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| <b>No.19024</b> | <b>OVG Manchester</b> | <b>DESIGN NOTE</b> | <b>018</b> |
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| <b>Date:</b>        | 13/02/2020           |          |
| <b>Subject:</b>     | Ventilation Strategy |          |
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## 1.0 EXECUTIVE SUMMARY

This document intends to identify and describe the various ventilation systems to be utilised within the proposed OVG Manchester development. The ventilation strategies employed throughout the building generally align with the Manchester City Council document GD 03 and the DEFRA Guidance on the Control of Odour and Noise from Commercial Kitchen Exhaust Systems (Although this has been withdrawn and has not yet been replaced, it is directly referenced within GD 03).

## 2.0 MECHANICAL VENTILATION SERVICES

Mechanical ventilation (supply and / or extract) will be included to the following areas:

- Hall
- Catering operations
- Kitchens
- Concessions
- Staircases
- Toilets / changing rooms
- Plantrooms
- Loading bay / fume extract
- Store / Ancillary areas
- Smoke control zones
- Atrium
- Bars / Clubs / Lounges
- Offices and production suites
- Concourses
- Talent and crew areas

## 3.0 HVAC MAIN PLANT

The heating and cooling demand throughout the building will predominantly be met by the provision of Air Source Heat Pump (ASHP) technologies.

For the Hall, this technology shall take the form of Air Handling Units (AHUs) with an integral reversible ASHP that utilises the Hall exhaust air as a heat source or heat sink, as required.

The ASHP AHUs serve to provide heating and cooling to temper the air from external conditions to meet the internal comfort criteria within the Hall.

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Variable Refrigerant Flow / Volume (VRF / V) ASHPs provide the heating and cooling to the remainder of the building, with the ventilation requirements to each space met by local MVHR units.

## **4.0 VENTILATION STRATEGY**

### **4.1 Concourse and Front of House Circulation**

All concourses and Front of House (FoH) circulation areas shall be served by a decentralised ventilation strategy, allowing full flexibility of operation to areas within the building, allowing zones, sections and areas to be run independent of any others.

This approach will utilise local MVHR units, each provided with duct-mounted attenuation sized to maintain the noise criteria of both the MVHR's local area and the areas served by distribution ductwork. The MVHR units will draw intake air from the façade of the building via weatherproof louvres. Each louvre shall be partially concealed behind the architectural mesh cladding to the building.

The intake air is passed through G4 and F7 filtration and a cross-flow heat exchanger to temper the air. The supply air will be distributed via low pressure ductwork and introduced into the occupied space via supply air diffusers or FCUs. Where necessary, heater batteries (either electric or LTHW) shall be provided to ensure minimal impact on internal conditions is experienced during periods of low ambient temperatures.

Extract air shall be drawn directly from the space to the MVHR generally via bellmouth extract terminals. The extract air shall be passed through a G4 filter and then a cross-flow heat exchanger to provide free heating / cooling to the intake air.

The exhaust air shall be ducted from the MVHRs to the external wall of the building and rejected via louvres that are both local to the connected MVHR and allow for 10m separation from any intake louvres, as required by BREEAM.

This decentralised ventilation strategy reduces the need for vertical ventilation risers internal to the building, and allows less GIA to be absorbed by services risers.

All air intakes shall be positioned a minimum of 10m from exhausts, and 20m away from sources of pollution to achieve the available credit within section Hea 02 of BREEAM.

All MVHRs shall be provided with inverter driven fans and controlled via a network of temperature and air quality sensors as well as the central BMS system. This shall allow a variable volume system to be provided, thus allowing for maximum energy efficiency from these systems.

Where ductwork, pipework and all other HVAC services are to be installed in areas without ceilings or shall otherwise allow the services to be visible from Front of House (FoH) areas, ductwork shall be provided with a galvanised steel finish and pipework shall be neatly cladded in aluclad (pending confirmation of the architects aesthetic intent) and coloured black (RAL 9005).

The contractor shall be required to ensure that all finishes and installations within these areas are finished to an exemplary standard and meet the architect's aesthetic intent rather than detracting from the quality of the space.

