GENERAL

A fully automatic building management system (BMS) shall be provided to control all elements of the building services installation in both buildings.

A head end monitoring and controlling all items of plant through displayed graphics shall be installed in purpose made control panel, complete with LCD touch screen and located in the FM office.

The BMS shall be monitoring and/or controlling all main items of plant including the heating, VRF and ventilation systems. It shall adjust the operation parameters of the systems to allow them to run efficiently and more importantly as intended by the building operator. The BMS shall also be monitoring energy uses for the different components and receiving alarms from all the systems elements.

The BMS shall monitor and/or control the following:

- Air source heat pumps
- VRV systems
- LTHW distribution pumps
- Pressurisation unit
- Thermal store
- Temperatures - outside air, LTHW system temperatures, cold water system, hot water system
- Ventilation systems – air handling units, fans
- Cold water services - booster set, high and low level tank alarms, water conditioner, wash down tank etc.
- Hot water systems
- Smoke extract systems
- Motorised fire and smoke dampers
- Motorised volume control dampers
- All meters and sub-meters
- Leak detection system
- LV switchgear
- Landlord lighting
- Sump pumps
- Trace heating system
- Lift panel common alarm
- UPS

Control of the building systems shall be provided by a direct digital control (DDC) system, including a head end management station, network controllers and DDC units. All control algorithms, computation and energy management functions shall be software-based and resident in the DDC system.

The operator shall have the capability through the head end or network controllers to access all programs, display all data resident in the system memory and perform analogue and digital functions.

All fans, pumps and other similar drives shall be variable speed drives. Simultaneous enabling of drives shall be prevented by a sequential start program in the DDC system. This program shall also provide sequential restart after failure of drives that were running prior to power failure or fire alarm shutdown.

Software time delay relays shall be provided in the DDC system to allow fan motors to cool down before restarting. Motors shall have both a minimum interval time (between consecutive starts) and a minimum off time (between start and stop). The time periods shall be based on the motor rating.

In the event of a fire alarm condition the BMS shall receive a signal from the fire alarm system which shall shut down all HVAC systems.

Automatic restart of fans after a fire alarm or power failure shutdown shall be software prohibited through the de-energisation of the remote start/stop contact. Fan restart shall be manually initiated by the operator either locally or remotely through the head end.

All equipment not equipped with a packaged built in control panel will be provided with a starter free issued by the controls' contractor to the electrical contractor for installation and wiring on site.

APARTMENTS

Each apartment shall be provided with a dedicated BMS consisting of a DDC outstation controller capable of providing all the necessary controls and monitoring functions required to enable the apartments heating, cooling, hot water and ventilation systems within the apartment.

The system shall monitor and/or control the following:

- MVHR unit
- Hot water cylinder
- UFH pump
- VRV indoor units
- Condensate pumps
- All meters
- Leak detection
- Trace heating

The BMS controller shall be located within the 'wet' services cupboard and shall be interfaced with the home automation touch screen for all control functions and displays.

Each apartment shall be provided with a programmable time clock controller to enable user interface.

System Set Up

The apartment BMS controller shall be utilised to programme all set points:

- Temperatures
- Fan speeds
- Dead bands
- Occupancy times

Local/central home automation system panels shall be utilised to change local temperatures, fan speed and turn the system on/off or set it to automatic mode as required by the purchaser.

DAY 1/OPTIONS SET UP FOR HANDOVER

1) Default Set Points

Heating	20°C Bedroom/Dressing room
	22°C Living room
	22°C Bathroom
	19°C Toilet
Cooling	24°C all cooled rooms
Dead band	±2°C of the default set point
Internal set back	15°C Winter
	30°C Summer
Frost protection	10°C
Fan speeds on fan coil units	low speed
Scheduling	6am-9am / 5pm-10pm Monday to Friday
	7am-11pm Saturday and Sunday

2) Heating Only (Winter Mode)

Same set points as default.

3) Cooling Only (Summer Mode)

Same set points as default.

4) Holiday Option

Everything OFF except required areas:

- Rooms where 24/7 system ON is required (e.g. cupboard etc.)

