tested in accordance with BS EN 50200 and the 120min survival time when tested in accordance with Annex B BS 8519:2010

² control cables meeting the PH60 classification when tested in accordance with BS EN 50200 and the 120min survival time when tested in accordance with BS 8434-2

³ control cables meeting the PH30 classification when tested in accordance with BS EN 50200 and the 30min survival time when tested in accordance with Annex E of BS EN 50200

⁴Power cables meeting the 60 minute survival time when tested in accordance with BS 8491

⁵Power cables meeting the 120 minute survival time when tested in accordance with BS 8491.

4.3 Fire rated cables shall not have a red outer sheath unless used for connection of an Automatic Fire Detection (AFD) system.

4.4 Fire rated cables mounted externally shall have a white outer sheath to avoid UV degradation, unless the manufacturer specifically allows or recommends other colours for use in outdoor applications. (Prysmian for example currently allow black to be used for FP400 and FP600S in external environments).

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4.5 MICC cable shall not be used for any output circuit from an inverter.

Note: Inverter manufacturers do not recommend the use of MICC cables due to capacitance issues.

4.6 Where manufacturer's instructions for equipment specify a wiring system for compliance with the EMC Directive, this shall be used unless there is an overriding technical reason not to.

4.7 Switchgear, i.e. switch fuses, bus bars, switches, fuse boards etc. shall be of a reputable manufacture and comply with appropriate British or IEC Standards and be appropriate to the type of installation proposed.

5.0 Design

5.1 The wiring installation design shall be carried out by the electrical installer from loading and other relevant information such as layout and wiring connection diagrams supplied by Colt. It is the responsibility of the installer to obtain all relevant information to inform that design decision.

5.2 Selection of the wiring system and cables employed shall be by the Colt engineer, taking into account any client specification. This shall be specified in the Colt quotation to the client and in the electrical schematic drawings.

NOTE: Any subsequent change to the system type at the client's instruction shall be at the client's cost.

5.3 For calculation purposes, the design ambient temperature shall be taken as 30°C unless advised otherwise by the Colt engineer.

5.4 Where a supply is taken from a switch or other outlet provided by the client, the voltage drop calculation shall include the cable from this point back to the mains intake position and the current taken by any other equipment on this line.

5.5 The voltage drop to any point on the system from the mains intake position shall not exceed the recommended voltage drops set out in BS7671. This will be dependent on the equipment used.

5.6 Protective conductor (earth wire) in conduit shall not be less than 2.5mm².

5.7 All switchgear shall be suitable for the fault levels present at the point in the system where they are installed.

5.8 Motor fuses required on shaft system is Motor Protection Circuit Breaker MPCB. HRC type BS88 in use in system other than shaft and where specified.

5.9 All equipment installed in hazardous areas shall be selected to comply with ATEX regulations.

6.0 General Installation

6.1 General

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6.1.1 All installation shall be carried out to a good commercial standard by competent personnel to the satisfaction of the Colt engineer and client's own electrical inspector (where appointed).

6.1.2 Before commencing installation, confirmation must be received in writing from client or main contractor that the proposed load can be accepted into the system. Values of fault level and earth loop at the start of the Colt installation must be provided or measured.

6.1.3 Equipment shall be fitted in position as specified in layout and connection diagrams by Colt. Ensure that the current version of all drawings is used.

6.1.4 Thermostats, smoke detectors, CO detectors or similar equipment shall be sited in the specific positions indicated on drawings to ensure correct system operation.

Where thermostats or temperature sensors are to be mounted on external walls or building steel work they shall thermally insulated from the structure.

Where low voltage sensors are fitted these shall be wired in screened cable unless otherwise indicated in the manufacturer's instructions.

Thermostats, temperature sensors and CO sensors should be mounted at a nominal 1.5m above floor level unless specified by the Colt engineer.

Smoke, heat or fire detectors should be ceiling mounted unless otherwise specified.

If positions are not shown on drawing, these must be obtained from the Colt engineer in writing. Any changes to location must be agreed by the Colt engineer prior to commencement.

6.1.5 Cables, unless laid loose in conduit or horizontal containment, shall be straight and parallel.

6.1.6 Fixings shall be sufficient with spacing not exceeding that laid down in BS 7671 and/or manufacturer's instructions.

6.1.7 All terminals shall be fitted within sealed enclosures appropriate to local conditions. Minimum IP40. Minimum IP55 if external.