### **4.2 Toilets**

Each toilet area throughout the building shall be provided with mechanical extract of 6 - 10 Air Changes per Hour (ACH) via extract air valves, extract air grilles and / or bellmouths as appropriate to the area. Extracted air shall be drawn through galvanised low pressure ductwork to an extract fan and exhausted via weatherproof louvres in the façade of the building.

Where possible, extract air from toilets shall be extracted via local MVHRs to allow heat energy to be recovered from the extracted air.

Where MVHRs are not available, packaged twin extract fans shall be utilised, complete with auto-changeover functionality.

Make-up air to each toilet block shall be from adjacent spaces. Air paths shall be provided either by natural make-up from adjacent areas, such as the concourse, via transfer grilles or Air Transfer Fans (ATFs) for larger WC blocks. ATFs will allow for make-up air to be delivered to larger WC areas without enforcing excess pressure on the MVHRs / AHUs extracting from these areas.

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This design allows for the WCs to be heated via the warm make-up air from the adjacent spaces. This strategy means that no further means of heating are expected to be required to WC areas within the building.

Generally all Toilet Extract systems discharge their exhaust air above external occupied zones, with the exception of the South West corner of Level GF. Here 3no. systems discharge through the Level GF external wall, below podium level. In order to eliminate odours within these systems, the exhaust air shall be treated via in-line UV-C filtration to neutralise Volatile Organic Compounds within the air flow.

#### **4.3 Concessions**

At this stage it is assumed that all concessions located on the concourses shall be fully capable of cooking hot food and the HVAC provisions have been designed with this in mind.

Pending confirmation of the catering strategy and requirements, each concession has been allocated an ecology AHU capable of extracting 3.5m<sup>3</sup>/s of kitchen extract air. The kitchen extract air is expected to be drawn from canopies located above the cook line within each concession. Each canopy shall include in-line grease baffles and UV-C filtration in addition to Ansul R202 fire suppression.

The kitchen extract air shall be ducted via low pressure ductwork to ecology AHUs located locally to each concession. Each ecology unit shall be provided with a UV filter, an ElectroStatic Particulate (ESP) filter, a panel / bag filter and an activated carbon filter.

The filtered kitchen exhaust air shall then be ducted via low pressure ductwork to weatherproof louvres in the façade of the building. Wherever possible partial make-up air to each concession shall be drawn directly from the adjacent concourse areas.

Heating and cooling shall be provided to the concession queuing areas via VRF / V FCUs. This shall allow the make-up air to the concession to be cooled prior to entry to the concession allowing thermal comfort to be provided to the concession occupants and the queuing guests.

(Note: the concession / satellite kitchens located on the West side of Level 02 are currently in abeyance and require resolving in the next stage once the project wide catering requirements are understood.)

#### **4.4 Commissary Kitchen**

Kitchen extract air is to be drawn from induction canopies located above the catering equipment. Each canopy shall include in-line grease baffles and UV-C filtration in addition to Ansul R202 fire suppression. From here, the kitchen extract air shall be ducted via low pressure ductwork to an ecology AHU located locally to the main commissary.

The ecology AHU shall be provided with a UV filter, an ESP filter, a G4 filter, an F7 filter and an activated carbon filter. The filtered kitchen exhaust air shall then be ducted via low pressure ductwork to a weatherproof louvre in the façade of the building.

Filtered, tempered outside air shall be provided in part to the kitchen directly, via the induction canopies and supply air terminals co-ordinated with the kitchen layout, and additionally to adjacent areas to ensure the cooking areas are maintained at a slight negative pressure.

Make-up air drawn from adjacent areas shall be provided via dedicated air paths via transfer ducts equipped with cross-talk attenuation.

FCUs shall provide spot cooling within the kitchen to maintain thermal comfort conditions.

The kitchen gas supply solenoid valve will be interlinked with the kitchen ventilation system. The gas will only become available when the ventilation system is confirmed as operational, and will automatically shut off the gas supply should the kitchen ventilation systems fail.

Ductwork shall be installed in accordance with HVAC TR17 in terms of access for cleaning and insulated where required to prevent condensation of cooking vapours.

Dishwasher rooms will be provided with a dedicated extract system equipped with stainless steel ductwork. Horizontal sections of ductwork will be set to a fall to prevent condensation pooling within the ductwork.

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#### **4.5 Premium Areas**

Premium areas within the building such as clubs, lounges, offices, talent areas and crew areas shall be provided with overhead FCUs with outside air derived from local MVHRs within ceiling voids.