DAY 2/PURCHASER'S SET POINTS

The controls system shall allow full flexibility to the purchaser to change/override these settings.

The BMS specialist should include for a separate visit to set up the system to accommodate the purchaser's requirements.

The system shall also be capable of transferring alarms to the main building head end.

Heating System

During the occupied hours, when the space temperature is below the set point temperature on the main controller the underfloor heating in that room will be enabled.

During unoccupied periods, the BMS will monitor the space temperature within the whole apartment and if the space temperature falls below the frost protection set point it will enable the heating system until the average temperature is greater than set back temperature.

Cooling System

Fan coil units shall be enabled by the occupancy times and the temperature sensor within the space. During the unoccupied hours the system shall monitor the apartment temperature and start the system in case the temperature rises above the setback temperature.

The BMS system shall 'hold off' the cooling system if the underfloor heating within the same area is enabled.

B6.1 SCOPE OF WORKS

RESIDENTIAL HEATING SYSTEM

The air source heat pumps shall be provided with an integral controller including water temperature control and sequencing. An electronic control module shall control modulation sequence, temperature display, fault diagnostics, integrated frost protection and pump overrun.

The controller shall be provided with any necessary interface modules to allow the operation to be controlled via a 0-10V input signal.

The controller shall receive input from the BMS on requirement for heating and provide a common alarm signal to the BMS. The common alarm signal to the BMS shall include primary pumps and shut off valve failure.

The controller shall also enable the associated primary pumps and open/close associated shut off valves on start/stop. The pumps shall be enabled on demand maintaining a constant temperature variable flow. Differential pressure switches installed across each pump shall be wired into the pump VSD. If flow is not established upon activation of any pump after a 30 second (adjustable) time delay, an alarm shall be transmitted to the head end.

The pressurisation unit shall operate via its own integral controls to maintain the system pressure. Should the system pressure go 'out-of-limits' then the heating plant shall shutdown and an alarm shall be raised. The alarm shall be monitored by the BMS and visual indication shall be provided on the control panel facia.

All ancillary equipment shall operate via their own integral controls with high level BMS interface provided for fault and enable.

The BMS shall be able to monitor and control all circuit temperatures, control valves and pump inverters.

The BMS shall receive the requirement for heating from either one of the apartment controllers or the space temperature sensors in the landlord areas.

The BMS shall monitor the temperature within the thermal store and shall operate the thermal store distribution pumps as the lead source of heating. The distribution pumps circulate water from the thermal store to the secondary system. The pumps shall operate on a duty/standby basis via the BMS. The duty pump shall operate whenever the thermal store is charged.

The pumps shall be monitored for water flow (derived from a water differential pressure switch installed across the pumps) and in the event of the duty pump failing the standby pump shall be started. The BMS shall interface with the manufactures pump controller/optimiser.

The duty pumps shall operate whenever a heat pump is required. The pumps shall be monitored for water flow (derived from a water differential pressure switch installed across the pumps) and in the event of the duty pump failing the standby pump shall be started.

The secondary heating pumps circulate constant temperature water to the secondary circuit. The pumps shall operate on a duty/standby basis via the BMS. The duty pump shall operate at all times. The pumps shall be monitored for water flow (derived from a water differential pressure switch installed across the pumps) and in the event of the duty pump failing the standby pump shall be started.

The BMS shall rotate all pumps on a weekly basis.

VRV SYSTEMS

Office

All VRV systems shall be provided with a centralised controller with web server capabilities. These shall be 'free-issued' to the controls sub-contractor for mounting within the floor control panel if required and shall also provide a means of interrogation of the VRV system.

The centralised control panels shall be interfaced to the BMS. This shall allow the tenant complete control over all features of the VRV system, as well as the building manager through the head end, should a future tenant occupy multiple floors and install a central BMS system.

A space temperature sensor shall be installed in each of the tenanted areas. The space temperature sensor along with the outside air temperature sensor shall be used to provide an optimum start signal for the VRV plant. This shall energise the VRV system at a pre-determined time to ensure that the tenant's floor is up to temperature at the desired occupancy time. The space temperature sensors shall also provide fabric protection to the tenant's areas by energising the respective VRV systems during un-occupied periods should low space temperatures be sensed.

