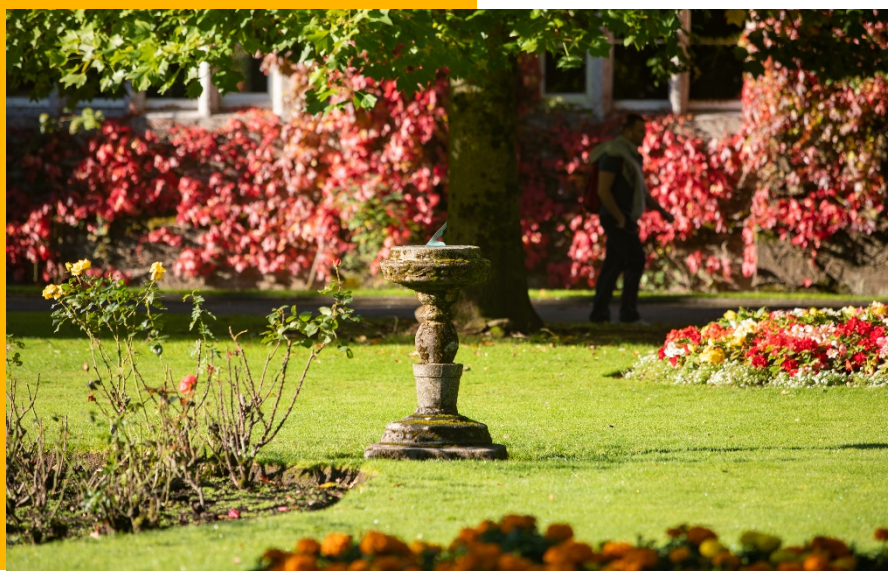
CORK UNIVERSITY BUSINESS SCHOOL

CAPITAL PROJECTS OFFICE

DESIGN GUIDANCE MECHANICAL, ELECTRICAL AND PUBLIC HEALTH SERVICES.



UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

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Notice

Document Revisions

Issue	Prepared by	Reviewed by	Authorised by	Date Issued	Status
A	F. Wall / B. Walsh / T. Carey	B&E Facilities Management	T. Cronin.	16.09.20	Initial Draft.
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Contents

1.0 INTRODUCTION

This document outlines the parameters that form the basis on which the mechanical and electrical [M&E] engineering and public health services are to be developed for the projects within UCC.

This document is to be read in conjunction with the following other tender documentation:

- Tender Information Memorandum
- Definitive Project Brief,
- UCC Design Team Procedures,
- Mechanical and Electrical Schedule of Services,
- Architectural Schedule of Services,
- Civil / Structural / Fire Schedule of Service; and
- UCC SOPs.

1.1 ENGINEERING STRATEGY.

Engineering services will be designed to obtain the optimum benefits from the capital invested. Where alternative solutions are available their consequential capital and revenue implications will be compared using option appraisal analysis. In this regard UCC will make available their present energy tariffs to the Design Team. The most innovative technologies will be considered and used where justifiable, under CIBSE TM54 – Evaluating Operational Energy Performance at the Design Stage.

1.2 REGULATIONS CODES AND STANDARDS

The Mechanical, Electrical and Public Health services for will be designed in accordance with the current editions of the following non exhaustive list:

- Irish Building Regulations,
- Fire Officer Requirements,
- Building Control (amendment) Regulations,
- Relevant Irish (IS), European (EN), and British (BS) Standards,
- National and EU Energy Efficiency Regulations & Energy Performance of Building Directive,
- UCC Safe Operating Procedures,
- Industry best practice,
- CIBSE Design Guides Codes and Technical Memoranda,
- IS10101 National Rules for Electrical Installations,
- ISO 7396-1 Medical Gas Pipeline Systems,

- I.S. 3218:2013 - Fire detection and alarm systems for buildings,
- I.S. 3217:2013 - Emergency Lighting Standard,
- I.S. 426:2014 – Energy Efficiency Regulations,
- Safety, Health and Welfare at Work Act 2005, and the current editions of the entire suite of associated Regulations, including Safety, Health and Welfare at Work (General Application) Regulations, Safety, Health and Welfare at Work (construction) Regulations, others etc,
- EN 81-20 and 81-50 Vertical transport,
- Local Authority / County Council Bylaws,
- Fire Officers Recommendations,
- HTM Guidance Documents,
- HBN 13 Sterile Services Department,
- Department of Environment, Climate & Communications National Climate Action Plan; and
- Construction Product Regulation (under No. 305/2011)
- Machinery Directive 2006/42/EC
- Electromagnetic Compatibility (EMC) Directive 2014/30/EU
- Low Voltage Directive 2014/35/EU
- Equipment and Protective Systems intended for use in Potentially Explosive Atmospheres
- (ATEX) Directive 2014/34/EU
- Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU
- Pressure Equipment Directive 2014/68/EU
- EN 60204 Safety of Machinery – Electrical Equipment of Machines
- EN 61000, EN 55011, EN 55022 where applicable (Harmonic Emissions)
- EN 55024, where applicable (Harmonic Immunity)
- IS EN 62305 Protection against lightning
- IEC 60364-4-44 Protection for Safety – Protection against voltage disturbances and electromagnetic disturbances.
- IEC/TR3 61000-3-6 (Harmonics)
- IEC/TR3 61000-3-7 (Voltage Fluctuation)
- Any other relevant legislation

1.3 BUILDING REGULATIONS PART L

The Building Regulations Part L Conservation of Fuel and Energy – buildings other than Dwellings (2017) is the current national standard dictating the energy consumption and carbon emission requirements of new buildings (other than dwellings). Compliance with Building Regulations is a legal requirement, and applies to all aspects of the regulations

The design will comply with the current requirements of Building Regulations Part L – for:

- Solar overheating,
- Overall heat loss; and
- Primary energy consumption and carbon emissions.