The aesthetic intent within these areas is expected to be of a higher level, and it is expected that the HVAC services should align.

It is therefore currently assumed that low pressure ductwork from the MVHRs and FCUs shall connect to terminals such as linear slot diffusers integrated within the architectural ceilings.

Temperature control to clubs and lounges shall be centrally controlled via the BMS; offices, talent areas, crew areas and staff areas, shall be controlled centrally by the BMS with local set- point adjustment via simple controllers.

#### **4.6 Back of House Circulation Areas**

BoH circulation areas, such as BoH lobbies shall be provided with mechanical ventilation via MVHR units in the same manner as FoH circulation areas.

These spaces are generally conditioned via heat recovery from the MVHR units. Detailed assessment will be carried out during stage 4 to assess whether additional heating (via heater batteries, radiators or FCUs) is required.

#### **4.7 The Hall – Central AHUs**

Ventilation to the Hall is to be provided by 16no AHUs each equipped with integral heat pump technology located at roof level within the services trench.

Each AHU is to be sized to deliver 12m<sup>3</sup>/s of supply air, allowing for comfort conditions and internal air quality to be maintained for all event types within The Hall, as detailed within the Basis of Design section of this report.

The AHUs will be mounted on a Big Foot support system, and be provided with access gantries to allow ease of access to top and bottom decks.

In cooling mode, the integral ASHP and heat exchangers extract heat from the supply air stream within the Supply Unit located on the bottom deck of the AHU, and reject it into the air exhaust air stream within the Extract Unit located on the top deck of the AHU. This action cools the supply air stream being delivered to the Hall, by using the rejected exhaust air from the Hall as a heat sink.

If external conditions are appropriate, the AHU will not initiate the ASHP and condition the Hall environment with free cooling or heat exchangers alone for improved annual energy performance.

In heating mode, the operation of the ASHP is reversed, whereby the Hall exhaust is used as a heat source for warming the supply air. Through effectively cooling the exhaust air within the Extract unit on the top deck of the AHU from the Hall, the heat from the exhaust air stream is transferred into the supply air stream in the Supply Unit on the bottom deck of the AHU.

Intake air is drawn from within the Level 05 services trench in to the AHU via an inlet air attenuator. The inlet air attenuator is sized to ensure the noise breakout from the AHU complies with the site acoustic criteria.

The inlet air is then filtered before being passed through a thermal wheel, DX cooling coil 1, DX Heating / Cooling coil 2, Run-around heat exchanger coil and a backup electric heating coil for conditioning. A high efficiency array of plug fans with EC motors will deliver the air into The Hall via a supply side attenuator. The supply side attenuator will be sized and positioned to maintain the integrity of the acoustic properties of The Hall envelope, preventing a path for noise to breakout. The duct penetrations from outside into The Hall will be horizontal to allow for conventional methods of weatherproofing.

From within The Hall, the conditioned and filtered supply air will be distributed via a series of ductwork legs and delivered to The Hall via a range of diffusers and jet nozzles. Various ductwork legs will be provided with motorised dampers interlinked with corresponding flow grids to allow the ventilation system to accommodate a range of event types.

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Supply ductwork has been arranged to limit the extent of ductwork entering the zone of the technical floor in order to facilitate maximum flexibility for the occupier. All volume control dampers controlling the airflow to each nozzle will be accessible from The Hall Lighting Gentries.

Air temperature sensors and air quality sensors shall be positioned within The Hall to ensure that comfort conditions and a good level of indoor air quality is maintained within the space and dictate the control of the AHUs.

The return air will be extracted directly from The Hall via bellmouth extract terminals located at high level within the roof structure. The return air will route back to the AHU via a duct mounted silencer mounted within the acoustic envelope of The Hall. The air will pass through a series of heat exchangers and refrigerant coils prior to being exhausted to atmosphere. There will be an air side attenuator to control the noise breakout from the AHUs in compliance with the site acoustic criteria. The Exhaust air will terminate within the Level 05 external façade screens.

All ductwork within The Hall will be pre- insulated, and finished in matt black (architect to specify RAL colour).