An outside air temperature sensor shall be installed. This shall be used as a reference temperature to all tenants' control outstations for optimum start signals.

The VRV system shall be enabled via the BMS to run between the hours of 0800-1800 (adjustable).

The system shall also operate when required to provide fabric protection to all floors. Fabric protection shall initiate when the internal temperature falls below 10°C (adjustable) and continue to operate until the temperature reaches 14°C (adjustable).

The centralised controller shall monitor and control the fan coil units, BS boxes and external heat rejection plant associated with the floor via a BMS interface.

The centralised controller shall provide the minimum control to each fan coil unit:

- Run and stop operation
- Mode selection
- Temperature settings
- Fan speed setting
- Timer operation (night set back/fabric protection)
- External outputs/inputs in accordance with the scheduled points list
- Web server settings via BMS
- Password protected access

The controller shall share information with the BMS outstation (Trend or equal and approved) and back to the head end via the network.

Any faults/alarms registered at the outstation shall be viewed at the head end.

Should the AC equipment be operated outside of normal working hours, the BMS shall enable the main ventilation plant and associated refrigerant heating/cooling system.

Each system shall be linked to window contact sensors at their respective floors such that the VRV system will switch off in the case of any window being open.

Apartments

Residential VRV system shall be provided with a centralised controller with web server capabilities, interfaced to the apartment BMS.

COMMS/UPS ROOM SPLIT SYSTEMS

Each standalone system shall be controlled under the dictates of return air temperature sensor at the rear of the wall mounted fan coil unit located within the area.

The system shall operate 24/7 to maintain the required design set point. The system shall operate at night set back mode (at any time) when the wall mounted temperature sensor registers a temperature of 14°C.

The system shall be disabled if a fire signal is registered at the main control panel.

Any faults registered at the system shall be sent to the BMS.

VENTILATION SYSTEMS

All ventilation systems (air handling units, fans) shall be provided with their own packaged controllers. All systems are constant volume, but inverter driven.

Each fan shall be provided with a differential pressure switch provided by the controls contractor which will transmit an alarm to the BMS head end in the event of fan failure.

On receipt of a fire signal the plant will be commanded to its normal OFF condition. A fireman's override switch will be provided by the controls contractor for smoke clearance using the extract fans.

Air Handling Units

The air handling units shall be enabled by an optimisation-based time schedule to provide tempered fresh air during occupied hours (0800 to 1800 hours (adjustable), typically 5 days a week (adjustable).

SUPPLY

Differential pressure switches located either side of the supply fans shall prove airflow. In the event that airflow is not proven, an alarm shall be sent to the on-floor control panel. Only when airflow is proven the DX/ electric heater battery shall be enabled.

The fresh air handling units shall maintain a minimum supply air temperature of 20°C (winter)/ 24°C (summer).

Differential pressure switches across the filter bank shall provide filter condition indication to the on-floor control panel.

EXTRACT

The extract fan shall be enabled when the supply fan starts.

Differential pressure switches located either side of the extract fan shall prove airflow. In the event that airflow is not proven, an alarm shall be sent to the central BMS.

Differential pressure switches across the filter bank shall provide filter condition indication to the on floor control panel.

Duct mounted temperature sensors located within the AHU and distribution ductwork shall interface with the heat recovery system.

OPERATION

The handling units shall maintain a minimum supply air temperature of 20°C (winter)/ 24°C (summer). Heater battery output shall be controlled to maintain the supply air temperature.

Winter

Ambient air at -4°C/saturated (peak design condition) shall pass through the filter and a differential pressure sensor shall monitor the pressure either side. A critical alarm shall send a signal to the on floor control panel if the filter is dirty. The air shall pass through the heat recovery section, with the air on and air off monitored via internal thermostats within the AHU.

The intake air shall pass through the fan chamber and through the heater battery. The heater battery shall be energised if the supply air sensor indicates a temperature below the set point of 15°C.