To comply with the above Part L sections, the following must be achieved:

- Efficient glazing and sufficient window opening area that minimises solar gain but optimises natural ventilation,
- Naturally, ventilated rooms will not exceed 25°C for more than 5% of the occupied period from March to October,
- The Design Team will carry out a detailed computerised environmental simulation model to analyse and recommend the optimal internal environmental design conditions. The designer shall run a computer simulation package to determine the best result taking account of u-values, orientation, heat gains, and internal design conditions,
- Fabric heat loss must be limited,
- Provide energy efficient Mechanical & Electrical Plant. The calculated Primary Energy Consumption and Carbon Emissions of the development must be less than Part L set values,
- The above calculations must be performed on SEAI approved thermal simulation software,
- ISO 7730 2005,
- HTM03-01 where applicable for medical suites (UCC to advice); and
- Health & Safety Legislation.

An Integrated Environmental Solutions (IES) 3D-Modeling and Energy Simulation / Dynamic Thermal Simulation Modelling (3D – IES Modelling) or equivalent shall be carried out on the M&E design which will enable the end user to assess every aspect of thermal performance, from annual energy consumption and carbon emissions down to individual surface temperatures.

IES reports to be issued to UCC as part of the deliverables of Stage 2a.

This process will assist in early identification of problematic areas and will ensure a resolution of any issues prior to stage three design stage with respect to the following:

- Thermal performance analysis,
- Building fabric design,
- Occupant comfort analysis,
- Natural ventilation studies,
- Façade analysis,
- Energy consumption prediction,
- Plant design and sizing,
- Mixed-mode design,
- Carbon emissions,
- Computational Fluid Dynamics (CFD) boundary Conditions; and
- Whole Life Cycle Costing Analysis.

1.4 FLEXIBILITY AND ADAPTABILITY

The mechanical and electrical services including plant space, distribution routes, and service risers are to be designed with flexibility, adaptability and future expansion in mind. Safe access for plant maintenance, repair and replacement is essential, in full compliance with Manufacturer's installation requirements. Any marginal decisions on Safe Access, should be fully discussed with UCC's Engineering Services Management.

Appropriately sized plant rooms and floor to ceiling heights are required to ensure suitable access to services and future expansion. A future expansion factor of 30% will be applied to either; central plant capacity or central plant space allocation whichever is deemed most appropriate.

The design consultant shall identify all serviceable Mechanical & Electrical Plant, that has heavy components to be replaced. They shall ensure that each component can be safely replaced, without the need for manual handling such as lifting beams, working and manoeuvrability etc in accordance with all manufacturer's requirements.

The future expansion allowance will also apply to incoming utility supplies e.g. water, electricity, telephony, Comms, Fire Alarm Network, other etc.

1.5 BUILDING ZONING

The Mechanical and Electrical engineering services will be fully zoned according to individual spaces contained within the building. The zoning strategy will take into account the building orientation, occupancy profiles and naturally occurring thermal

zones. Building functions such as production kitchen, administration blocks, lectures theatres will be zoned separately.

Heating, ventilation, and electrical zoning will be configured to promote flexibility, to accommodate set back control, shutdown of areas based on occupancy and allow extension / renovations at a later date. Sub-metering of significant energy users and distinct areas/building functions is required, i.e. MCC's, lighting boards, General service supplies, data centre etc.

1.6 PLANT LOCATION AND ACCESSIBILITY

A centralised building services plant strategy is preferred. Central thermal and electrical plant will be suitably located to optimise distribution routes, provide suitable access for maintenance and repairs. Designated access clearance and walkways for plant removal will be provided.

Sufficient space for future plant additions is to be provided and clearly identifiable within the plantroom.

Primary distribution headers will also include for future tie-ins and will include for valve and capped circuit stubs. Exact number of spares to be agreed with UCC.

All pipework fittings (valves, flanges, strainers, pumps etc. and heat generating equipment (calorifiers and heat exchangers etc.) shall be suitably insulated. All pipework in external areas or internally within 1m of plantroom louvres shall also be fitting with metal clad.

All valves and fittings, etc. in external areas or internally within 1m of plantroom louvres shall be insulated and fitted with metal cladding complete with removable covers. All valves shall have extended spindles to the outside insulation and or cladding.

Location of plantrooms and external plant will ensure the effects of noise and air pollution to residents and neighbours are minimised. Plant location will also eliminate risks from flooding.

The positioning of all rooftop plant is to be considered with respect to all other plant. For example:

- The extracted air from AHU 1 must not entrail with the supply air of AHU 2,
- Dirty extraction must not short circuit with the supply air of an AUH; and
- Overall height of chemical extraction ductwork must take into consideration other fixed structures, such as cladding structures, stepped rooftops, etc.

Suitable access is to be provided around all plant for maintenance and repairs. All serviceable elements are to be fully accessible.

Designated access clearance and walkways for plant removal will be provided.

A minimum head height of 2 metres will be maintained in all plant room walkway.

Suitable lifting eyes / block & tackle will be installed in order to remove failed / faulty plant components, such as motors, fans, coils, above water storage tanks, etc.