#### 4.7.1 Event Modes

Whilst the primary function of the OVG Manchester Arena is to provide the area with “The world’s best music venue”, the Hall Ventilation System has been additionally configured to service a “multi-purpose events arena”. This approach provides the greatest level of flexibility in commercial offering of events that can be held.

The ductwork configuration allows for specific areas within The Hall to have the ability to be turned on and off as required to accommodate a range of event types. The ventilation system can be tailored for each event type via the BMS. This approach will generate energy savings by only delivering conditioned ventilation to where it is required, and in the case of smaller shows, turning off entire AHU systems.

##### 4.7.1.1 Concert Mode

Standard Concert Mode (Seated, Standing, Award Shows, and Touring Shows) consists of flat floor seating or standing and seating to the tiered banks facing the stage. The tier located behind the stage is not required, and as such, the jet nozzles to this area are switched off.

##### 4.7.1.2 Sport Mode

Sport Modes (Boxing, Basket Ball and E-Sports) utilise the tier located behind the stage.

The ventilation nozzles serving this area are activated to accommodate this area. The supply air serving the central portion of The Hall is dialled down to accommodate the additional tiered bank.

##### 4.7.1.3 Ice Pad Mode

Ice Pad Mode (Ice Hockey and “Disney on Ice”) allows for a temporary ice pad to be located in the centre of the event space. The central duct runs delivering air to the supply nozzles above the ice pad position are turned off to prevent ventilation air being blown directly over the ice pad. This will improve the quality of the ice surface and minimise risk of frosting occurring. (Note: The building services included in this design DO NOT comply with NHL requirements)

##### 4.7.1.4 EDM Mode

EDM Mode (Partial occupancy event, not utilising upper tier) consists of flat floor standing only, with the option of not using and partitioning off the upper tiers to create an intimate environment. This mode allows for the majority of the ventilation to the upper tiers to be switched off since they are not required allowing energy savings to be made.

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#### 4.7.1.5 Short Hall Mode

Short Hall Mode (Seated and Standing) allows for reduced capacity concerts to be held. This is achieved by moving the stage forward within the venue and curtaining off the area behind the stage. In this mode, the AHU's serving the areas behind the stage are switched off.

#### 4.7.1.6 Pre-Show Mode (Ventilation to Atrium)

During Pre-show mode, it is anticipated that there will be a large occupancy (up to 3,000 people) within the Atrium before and after the show. During this period, conditioned air from the AHUs situated closest to the North East and South East corners (2no. units) are diverted from The Hall to the Atrium, through the use of motorised volume control dampers.

The supply air is routed down to the soffit of the Level 02 Atrium, utilising flat oval ductwork, and distributed into the space via drum jet diffusers. High level bell mouth terminals within the Atrium will return the air to the AHUs. All exposed ductwork and nozzles will be finished in matt black (architect to specify RAL colour).

When the show starts, the motorised dampers will reconfigure diverting the majority of the air to The Hall, retaining a provision of make-up air to the Atrium for WCs, Concessions etc. connected to the Atrium. The system is not intended to operate in Show and Pre-Show modes concurrently.

## 5.0 SMOKE EXHAUST SYSTEMS

### 5.1 Fire Fighting Stair Cores

Each firefighting stair core shall be provided with a mechanical smoke extract system to the lobbies and an Automatically Opened Vent (AOV) at the head of the stair core which shall be opened under fire condition.

The smoke extract system will consist of a duty and standby variable speed extract fans with inverter drives, linked to pressure sensors within the lobby at each level via a control panel. A motorised damper will be provided between the extract shaft and lobby at each level. A 1m<sup>2</sup> ventilator is needed in the stairwell for air inlet.

The pressure sensors maintain acceptable pressure difference between the lobby and stairs, typically 25Pa. This ensures that excess pressures do not draw extra smoke past door seals or cause excessive door opening forces.

### 5.2 The Hall

At this stage it is assumed that a mechanical smoke exhaust system shall be provided to The Hall. This system shall be capable of maintaining

150m<sup>3</sup>/s of smoke extract under a fire condition within the Hall. This will be reviewed upon receipt of the results of the CFD smoke analysis to the Hall.

This will be provided by seven fire rated smoke extract fans, located externally within the "roof trench", with bellmouth extract points at high level within the Hall. Makeup air will be provided from low level via the vomitory access doors and Hall fire doors.