Differential pressure sensors shall be located either side of the fan to prove airflow back to the control panel.

The AHU extract fan shall be enabled after the supply fan was switched on. The supply and extract fans shall be interlinked.

Return air from the office space deemed to be 24°C @ 50% RH shall enter the AHU from the ceiling void. The air shall pass through a panel filter and heat recovery section before discharging to atmosphere via the extract fan.

Summer

The general operation denoted under winter mode shall be mimicked for the summer mode.

SHUT DOWN

When disabled by the local on floor panel, LTHW heater battery and extract fan shall be disabled. The supply fan shall continue to operate for 5 minutes (adjustable) until the heat has been dissipated.

FIRE ALARM

A fire alarm interface direct to the on floor control panels when activated shall disable all equipment fed from this outstation. The equipment shall be restarted automatically once the fire signal has been reset.

Toilet Extract And Back Of House Extract Fans

The fans in the common areas shall be provided with their own packaged controller and shall be enabled by a BMS time switch signal. All systems shall be constant volume but inverter driven. The BMS shall receive a fault signal from each fan control panel.

On receipt of a fire signal the ventilation plant shall be shutdown.

A fireman's override switch shall be provided by the controls sub-contractor for smoke clearance using the basement extract fans. The switch shall be 'hard wired' and shall provide 'normal/off/extract only' control of the landlord's fans.

Apartment Ventilation - MVHR

All units shall be provided with their own packaged controller and shall be monitored by the apartments' BMS controller.

MVHR UNITS SCHEDULE

SCHEDULE	M016 - MECHANICAL VENTILATION WITH HEAT RECOVERY UNITS	AUTHOR	MR	CHECKED BY	LN

REFERENCE	SERVING APT. TYPE No. OFF		MAXIMUM HIGH RATE (BOOST) [l/s]	MINIMUM LOW RATE (BACKGROUND) [l/s]	EXTERNAL STATIC PRESSURE [Pa]	MAX SFP [W/(l/s)]	OVERALL DIMENSIONS W x D x H [mm]	WEIGHT [kg]	BREAKOUT NOISE @ 3m [dBA]	MAX POWER INPUT [W]	MODEL
MVHR-GR-F01-01	1	1	39	19	150	1.5	660 x 443 x 760	24	33	40	Sentinel Kinetic Advance
MVHR-GR-F02-01	2	1	39	19	150	1.5	660 x 443 x 760	24	33	40	Sentinel Kinetic Advance
MVHR-GR-F03-01	3	1	39	25	150	1.5	660 x 443 x 760	24	33	40	Sentinel Kinetic Advance
MVHR-GR-F04-01	4	1	39	19	150	1.5	660 x 443 x 760	24	33	40	Sentinel Kinetic Advance
MVHR-GR-F05-01	5	3	47	27	150	1.5	660 x 443 x 760	24	35	51	Sentinel Kinetic Advance
MVHR-GR-F06-01	6	3	39	25	150	1.5	660 x 443 x 760	24	33	40	Sentinel Kinetic Advance
MVHR-GR-F07-01	7	3	47	35	150	1.5	660 x 443 x 760	24	35	51	Sentinel Kinetic Advance
MVHR-GR-F08-01	8	1	47	35	150	1.5	660 x 443 x 760	24	35	51	Sentinel Kinetic Advance
MVHR-GR-F09-01	9	1	61	44	180	1.5	660 x 443 x 760	24	39	82	Sentinel Kinetic Advance

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CONTROLS AND ANCILLARIES

- All units shall be fitted with integrated digital controller.
- All residential MVHR units required to boost their rate shall be controlled by a light switch input from the bathrooms with a 15min run on facility after the light switched is turned off. Where the apartments' ventilation minimum high rate equals to minimum low rate the unit shall run on continuously without the boost mode.
- All units shall be provided with G4 filter for supply and extract.
- All units shall be acoustically lined.
- All supply air connections to the grilles within habitable rooms shall be made of flexible acoustic duct (min. 500mm long.)