IT Comms Room air conditioning systems shall be designed with redundancy, such that the operation of the room shall not be affected in the event of failure of the air condition system. The proposed solution shall be cost effective in terms of its life cycle costs. Consideration to be given to heat rejection.

2.0 ENERGY EFFICIENCY & SUSTAINABILITY

The key drivers in relation to M&E aspects of energy efficiency and sustainability are:

- Comply with current Building Regulations Part L,
- Achieve a minimum BER A3 Rating,
- Air Pressure Testing (Air Tightness Testing). Minimum leakage of building fabric less than 5m3/hr/m2 @ 50 Pa,
- Relevant Irish and European Legislation,
- IS 399 Energy Efficient Design Management,
- SI 243 of 2015 E.U. Energy Performance Building Directive,
- SI 426 of 2014 E.U. Energy Efficiency Regulations,
- SI 151 of 2011 E.U. Energy Efficient Public Procurement,
- NEEAP [2014] – Public Bodies,
- BREEAM (Standard as noted within the Definitive Project Brief),
- Near zero energy buildings (NZEB); and
- EN 15232.

The Design Team (& Main Contractor) is required to remain engaged until completion of 12 full months of occupation to carry out a DEC and compare it with the design BER rating and make recommendation for the building occupier going forward.

The energy strategy will strive to reduce energy use in the building through the following approaches:

- Passive design met,
- Efficient systems and plant for generation and distribution of energy,
- Appropriate Building Automation Control systems including metering philosophy and equipment; and
- Renewable energy technologies.

2.1 PASSIVE DESIGN

Energy use within the building will be minimised through the use of passive design techniques designed by. a suitability qualified passive designer.

The orientation, form and fabric of the building will be maximised to maintain and control the comfort of the internal environment. Improve building thermal envelope performance, air permeability, insulation U-values and glazing g-values.

Internal areas requiring mechanical ventilation and cooling will be minimised. Natural ventilation will where practical be utilised throughout the building. Restrictions to window openings for personnel safety will be considered from the outset and factored into natural ventilation analysis.

In conjunction with the architect window design must provide a balance between maximising daylight, reducing solar gain in summer and maximising solar gain in winter.

A suitable 'g'-value target for glazing will be considered from the outset of the design.

2.2 ACTIVE DESIGN

All new energy consuming products shall be on the SEAI Triple E register.

All light fittings will be high efficiency LED and conform to IEC 62722-2-1:2014, IEC 62717:2014 An automatic day light-linked lighting control system will be provided to all areas benefiting from natural light. Simple, modular type lighting control systems are preferred. Every room to have a minimum of a 2-gang switch.

Central plant including pumps, fans and motors will be high efficiency (IE4 minimum and next generation when IE4 is superseded) and specified with variable speed control and BACnet modules.

Natural Gas Boilers will be high efficiency units with a minimum seasonal efficiency not less than 91% and low NOx emissions, (refurbishment projects only).- These are a last resort – the goal is to be an electrified building.

Chillers and mechanical cooling plant where specifically required will be high efficiency. Chiller Energy Efficiency Ratio (EER) will be a minimum 5. Fresh air cooler type systems shall be considered by the design team for appropriate use within the building.

All reject heat, where reasonably practicable is to be recovered. All plant shall be centralised. The Global Warming Potential (GWP) of all refrigerant media shall be less than 500.

Ventilation systems where practical will include for high efficiency heat recovery such as, thermal wheels, crossflow heat exchangers and run around coils.

Low velocity ductwork, pipework and air handling units will be used to reduce fan and pump energy. Supply & Extract air ductwork and hot and cold-water pipework should be suitably insulated.

All ventilation and fan products must be ErP & EN 13779 compliant.

Zoning will be such that areas operating on different time schedules can be independently controlled and/or set back / shut off when not in use.

A BACnet based building energy management system (BEMS) will include smart metering and monitoring and will be provided as part of the overall building management system (BEMS).The design of the building services installation will allow ease of control and monitoring of energy throughout the building. See sperate BEMS Specification.

Loop drawings shall be produced for each item of BEMS equipment, including equipment location information. All BEMS component are to be BCANET compatible.

2.3 RENEWABLE ENERGY TECHNOLOGIES

Renewable energy technologies will be appraised for its suitability to the site and energy use profile of the building. Alternative energy systems will only be implemented following a thorough technical and economic analysis and can demonstrate clear operational, carbon and cost benefits to UCC. Strong preference will be given to proven, reliable, Energy saving, optimum Life Cycle Cost efficient technologies.

Renewables energy technologies to be considered are:

- Photo Voltaic,
- Wind,
- Geothermal Heat Pumps,
- Ground Source Heat Pumps,
- Air source heat pumps,
- Battery Storage; and
- Combined Heat & Power.

3.0 INCOMING UTILITY SUPPLIES

3.1 NATURAL GAS

3.1.1 General

In principal, all new buildings are not to be supplied with natural gas**.** Should natural gas be required for any reason, then the design team shall rule out all other alternatives in the first instance and fully justify the need for natural gas.

3.1.2 New Connections

If a gas connection has been justified, then a new metered connection to the local area gas network will be provided to supply the development where Laboratories, etc. are required. The natural gas supply will enter the building via a dedicated gas riser. The installation will be a fully welded pipe-in-pipe arrangement to the point of use, as reasonably practicable. This is to reduce gas sensors within ceiling voids.