6.1.8 Where flexible/LSOH sheathed cables are brought into enclosures / trunking / conduit, entry shall be via a compression gland rated to equal or exceed the enclosure IP rating.

6.1.9 All cables shall be installed strictly to manufacturer's recommendations, including all recommended fixing spacings, metal clip/tie spacings, bend radii, connectors, terminations, suppressors, jointing methods, etc.

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6.1.10 All cores shall be identified in relation to their terminations and all multicore cables shall have a unique reference at both ends, fixed to the outer sheath. So far as is reasonably practicable, wiring shall be so arranged or marked that it can be identified for inspection, testing, repair or alteration. Any bare conductors shall be suitably sleeved with the appropriate colour as prescribed in table 51 (BS7671).

6.1.11 Where holes are made in the building fabric, these shall be made good upon completion of wiring installation. Where the construction is fire resisting an approved sealing method shall be used to maintain the fire resistance of the construction.

6.1.12 'Danger' and other appropriate warning labels shall be fitted where required. Warning Notices and labels shall include:

- Voltage Warning.
- Isolation Notice.
- Periodic test & Inspection Notice.
- Earthing and Bonding Connections
- Non-standard Colours (alterations to existing)
- Alternative Supplies Warning Notice.

6.1.13 Isolators shall be fitted as required by regulations and:

- a. Where more than one supply enters a piece of equipment, all supplies (including control circuits) in excess of 48 Volts shall be switched by one common isolator.
- b. Every heater, fan or other similar equipment shall have means of isolation.
- c. All isolators shall be capable of accepting a padlock to lock the isolators in the off position.
- d. Semi-conductor devices (solid state switches) may not be used as isolators.
- e. Fused spurs or plugs and sockets may be used to isolate low power equipment. These shall not include switches. NOTE: Switches are likely to be misused.

6.1.14 All distribution systems shall include fuse charts specifying circuit description, fuse type, manufacturer and size.

6.1.15 Cables to Weatherbeater sensing heads and similar low current sensors shall be run in separate conduits and/or screened from mains cables. Requirements for particular items shall be checked with suppliers of the equipment. (Minimum size 16/0.5mm²).

6.1.16 Extra low voltage (ELV) circuits shall be segregated from normal mains voltage circuits and equipment unless the insulation is rated to that of the highest voltage in the adjacent cables. Cables rated for ELV may be used, but these cables require sleeving where they enter mains equipment. This sleeving may not be coloured yellow/green.

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6.1.17 The use of flying leads with flameproof motors should be avoided. The motor should be wired to a suitable terminal box mounted externally on the fan casing by the fan manufacturer.

6.1.18 All terminals shall be retightened before final closing of enclosures.

6.1.19 All unused holes in electrical enclosures shall be properly blanked to the appropriate standard, minimum IP 40 internal, IP55 external. All lids and stop ends shall be fitted to trunking boxes.

6.1.20 All damage to surface finish shall be made good with appropriate paint, including exposed conduit threads.

6.2 Powered Smoke Ventilation

6.2.1 Installations shall comply with all relevant parts of section 6.1 as well as with this section. The requirements of this section are more detailed in some areas than those of BS 9999. The requirements of BS 9999 may be accepted as an alternative, if specified by the client.

6.2.2 Circuits of safety services shall be selected in accordance with Chapter 56 (BS7671), BS5819, EN 12101-10.

Circuits for safety services must be independent of other circuits so that any electrical fault or any intervention or modification in one system must not affect the correct functioning of the other.

6.2.3 HRC fuses shall be used in suitable high temperature holders to provide cable overload and short circuit protection. It will be necessary, as well as carrying out normal voltage drop calculations, to first size the fuse to carry motor starting current and then check to ensure that the cable is large enough to be protected against overload by that fuse

NOTE: This is because the motors are not fitted with overload protection and are run to destruction to obtain maximum operating time under emergency conditions.

6.2.4 Magnetic MCB are acceptable as an alternative to HRC fuses but thermal MCB units shall not, in any circumstances, be used to protect smoke and heat exhaust ventilators.

6.2.5 Independent primary and secondary power supplies shall be provided to BS8519. These shall be kept separate up to an automatic transfer switch (ATS) which should be located in or close to the Colt control panel. The power supplies shall conform to the requirements of BS 9999. The ATS shall conform to the requirements of BS EN 60947-6. Where required, the ATS should be fitted with a bypass in accordance with BS 8519.

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NOTE: All cabling and connections providing power up to the ATS or a local junction box are normally by others.