NOTES

- All residential MVHR units are based on Vent-Axia Sentinel Kinetic Range and shall be as manufactured by Vent-Axia Ltd. or equal and approved.
- All residential MVHR units shall be SAP eligible (Appendix Q).
- All fans shall be inverter driven.
- Total maximum power input represents overall wattage for both motors.
- All ductwork serving residential MVHR units shall be flat plastic system (Domus system or equal and approved). The system shall be designed with a minimum pressure drop in mind (i.e. 45° bends should be used etc.)
- Final pressure drops shall be calculated based on the coordinated installation drawings.
- Fresh and exhaust air ductwork shall be insulated between the fan unit and the façade.
- The stated breakout noise represents the boost mode.
- Set of replacement filters shall be provided.

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SCHEDULE	M012 - AIR HANDLING UNITS	AUTHOR	MR	CHECKED BY	LN

UNIT REFERENCE No.		AHU-GR-00-01	AHU-PH-00-01	AHU-PH-00-02	AHU-PH-06-01	AHU-PH-06-02
SERVING		GIR landlord's areas	Affordable office	Hub and reception	PH office (tenant B)	PH office (tenant A)
LOCATION		GF bin store	PH GF plantroom	PH GF plantroom	PH roof plant enclosure	PH roof plant enclosure
MANUFACTURER		FläktGroup	FläktGroup	FläktGroup	Swegon	Swegon
MODEL		Eco Premium 5	eQ-011	eCO Top-04	Gold 60 RX	Gold 40 RX
PANEL FILTER EFFICIENCY		G4	F7	F7	F7	F7
FROST COIL TYPE		-	-	-	-	-
BAG FILTER EFFICIENCY		-	-	-	-	-
HEAT EXCHANGER	TYPE	plate	rotary	rotary	rotary	rotary
	EFFICIENCY (%)	70.8	70.8	77.1	57.5	80.3
COOLING COIL	TYPE	-	-	-	DX	DX
	AIR TEMP OFF (°C)	-	-	-	24	24
HEATING COIL	TYPE	electric, duct mounted	electric, duct mounted	electric, duct mounted	DX + electric	DX + electric
	AIR TEMP OFF (°C)	20	20	20	20	20
HUMIDIFIER TYPE		-	-	-	-	-
SUPPLY FAN	AIR VOLUME FLOW RATE (m^3/s)	0.56	1.1	0.49	5.75	3.65
	EXTERNAL STATIC PRESSURE DROP (Pa)	150	150	150	250	250
	FAN MOTOR POWER (kW)	0.35	1.03	0.431	6.57	3.52
	VOLTS/PHASE/HERTZ	230/1/50	400/3/50	230/1/50	400/3/50	400/3/50
EXTRACT FAN	AIR VOLUME FLOW RATE (m^3/s)	0.43	1.0	0.49	3.2	3.1
	EXTERNAL STATIC PRESSURE DROP (Pa)	120	100	150	150	150
	FAN MOTOR POWER	0.202	0.954	0.414	2.97	2.63
	VOLTS/PHASE/HERTZ	230/1/50	400/3/50	230/1/50	400/3/50	400/3/50
LENGTH (mm)		2000	1200	833	4894	4764
WIDTH (mm)		1720	1950	1720	2518	2190
HEIGHT (mm)		470	1502	1539	2408	2279
WEIGHT (kg)		280	712	300	2275	1753
SOUND PRESSURE LEVEL @ 3m (dBA)		39	61	52	64	61
SOUND POWER LEVEL (to surroundings) (63), 125, 250, 500, 1k, 2k, 4k, 8k Hz (dB)		67,66,62,52,44,37, 34,30	55,60,69,52,45,49, 44,21	68,56,59,42,39,40, 34,30	77,69,62,66,51,50, 47,50	74,66,59,63,48,47, 44,47