The application to Gas Networks Ireland will include 30% future expansion capacity.

Sub metering, gas proofing systems and independent isolation of the gas supply to each laboratory is required.

All kitchen appliances are to be electrical and not gas.

Refer to section 4.2.6 for further details

3.2 MAINS WATER SUPPLY

Mains water will be supplied from Irish Water public water supply. The size of the break tank will be determined from water use calculations and will ensure a full turnover of water within a 24-hour period for health and safety. Where incoming water pressure is inadequate pumps shall be provided in accordance with current regulations.

All water tanks shall be twin compartment potable cold-water tank and shall have adequate access for cleaning and suitable means for extraction of persons from confined spaces. It is UCC's preference to have side access to all cold-water storage tanks, for safe entry, exit and rescue from the confined space of the tank. Top access will also be required, with clear head height room, and lift eye provision overhead.

The support structure to the tank shall be external with all nuts, bolts, washers etc to be stainless steel grade 316.

The incoming water pressure and flowrates shall be checked to determine if they are sufficient to meet the fire hydrant requirements and fill the cold-water storage tanks.

The mains water should be fitted with appropriate backflow protection devices. The mains water loop will supply all drinking water outlets, sinks and kitchen. Mains water quality tests shall be conducted as per HPSC/HSE guidance to determine if secondary disinfection and or treatment are required.

The incoming mains will be an appropriately sized metered supply, to detect low – high flows, with a pulsed output and BACnet connection to the BEMS. Sub-metering of the mains water supply to the cold-water storage tanks, the buildings mains water ring main, DI plant, production kitchens etc is required.

3.3 ELECTRICITY

3.3.1 Electrical Supply Capacity Calculations

Electrical supply capacity calculations shall be based on detailed load schedules, these shall be submitted to UCC Engineering Maintenance and Utilities sections prior to applications to ESB Networks for new connections or at stage 1 where the proposed building shall be supplied from the existing campus electrical infrastructure.

3.3.2 New Buildings

The electrical supply capacity for proposed buildings shall include an allowance for 30% spare capacity for any future expansion.

3.3.3 Existing Buildings

The existing electrical power supply capacity shall be assessed to ensure that there is adequate capacity for the refurbishment. The M&E Consultant shall apply to the ESB on behalf of UCC for an upgrade to the supply capacity where appropriate. The M&E Consultant shall seek approval from UCC Engineering Maintenance and Utilities sections prior to submission.

4.0 MECHANICAL BUIDLING SERVICES

4.1 VENTILATION

Good ventilation throughout the development is essential. The primary purpose of ventilation within the development is to provide:

- Comfortable environmental conditions,
- Adequate Fresh Air for Building occupants,
- Remove Pollutants (Chemical, Biological other etc.),
- Acceptable indoor air quality; and
- Heating and cooling.

Where natural and or mixed mode ventilation is proposed particular reference will be made to the following design guides:

- Technical Guidance Document F,
- CIBSE Guide B,
- CIBSE AM 10: Natural Ventilation,
- CIBSE AM 13: Mixed Mode Ventilation; and
- CIBSE TM 52: Limits of Thermal Comfort, Avoiding Overheating.

The M&E consultant shall inform UCC of all other relevant guidelines.

All ventilation equipment must be connected back to the building automation control and allow the equipment to be controlled, scheduled and operated.

The design shall as reasonable possible ensure that staff or students stations are not to be located directly under or adjacent draft, natural or mechanical. Appropriate use of eyelash grills, diffusers etc shall be considered in the design.

4.1.1 Natural Ventilation

It will be a principle of the development that natural ventilation is preferred over mechanical ventilation. An integrated design approach requiring optimum use of building form, orientation and structure will be required to maximise the natural ventilation potential of the building.

To provide an effective natural ventilation system detailed consideration will be made in respect to window design and room dimensions.

Within the development it is proposed to provide natural ventilation to all areas where feasible.

Practical considerations to be considered when evaluating the suitability of natural ventilation will include proximity to sources of noise pollution and security as well as

the internal layouts of the building. The M&E designers will work with the project team to develop and co-ordinate the strategy, paying particular attention to the placing of workspaces and occupants and the impact that it can have on the occupant's comfort.

Thermal simulation modelling is required to demonstrate the effectiveness of the natural ventilation strategy. Where natural ventilation cannot maintain the specified internal design temperature mixed mode and/or mechanical ventilation will be considered.

As part of Part L compliance an overheating study is required

Where window actuators are deployed, they should be of the actuated type and be:

- Directly controlled by the BEMS – i.e. not by a separate window control system; and
- Local dial switch arrangement to allow the user to open / close the window manually for a set time, before the BEMS takes over.

In naturally ventilated room where the occupants have a role in "operating" the ventilation system, the M&E consultant shall ensure that CO2 NDIR Sensor/Humidity/Temp sensors are installed and linked to BEMS. Sensors to include {or be easily fitted with} a traffic light system for the IAQ (Indoor Air Quality).

4.1.2 Mixed Mode Ventilation

Mixed mode ventilation is a strategy that combines natural ventilation and mechanical ventilation. Effective use of the building fabric and envelope will be implemented to reduce internal peak temperatures and then only using mechanical ventilation when the comfort criteria can no longer be maintained by natural ventilation strategy.

In general, mixed mode ventilation will be provided in the following areas:

- Small multi-occupancy offices where natural ventilation alone is not suitable,
- Small to medium meeting rooms; and
- Smaller Canteens.