- 6.2.6 All cables (from the building supply intake through to the ventilators) shall comply with 4.2.
- 6.2.7 All smoke ventilation wiring circuits shall be regarded as Category 3 Circuits to BS 7671. Where this is not possible, such as the thermal cut-out on the motor, arrangements shall be made to isolate these circuits under hazard conditions. Colt control panels are arranged to provide this feature.
- 6.2.8 Wiring systems including cables shall be supported in such a way that they will not be liable to premature collapse in the event of a fire. Steel or copper clips, saddles or ties suitably spaced, in accordance with the manufacturer's instructions, are examples that will meet this requirement. Non-metallic cable clips or ties shall not be used as the sole means of support, although may be used for supplementary support or to dress cables on metallic cable tray/ basket.
- 6.2.9 Isolators fitted at the extract ventilator position shall be lockable in both off and on positions and be temperature rated to match the fan rating. If no suitable isolator is available to match the fan fire rating the isolator should be located outside or in a protected area, but not mounted onto the fan or duct or in the smoke discharge path.
- 6.2.10 Junction boxes shall be metal with ceramic terminals, where required.

6.3 Natural Smoke Ventilation

- 6.3.1 Electrical systems for power/pressure to open (PTO) and drive open/drive closed ventilators shall comply with Sections 6.1 and 6.2.
- 6.3.2 Electrical systems for PTC ventilators shall comply with section 6.1. They shall also comply with section 6.2 if it is required that ventilators outside the fire zone remain closed under fire conditions.

NOTE: pressure to close (PTC) natural smoke ventilators will fail to the open position in case of control failure and therefore the electrical requirements are less onerous.

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6.4 OPV

6.4.1 Power cable to smoke ventilators controlled by the OPV system shall comply with the requirements of section 6.2 or 6.3.

6.4.2 Data cable is SELV (17 - 28 Vdc). Equipment is daisy chain connected to the control panel.

OPV data cable should be screened or be separated from power cables.

6.4.3 Data cable for smoke control systems shall be fire resistant. See 4.2 for suitable cable specification.

NOTE: 1.5 mm² cable is normally suitable for up to 1.25km with 126 devices on Apollo systems.

6.4.4 6.4.4 RS 485 connection cable to fireman's override panels is SELV (24 Vdc). 4 core & screen (as 4.2. c) is recommended.

NOTE: The cable does not need to be separated from power cables (if suitably voltage rated). 1.5 mm² cable is normally suitable for up to 650m with 8 fire override panels (at 100 mA each).

7.0 Testing

7.1 Every electrical installation shall, during erection and on completion before being put into service, be inspected and tested to verify, so far as reasonably practicable, that the requirements of the current regulations have been met. Including:

- a. Inspection, as per section 642 (BS7671)
- b. Continuity of conductors
- c. Insulation resistance
- d. All fan installations shall have the insulation resistance tested with isolators both in the "On" and "Off" positions.
- e. During the above tests all low voltage electronic equipment must be disconnected.
- f. Testing shall be carried out with all lids/covers in place and the system completed.
- g. All networks addresses shall set and clearly marked on the equipment.
- h. All networks addresses will be tested and verified by the installer.
- i. All test equipment should be calibrated with calibration certification available upon request.
- j. A schedule of circuit details and test results must be used to record the above results.
- k. All required details must be established in order that an electrical installation certificate can be issued on completion.

8.0 Commissioning

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- 8.1 All smoke and heat ventilation systems, and other systems where necessary, shall be commissioned on completion by a Colt commissioning engineer following the relevant Colt commissioning guidance and procedures. Commissioning should not commence until the relevant circuits have been completed, inspected and tested and the relevant electrical certificate and supporting test sheets issued.
- 8.2 Upon completion of commissioning, all lockable switches and isolators shall be padlocked into the 'on' position.
- 8.3 Attendance by the electrician who carried out the wiring may be required for the first day of commissioning.

9.0 Documentation

- 9.1 Full documentation as required by BS 7671 shall be provided in duplicate (one copy for client, one copy for Colt retention) immediately on completion of the wiring and testing. This documentation is required for contract completion.
- 9.2 9.2 Documentation shall include:
- relevant electrical certificate
- 9.3 This shall include, or be accompanied by, sufficient information to allow the system design and installation to be checked for compliance with the regulations and to allow for design modifications at a later date if required, i.e. line diagram with cable sizes, fuse size and type, unit type and currents, drawings showing as installed wiring routes.