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NOTES

GENERAL

- All AHUs shall be manufactured by the supplier stated above or equal and approved.
- To be constructed to all British and European Standards.
- All units to comply with ErP Commission Regulation (EU) No 1253/2014.
- Each section to have a permanent label to indicate function and any other relevant information.
- AHU to be equipped with dedicated control panel sited on side of unit (mounted externally). All AHU components shall be pre-wired for power and controls prior to delivery to site. The outstation shall be free issued to the AHU manufacturer by the control's contractor.
- Power shall be provided to the control panel via the electrical services contractor.
- AHU to be suitable for internal or external locations as determined.
- All panels to be double skinned with 50mm high density insulation.
- Units shall be fitted with motorised air intake shut-off dampers.
- Ensure that the units are mounted at a sufficient height to allow installation of condensate drain traps. Provide details of condensate size to the mechanical contractor for final connection.
- All access sections to be hinged, lockable doors.
- Electric heater to be thyristor controlled.
- Allow for all units to be delivered, off-loaded and positioned in final locations on site.
- Condensate drip trays are to be fully removable, painted galvanised sheet steel.
- Ensure all holes required for fixing of temperature/humidity/pressure sensors are provided prior to delivery to site.
- Provide factory fitted pressure sensors across all filter sections.
- Allow for a standard RAL colour finish.
- Allow for a complete set of replacement filters for installation following testing and commissioning.
- Allow for commissioning, testing and the cost of certification.
- Allow for all As Built drawings and O&M Manual information.
- Controls outstation to be TREND.
- This schedule shall be read in conjunction with control section B6 of the specification.
- Sealant, gaskets and fixing bolts to be provided for site assembly.
- Ends of the units to be fitted with flanges to allow connections.
- AHUs to be capable of satisfying the required noise level parameters.
- AHUs to be fabricated, assembled and, if selected, tested prior to dispatch. As a minimum, fans are to be tested for vibration and direction of rotation.
- The AHU manufacturer to be responsible for any site reassembly.
- AHU to be arranged as shown on the drawings and no larger than indicated.
- Double glazed view glasses to be fitted to all fan, humidifier and access sections.
- Unit access areas to be fitted with bulkhead lights, IP67 rated and pre-wired to external switches. Lamps to be low energy / LED. Allow for a complete replacement of lamps following testing and commissioning.
- External units to be fitted with matching pitched roof with guttering, down comers and shoe discharges.
- All external electrical equipment to be IP65 and weatherproof.
- The unit and base frame to be mounted on "TICO" mat or similar.
- Construction to include sufficient access sections to allow access to internal components for installation, maintenance and removal. Length to be 400, 500, 600mm dependant on application.
- Floor panels to be suitably strengthened to prevent distortion due to the weight.
- Cold plasma bipolar Ionisation units to be added to all AHUs and fresh air supply fan arrangements.

FRAME CONSTRUCTION

- Unit constructed to meet the leakage requirements of DW143 class A.
- To be constructed from 50mm extruded aluminium, galvanised steel or Aluzinc in a pentapost framework arrangement with cast aluminium corners or similar.

PANEL CONSTRUCTION

- Constructed from 50mm panels mounted in a framework.
- Casing should have a heat transfer and air tightness that meets current CEN Standards.
- The air leakage from the unit shall not be greater than that specified for the distribution ductwork.
- The minimum sound attenuation of the casing should be tested at pr EN 188 band ISO 3744-19.
- Provide panels with insulation not less than 50 mm thick and with the two steel skins, not less than 0.7 mm thick.
- The thermal insulation contained within the panels shall have a density of not less than 65kg/m^3 and a thermal conductivity no greater than 0.038W/mK.
- Where indicated provide panel skins of 1.0 mm thick galvanised sheet steel coated with 0.2 mm thick polyester, colour - determined by the Architect. Standard finish may be acceptable provided an acceptable sample can be provided.
- Provide access doors to all sections as all other panels but with the addition of door handles and hinges.
- Internal skins on humidifier sections and downstream sections to be treated with a waterproof protective coating.
- Handles to be provided on all removable panels.

INTERNAL COMPONENTS

- Stainless steel drain trays in humidifier and cooling coil sections.
- Test points shall be fitted between all components.
- To be constructed with coils bolted to full width diaphragm plates to eliminate bypass.
- Slide rails for coil withdrawal to be installed.
- Coil connections to be handed as indicated and be complete with screwed or flanged ends (loose counter flanges to be supplied).
- Floor panels adjacent to cooling coils and humidifiers to be installed.
- Dampers, filters & similar components to be bolted to full width diaphragm plates or frames to eliminate bypass air.