The mechanical element of the mixed mode ventilation will consist of full fresh air.

The ability for heat recovery when in mechanical ventilation mode, (typically implemented in winter, as openable windows at this time can cause draughts and discomfort to residents) can offer energy saving in some circumstances.

Consequently, it may not be necessary to install supplementary heating to offset heat losses that would otherwise be required if natural ventilation alone was employed.

4.1.3 Mechanical Ventilation

Mechanical ventilation will be provided in spaces where fixed ventilation rates are required to suit the usage of areas, to maintain fresh air quality, remove odours and moisture and generally provide a more controlled environment.

Mechanical ventilation systems will be designed to ensure air volumes are sufficient to deal with the heat loads from occupants, equipment and external conditions. Individual room or local zone control will be provided in strategic locations and will be accessible by UCC Engineering Maintenance and Utilities Departments only. Consideration is to be made for "make-up" air in areas where fume hoods are present or to be installed as part of the development.

Where mechanical ventilation is proposed, time schedule, occupancy and CO2 control will be the mode of operation for the system ,

Where a centralised mechanical ventilation system is proposed, the design should allow for the various zones to be isolated, depending on occupancy and time schedule, and the fan settings automatically adjust to maintain the same airflow volumes to other spaces.

Refer to Appendix B for Process Flow Diagrams that are the minimum benchmark within UCC.

Should close control environmental controls be required a separate design review shall be conducted with the end users to determine the most energy efficient means of achieving the environmental conditions required.

Fire/smoke dampers will be required where ventilation ductwork penetrates fire compartments. Subject to quantities and life cycle cost analysis a central addressable fire/smoke damper monitoring system will be considered. All fire/smoke damper controls shall be hard wired only and shall be fail safe.

Stale / exhaust air must be located as far away as possible from the supply air intake supply. The layout and configuration of all plant areas shall be agreed with UCC Engineering Maintenance department at each M&E design review stage.

4.1.4 CO_2 NDIR Sensor.

All CO_2 sensors are to be NDIR "nondispersive infrared" sensors for the measurement of carbon dioxide, CO_2.

The IR spectrum of CO2 is unique, matching the light source wavelength serves as a signature or "fingerprint" to identify the CO_2 molecule.

As the IR light passes through the length of the tube, the CO2 gas molecules absorb the specific band of IR light while letting other wavelengths of light pass through. At the

detector end, the remaining light hits an optical filter that absorbs every wavelength of light except the wavelength absorbed by CO2 molecules in the air sample tube.

This results in a more accurate CO_2 reading.

4.1.5 Dirty Extract Ventilation

Mechanical exhaust ventilation will be provided to the following areas:

- Dirty Utility,
- Staff and public WCs,
- Waste Holding Room,
- Laboratories,
- Workshops,
- Showers,
- Fume Cupboards; and
    - dedicated extraction for all fume hoods, 0.5m/s @ 500mm sash height; and
- Chemical stores.
    - Dedicated extraction for all Chemical Storage cabinets. The extract for the fume hood **shall NOT be used.**

Where possible dirty extract systems from toilet / kitchen areas will be combined to minimise central plant and ductwork distribution.

Combining systems should not reduce the effectiveness of control and ability for certain areas to implement setback control. Combined systems shall be designed such that no contamination from is possible between hazardous extracts and non-hazardous extracts or between operating and non-operating systems.

Hazardous extract system shall be vented such that the extract cannot pose any harm to personnel.

Extract system(s) final venting shall be designed such that the location of extract fans and outlets does not create a danger to personnel accessing roof areas etc. (i.e. high plume extraction fans)

4.1.6 Ventilation Instrumentation

The following instrumentation should be installed on mechanical ventilation systems at a minimum and displayed on the BEMS:

- External temperature,
- Supply / Extract dampers including position indicator,

- PDI reading across filters,
- Temperature readings before / after heating / cooling coils and post supply fan,
- VSD speed status / power load,
- Velocity sensor post supply fan,
- Heat meters on heat / cooling supply and run-around coils,
- CO2 / PPM meter post supply fan,
- CO2 / PPM meter on the return ducting,
- Temperature readings on the return damper and post run-around coil; and
- Duct frost (auto reset).

4.2 HEATING SYSTEMS

Heating will be provided throughout the building to:

- Provide comfort to the occupants,
- Provide heat for domestic hot water generation, if the predicted DHW demand requires it,
- To provide sufficient heating capacity to address fabric and ventilation losses of older buildings; and
- To protect the fabric and systems against freezing.

Designers should take a holistic view on the buildings heating requirements, and will consider the following:

- Location of plant to minimise pipe runs and heat losses,
- Chilled water turbo coolers with heat recovery options, should the design loads permit,
- Reusing waste heat from the processes within the building,
- Low grade heat sources on end of line heater batteries, and
- Partial occupancy patterns and the ability of shutting down heating loops to suit different patterns of use.

The heating systems should be capable of providing the following range of space temperatures, based on an external temperature range of minus (-) 4º C to 25º C

Offices /meeting rooms	20 -22º C,
Large conference spaces	19-21º C,
Teaching spaces / Labs	20-22 º C,
General circulation / atrium spaces	18-20 º C; and
Shower / Toilets / Kitchens	18 º C.

4.2.1 Heating Primary Plant

Fossil fuel fired heat generating plant is not permitted for new builds / significant refurbishment projects. It is UCC's preference to decarbonise all new buildings; therefore, it is UCC preference that all space heating plant is electrified.