### 5.3 Level 3 Concourses

Mechanical smoke extract system is to be provided to the Level 3 North, South and West Concourses, where spaces are double height. The system is designed to extract 10 air changes per hour from the space under smoke conditions. This will be reviewed upon receipt of the results of the CFD smoke analysis to the Hall.

The Fire rated smoke extract fans will be located at high level within the Level 3 concourses. All ductwork and fans to be finished in black (Architect to specify RAL colour).

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#### **5.4 Atrium**

Mechanical smoke extract system is to be provided to the Atrium. The system is designed to extract 10 air changes per hour from the Atrium under smoke conditions. This will be reviewed upon receipt of the results of the CFD smoke analysis to the Hall.

The Fire rated smoke extract fans will be located in the services trench at the roof level and utilise the general extract ducts serving the Atrium. These extract ducts will be fire rated to allow for dual use and motorised smoke fire dampers shall be used to alternate use between AHU (general extract mode) and smoke fan (fire mode).

#### **5.5 Level GF Talent Areas and Back of House**

The Talent Areas and Back of House spaces to the southern end of the building on Level GF will be provided with a smoke extract system. Since this area is too large to be ventilated all at one, the area has been broken down into several smoke control zones.

Each smoke control zones will typically consist of several rooms, but within a common fire compartment. When a fire is detected within a smoke control zone, all motorised dampers within the smoke control zone will open, and the common smoke extract fan will initiate. All other motorised fire smoke dampers will remain closed to ensure that the smoke extract occurs where it is required.

Under fire mode, the extract system will ventilate all rooms within the affected smoke control zone to 10 Air changes per hour.

Where a portion of the exhaust ductwork system utilises the general extract system, this ductwork shall be fire rated.

Mechanical makeup air supply ducts have been allowed to each zone, terminating with a fire smoke dampers. In fire mode, dampers will open in the affected zone, and close elsewhere, maintaining fire partition integrity.

#### **5.6 Loading Bay**

The loading bay shall be provided with a fume / smoke exhaust system assisted by an induction fan system.

These systems shall, under normal conditions, provide continuous background ventilation at a rate of 6 Air Changes per Hour (ACH) to control levels of petrol and diesel vapours and toxic gasses produced during normal operation of the loading bay.

Under a fire condition, these systems shall provide a minimum of 10ACH to allow for removal of smoke from within the loading bay.

The induction fans shall be located at high level to maximise the available headroom within the loading bay, ensuring suitable clearance for vehicular movement.

The induction fans shall promote air flow from the vehicle entrance and encourage air to flow throughout the loading bay and towards the extract terminals situated in the South end of the loading bay.

The roller shutter door providing security to the entrance to the Loading Bay during unoccupied hours will have vent openings at high level equivalent to 42m<sup>2</sup> free area, to allow the Loading Bay ventilation system to operate when the doors are closed.

The extracted air shall be exhausted to atmosphere via the Ventilation Turret mounted on the Level 01 podium. The smoke fans shall be dual speed, fully fire rated, and utilise a system of fire rated ductwork connected to high level extract terminals.

3no. fans, arranged in parallel, are included in the design.

Each fan shall be capable of extracting 14.0m<sup>3</sup>/s of air during normal conditions and increasing to 23.4m<sup>3</sup>/s during fire conditions. This provides 42.0m<sup>3</sup>/s of extract air during normal and 70.2m<sup>3</sup>/s of extract air during fire conditions.

Each fan shall be inverter driven and rated to run at 300°C for a minimum of 60 minutes.

The ductwork, fixings, supports and ancillary equipment shall be suitable for handling hot gases of temperatures up to 800°C.

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Each fan shall exhaust into a common exhaust plenum situated within the Ventilation turret, equipped with fire rated non-return dampers on each branch to eliminate recirculation through fans.

The fans shall be fed from a life safety electrical supply to ensure a power supply for up to 180 minutes in the event of a mains power failure.

In addition to the general loading bay extract system, additional hose reel extract fans shall be provided in the vicinity of the truck parking bays to provide the facility for truck engines to run whilst loading / unloading takes place. A product such as the Nederman Hose Reel 865 (or approved technical equivalent) will provide this facility. 1no. hose reel system shall be provided per parking bay (12no. total).