MOTORISED DAMPERS

- Motorised dampers to be provided of the multi-leaf type.
- Damper shafts to be extended with manual locking handle or actuator. To be accessible from alongside the unit.
- To be constructed from 18swg welded galvanised steel with aerodynamic hollow profile blades utilising low friction nylon bearings.
- To be constructed with a suitable linkage for rigidity and the prevention of distortion and jamming.
- Spindles to be carried in non-ferrous, nylon or ball bearings.
- Air seals to be provided at all casing penetration points.

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- To be classified low leakage by the addition of rubber lip seals fitted to the blade edges with leakage not exceeding 5% of maximum design air volume.
- Balancing dampers to be sized on a face velocity of 5m/s of design flow.
- Isolation dampers to be sized on a face velocity of 2.5m/s of design flow.
- For sizes up to 1000mm x 1000mm, 100mm wide blades to be used with friction torque of bearings and effect of air pressure not exceeding 10Nm and closed damper leakage no greater than 0.150m^3/s per m^2 damper for 1000Pa pressure differential.
- For sizes up to 1200mm wide (blade length) x 2000mm high, 165mm wide blades to be used with friction torque of bearings and effect of air pressure not exceeding 26Nm, and closed damper leakage no greater than 0.150m^3/s for 1000Pa pressure differential.
- For sizes above 1200mm x 2000mm multiple dampers to be used and installed uncoupled if actuator driven.
- Manually set dampers to have a visual blade position indicator and locking mechanism.
- Automatically operated dampers to have a means for indicating externally the position of damper blades.
- Damper motors to be supplied by the specialist controls subcontractor and fixed by the AHU manufacturer.

AIR FILTERS

- Capacities to be as indicated on the schedules.
- Refer to Filter section of the AHU Schedule.
- Purpose made seals to be provided to minimise air leakage around filters. The effectiveness of the seals shall not be impaired by periodic removal and refitting of the filter cells.
- All filter media to be of a material which is non-hygroscopic, shall not support vermin and be proofed against fungal and bacterial growth.
- The filter material to be of a type inherently fire proof and shall give off a minimum of smoke and toxic fumes in accordance with current regulations.
- A complete set of spare filter media to be provided for each filter bank.
- Panel filters to be mounted on slide rails to allow side withdrawal.
- Final filters to be mounted into manufacturers purpose made frames and be arranged for front loading or side loading dependant on size.
- Where the final filters are HEPA filters the sealing must be completely airtight so as to prevent the passage of aerosol when tested. Ideally to have a break in the frame to stop any bypass through the panel.
- Where filters are specified in terms of Filter Grade, this relates to the average atmosphere dust spot efficiency or arrestance in accordance with Eurovent 4/5.
- Where absolute HEPA filters are specified in terms of efficiency, this will either relate to the Eurovent 4/5 EU rating or EN 1822 MPPS H or U rating. All HEPA and ULPA filters to be face scan tested by the Supplier and delivered with appropriate test certificate.
- The completed HEPA/ULPA filter and frame assembly shall be capable of withstanding in situ testing in accordance with methods stated in IES RP006.2.
- Verify with the Local Authority whether samples of filter media are required. If so, provide two samples of each type to the Local Authority for checking and approval.
- Each filter bank shall be fitted with either a 0-250Pa or 0-500Pa range Magnehelic gauge as appropriate.
- The gauges to incorporate a signal flag to show indication of dirty filter condition and be supplied with a current calibration certificate.
- Differential switches to be supplied by the specialist controls subcontractor and fixed by the AHU manufacturer.

ELECTRIC HEATING COILS

- Capacity to be as indicated on the schedules.
- Coils to be installed on slide rails.
- The connections from each element to be taken to a readily accessible terminal box.
- The total resistance of the heater to air flow not to exceed 25 Pa and the face velocity not to exceed 5m/s.