Adequate resilience to enable continuous operation of the development will be incorporated into the primary heating plant.

The arrangement of primary heat generating plant shall ensure sufficient redundancy in the overall system, such that in the event of an individual unit fail, the overall system remains operational. A warning signal shall also be sent to the BEMS identifying the fault. In additional the system shall also allow for future 30% capacity increase, which shall not compromise the built-in redundancy.

Heat generation plant to be BACnet type and brought back to the BEMS for control and monitoring.

Heat generation plant to be hydraulically isolated when not in use or if there is no demand for heating.

Consideration to be given to the LTHW operating parameters, based on the building envelope as well as to the suitability of thermal storage.

In addition to the main heat generation plant the following ancillary equipment should be included:

- Pressurisation and expansion equipment,
- Degasser; and
- Water treatment as necessary to ensure long term operation of the system and maintain maximum efficiency and heat transfer. Water treatment as a minimum will include automatic dosing unit to inhibit corrosion of plant and pipework and to prevent the build-up of scale. Where water hardness is prevalent automatic dosing/softening plant will be considered.

The water dosing arrangement and associated readings should be connected to the BEMS.

4.2.2 Legionella

In designing against legionella, the consultant shall take account of the Approved Code of Practice (ACOP) L8 - The control of legionella bacteria in water systems, with key extracts outlined below.

Designers, manufacturers, importers, suppliers, and installers of water systems that may create a risk of exposure to legionella bacteria, must:

- Ensure, so far as is reasonably practicable, that the water system is so designed and constructed that it will be safe and without risks to health when used at work; and
- Provide adequate information for the user about the risk and measures necessary to ensure that the water systems will be safe and without risks to health when used at work. This should be updated in the light of any new information about significant risks to health and safety that becomes available, so that duty holders can ensure relevant changes are made to their risk assessment and controls.

Suppliers of products and services, including consultancy and water treatment services, aimed at preventing or controlling the risk of exposure to legionella bacteria, must, so far as is reasonably practicable ensure that:

- Measures intended to control the risk of exposure to legionella bacteria are so designed and implemented that they will be effective, safe and without risks to health when used at work,
- They provide adequate information on the correct and safe use of products, taking into account the circumstances and conditions of their use,
- Any limitations on their expertise or the products or services they offer are clearly defined and made known to the duty holder or the appointed responsible person(s),
- Any deficiencies or limitations which they identify in the duty holder's systems or written scheme to control the risk of exposure to legionella bacteria are made known to the duty holder or the appointed responsible person(s); and
- Their staff have the necessary ability, experience, instruction, information, training and resources to carry out their tasks competently and safely.

All water systems must be properly installed and commissioned as appropriate.

Anyone involved in the supply of water systems (designers, manufacturers, importers, suppliers and installers) must, as far as is reasonably practicable, ensure that the equipment is designed and constructed so that it is safe when used at work and enable safe and easy operation, cleaning and maintenance.

Hot and cold-water systems should be designed and constructed so they:

- Take account of and comply with all necessary legislation and legionella control guidance,
- Aid safe operation (e.g. without dead legs, or if this is not possible, limit the length of dead legs limited and disconnect or remove redundant or non-essential standby plant),
- Reduce stored cold water to the minimum needed to meet peak needs,
- Aid cleaning and disinfection (e.g. by providing suitable access points in the system); and
- Minimise heat gain/loss (e.g. hot and cold-water pipes and storage tanks should be insulated).

Manufacturers and suppliers of water systems must provide adequate information and instructions on their safe use. This should include information about those aspects of operation and maintenance which have a bearing on the risk.

Those who supply services, such as water treatment or maintenance services should make clear to the responsible person any deficiencies in the water system or measures that may pose a significant risk of exposure to legionella bacteria. They should also make the duty holder or the responsible person aware of any limitations in their own expertise, products or services so they can make arrangements to ensure that these deficiencies or limitations are addressed.

Service providers should also ensure that their staff and contractors are competent to carry out the task safely. They should be properly trained to a standard appropriate to the various tasks they perform, such as risk assessment, advising on water treatment measures, sampling or cleaning and maintaining water systems.

All staff and contractors should be suitably trained, managed and supervised and given appropriate resources or support. In particular, they should be aware of the action to take in situations outside their knowledge or experience.

The consultant as part of their Basis of Design Report to be issued on completion of Stage 2a shall outline their approach to the prevention of legionella in the generation and distribution of the water.

4.2.3 Heating Distribution

Low temperature hot water will be distributed via a number of heating circuits, such as:

- Space heating circuit, to radiators. (All radiators to be Low Surface Temperature),
- Perimeter heating circuit Trench heaters (where applicable to large glazed areas reception, entrance etc.),
- Radiant Panels,
- AHU heating coils,
- Reheat coils,
- LGWW beam systems; and
- Independent Domestic hot water circuit.

Underflooring heating and over-door air curtains are only to be considered once the design team has demonstrated that they are absolutely necessary. The building design should be optimised to eliminate the need for the above, such as adequately sized draft lobby's, revolving doors etc.

All pumped circuits will be provided with duty/stand-by pump (not dual head pumps) arrangement based on and inverter speed control and pressure sensors.

All pumps should come with BACnet module and the following points brought back to the BEMS:

- Supply / return temperature,
- Flow rate,
- Heat meter,
- kWhr demand / consumption,
- Pressure,
- Pressure independent control valves (PICV),
- Pump status; and
- VSD status.

4.2.4 Space Heating Controls

The heat distribution systems should be laid out in zones to suit the building layouts , expected occupancy patterns and the appropriate controls employed to allow the efficient operation of the system at varying occupancy levels.

Each zone will be brought up to a predetermined space temperature and PIR detection will then take over the control for that zone, i.e. additional heating will be supplied based on the occupancy of the area.

All control valves to heating circuits / AHU's will be 2 port valves only and the circuit will be weather compensated.

Local user control will allow the user to adjust the space temperature control by +- 2 deg C from the BEMS setpoint.

TRV's, if used, are to be easily accessible.

Temperature sensors must be deployed to accurately reflect the size and conditions in the areas and located appropriately, i.e. avoid solar gain, draughts, cold services.

For large lab process areas consideration needs to be given the end user operations and expected heat loads associated with the operations to ensure a uniform temperature can be maintained throughout the lab space.

4.2.5 Cooling Plant

Mechanical cooling to the building will be limited to specific areas. Cooling will be provided to specific areas of the building to:

- Provide comfort conditions for (large meeting rooms, lecture theatres, teaching laboratories and COMMS rooms where applicable); and
- Offset equipment heat gains, (ICT Comms Room).

Dedicated refrigeration plant will be required for production kitchen ventilation and central refrigeration plant including blast chillers, cold stores, etc.

All heat rejection plant should be reviewed to determine if the waste heat can be recovered and will be suitably located to ensure heat outputs and noise does not cause a nuisance to adjacent areas.

Lowest commercially available GWP refrigerants can be considered for the generation plant.

4.2.6 Gas Supplies

Natural gas can only be utilised when deemed necessary and fully justified by the design team for services such as labs / process use. From the main gas intake / meter room separate and dedicated supplies will be provided to the boiler house and laboratories.

Sub-metering will be provided at all gas consuming locations and a BACnet meter connected to the BEMS.

An ATEX risk assessment and EPD document must be carried out along with the following:

- The main Gas Slam shut valve shall be located outside the building and shall be operated by the gas detection and fire alarm systems,
- The main Gas supply Pipe network must be sleeved, with a section of exhaust pipe directed to the exterior of the building roof (As it is costly to maintain LEL ATEX Gas detectors in all ceiling &/or floor voids, etc),
- Gas Pressure Proving Systems shall be installed for each area where natural gas outlets are present,
- All LEL ATEX Gas detectors in the building are to be connected to a relevant Gas Pressure Proving System, locate Gas Slam Shut valve(s) and relevant air handling unit,
- The LEL ATEX Gas detectors shall be set at a setting of 10% of the Natural Gas LEL,
- A minimum of two (2) LEL ATEX Gas detectors are to be installed in each of the identified areas to detect any Gas leaks before they reach the critical LEL level. The final number of LEL ATEX Gas detectors per area shall be determined as part of the ATEX risk assessment
- The LEL Gas detectors need to sound a local audible alarm,
- All relevant areas shall have suitable signs highlighted at the entrance to each area; and
- A Gas detection event shall shut the local natural gas slam shut valve and be communicated as a fault to the fire alarm system. Upon resolving the event and resetting of the fire alarm the local gas slam shut valve shall automatically reset.

In additional to all other current legislation, all gas design and installation is to be RGII compliant.

4.2.6.1 Laboratories containing Gas

All process laboratories shall be sub-metered at all gas consuming locations. All meters are to be BACnet and connected to the BEMS.

An ATEX risk assessment and EPD document must be carried out along with the following:

- All process gas distribution networks must be sleeved, with a section of exhaust pipe directed to the exterior of the building roof.
- A minimum of two (2) LEL Gas detectors are to be installed in each of the identified areas to detect any Gas leaks before they reach the critical LEL level. The final number of LEL ATEX Gas detectors per area shall be determined as part of the ATEX risk assessment.
- All LEL Gas detectors in the building are to be connected to a relevant locate Gas Slam Shut valve(s).
- The LEL Gas detectors shall be set at a setting of 10% of the Gas LEL.
- The LEL Gas detectors need to sound a local audible alarm.
- A gas detection event shall shut the local gas slam shut valve and be communicated as a fault to the fire alarm system. Upon resolving the event and resetting of the fire alarm the local gas slam shut valve shall automatically reset.
- The Gas detection panel shall be in a safe area away from the affected area(s).
- All relevant areas shall have suitable signs highlighting the particular gas(es) at the entrance to each area.

In additional to all other current legislation, all gas design and installation is to be RGII compliant.

4.3 PIPEWORK AND EQUIPMENT INSULATION

In General, the following defines all the services that shall be insulated unless specified otherwise:

- LPHW flow and return pipework,
- Chilled water flow and return pipework,
- Hot water services flow and return pipework,
- Mains water and cold-water services,
- Steam and condensate pipework,
- Chilled/cold glycol systems,
- Equipment items; and
- Other components.

Only low GWP insulation materials are permitted.

All insulation work shall be carried out by an approved specialist. All materials shall be new and dry throughout the progress of the works. Poor quality or badly finished work will not be accepted, neither will irregularities in the thickness of insulating materials or in the material covering. All work shall be left smooth, clean and properly finished.

All Pipelines shall be insulated separately, and adjacent parallel pipes shall not be married together in one insulation covering.

All joints, surfaces, edges and overlaps shall be neatly finished and where possible, overlaps shall be arranged to be on the “blind” side and also shall be “water shedding”.