CHILLED WATER AND DX COOLING COILS

- The capacity is to be as indicted on the schedules.
- Coils to be installed on slide rails.
- Drain trays to be manufactured in Stainless steel.
- Install drain trays to eliminate ponding and extended beyond the component casing to allow inspection and cleaning.
- Install Intermediate drain trays where cooling coils exceeds 1.2m in height.
- All cooling coils to be constructed from copper tubes with vinyl coated aluminium fins. Standard aluminium fins may be acceptable dependent upon application.
- To be fitted with copper headers mounted in flanged galvanised mild steel casings not less than 1.6mm thick.
- Tubes to be seamless copper, 12mm o/d, 0.7mm wall thickness after attachment of fins.
- Cooler batteries greater than either 2.0m in width or 1.2m in height to be split to ensure ease of removal.
- The coils to be bolted to a full width diaphragm plate to eliminate bypass air and supported by slide rails for ease of withdrawal and to minimise distortion.
- Cooling coils to be arranged in a contra-flow pattern.
- The resistance to airflow of the cooling not to exceed 150Pa and the face velocity not to exceed 2.5m/s.
- Fin spacing not to exceed 400 fins per metre.
- The resistance to fluid flow of the cooling coil not to exceed 25kPa.
- Each coil to be works tested with air under water to one and a half times the maximum safe working pressure or to 1500kPa whichever is greater.
- Each coil to be provided with binder type test point on inlet and outlet.
- Each coil to be provided with a high level air vent and low level drain cock.
- Direct expansion refrigerant coils generally to conform to the requirements of chilled water cooling coils as described above.
- To be provided with inlet liquid distributors and return suction headers arranged to ensure even distribution of refrigerant to all circuits and to return oil to the compressor.
- The tubes to be staggered in the direction of airflow.
- Return suction headers and return bends to be located out of the air stream.
- All circuits to have an even number of tubes to ensure that liquid and suction connections are on the same side.
- Each refrigerant coil to be works tested with air under water to 2000kPa.
- On satisfactory completion of manufacturers testing the batteries to be dehydrated, charged with an inert gas and sealed.
- All coils to be fitted with a water droplet eliminator constructed from plastic.

ACCESS SECTIONS DOORS

- Access doors to be adjustable to allow for seal deterioration.
- All non-access panels to be removable.
- All access doors to be key lockable.
- The hinge pin to be withdrawable for door removal.

FANS GENERAL

- Refer to Fan specification notes.
- Each fan motor to be pre-wired to a suitable termination device.
- To be complete with a 4 pole local isolator with NC/NO auxiliary contacts.
- Fan sections should each include an inspection port and light (pre-wired to a switch).

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- Fans to be mounted on prepared bases incorporating anti vibration mountings and flexible connections at the fan discharge.
- Appropriate fan guards to be provided behind fan chamber access doors to the appropriate standard.
- Fan bearing lubrication points to be extended to the outside of the casing. Sealed for life bearings may be acceptable on smaller fans.
- Differential switches to be supplied by the specialist controls subcontractor and fixed by the AHU manufacturer.
- The fans to be isolated to prevent the transmission of vibration and non-combustible flexible joints to be provided to couple to adjacent sections of the complete unit.

THERMAL WHEEL

- The capacity to be as indicated on the schedules.
- When in operation at the design volume the pressure drop shall not exceed 100-200Pa dependent upon application and overall efficiency.
- The rotor matrix to be selected and designed for laminar air flow comprising alternate layers of flat and corrugated marine grade aluminium alloy or high grade aluminium foil mechanically fixed together to prevent distortion and to maintain structural integrity.
- The rotor is to be of sufficient strength to resist cleaning by high pressure steam at 150 bar without damage. Rotor speed at design condition shall be ten revolutions a minute at maximum efficiency.
- A variable speed drive and motor to be installed to enable the output air condition to be monitored and controlled.
- The sealing mechanism shall consist of either a circumferential brush, high grade felt or low friction slide seals and adjustable silicon rubber lap seals across the dividing frame and purger.
- The rotor shall be filled with sealed for life double roller bearings requiring no maintenance.

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