Where allowance must be made for pipe expansion and/or contraction, insulation shall be finished in a neat and approved manner permitting easy access and disconnection of removable items without disturbing the surrounding insulation.

A complete moisture and vapour seal shall be provided on cold surfaces by vapour barrier jackets or coating. All vapour barriers shall be continuous and where this is not possible, the vapour barrier shall be returned effectively and sealed to the pipe so as not to allow any ingress of moisture or water vapour.

Thermal insulation shall comply with the requirements of BS 5422 and BS 5970.

Fixing methods for insulation shall provide a zero direct metal paths, which thermally bridge the insulation, particularly where the insulation is metal face. Where insulation is installed in layers all joints in all layers shall be staggered.

Insulation materials and finishes shall be inherently damage proof against rotting, mould and fungal growth and attack by vermin, be non-hygroscopic and in all respects be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.

Unless otherwise indicated, all thermal-insulating materials used within any building shall, when tested in accordance with BS 476 Part 4, be classified non-combustible.

Alternatively, all thermal insulating materials used within any building shall be non-combustible with a facing of combustible material providing that the facing is not more than 0.8mm thick and it has a Class 0 surface spread of flame when tested in accordance with BS 476, part 7. Thermal insulating materials used within any building shall be free from substances which in the event of a fire would generate appreciable quantities of smoke, noxious or toxic fumes.

Insulation materials and their finishes shall be free from asbestos.

5.0 ELECTRICAL BUILDING SERVICES.

An electrical short circuit study and a discrimination study shall be completed as part of the design. All electrical distribution switchgear and cabling shall be rated in line with the results of the short circuit study.

5.1 MEDIUM VOLTAGE INFRASTRUCTURE

All medium voltage (MV) distribution cabling and equipment shall be rated for 10kv/20kV.

Incoming MV switchgear assemblies and associated cabling shall be sized for 30% spare capacity in addition to the projected building load.

Cast resin transformers are preferred. Oil-filled transformers shall only be used where they must be located externally. All oil filled transformers shall be suitably bunded.

All MV electrical switchgear shall be provided with a remote switching station.

The external MV earthing installation shall be accessible for testing.

5.2 LOW VOLTAGE INFRASTRUCTURE

Low voltage electrical distribution shall be via main and sub distribution boards. Each distribution board shall have a least 30% spare capacity on the supply cables/incomer/busbars, 30% spare installed switchgear and 30% spare space for future fit out.

Installed spare switchgear shall consist of a variety of current ratings and shall be based on the range of switchgear ratings protecting known loads.

All MCCBs shall be of plug-in type and the largest common size base shall be used for all MCCBs.

Main distribution board incoming and outgoing switchgear shall be provided with LSIG protection functionality.

All main distribution boards shall be provided with a generator changeover switch and a permanent connection to an external temporary generator connection panel.

The LV switchgear and control gear assemblies for main distribution and large sub-distribution boards will be minimum Form 4b construction.

Main distribution board and sub-distribution board naming shall be agreed with UCC Engineering Services Management.

All small sub-distribution boards, small MCCs, BEMS panel etc. shall be form 2.

Each comms room will have a dedicated SDB.

Critical IT equipment shall be provided with A and B electrical supplies. IT equipment to be supplied by MCB only, with suitable outlets.

A minimum of one sub-distribution board shall be provided per floor for all electrical installation. Supplying electrical outlets on multiple floors from a single distribution board is not acceptable.

5.3 CRITICAL EQUIPMENT

Critical equipment shall be supplied via a dedicated 'essential services' distribution infrastructure. This shall be segregated from the main distribution system at the main distribution board level and shall have central UPS/emergency generator back as appropriate.

All essential and critical equipment shall be identified by the design team and agreed with UCC Engineering Services Management and building users.

All essential service outlets shall have the following:

- Clearly labelled stating that they are live in the event of a power outage; and
- Shall be fitted with a 'T-pin' type and red in colour or similar to prevent their use for general electrical power supply.

Life safety systems are to be supplied by the essential services board where available.

5.4 CABLING & CONTAINMENT

All electrical wiring will conform to the requirements of the National Rules for Electrical Installations IS10101. All electrical equipment and systems supplied or employed to complete the electrical installation shall conform to the requirements of relevant Irish legislation, EU Directives, European Standards and Irish Standards.

All cabling shall be contained throughout its length. All cable containment shall be designed with 30% spare capacity. All cable containment shall be accessible such that additional cabling can be installed in the future.

Wiring for sockets and plant items shall not be less than 4 mm^2 cross section.

Wiring for lights shall be not less than 2.5 mm^2 cross section.

All terminations are to be made at main switches, distribution boards, ceiling boxes, socket outlet boxes.

Steel wire armoured (SWA) cabling shall be utilised for all external and underground installations.

All main distribution cabling shall be labelled at its source and destination, identifying the source and destination.

Cable trunking (Galvanised Metal) shall comply with BS 4678 and installed in accordance with the National Rules for Electrical Installations.

All conduit shall be heavy gauge, minimum size 20 mm diameter to BS 4568/Safe Electric requirements. Wiring shall be carried out using PVC insulated copper conductors which comply with Irish standards Specifications, IS 201, IS 202, IS 204 in accordance with the Irish standards Mark licensing scheme c/w IMEC mark.

Manufacturers or suppliers' certificate of compliance with the standard shall be provided if requested.

5.5 ELECTRICAL SWITCHROOMS

Separate electrical switch rooms are required from main distribution boards. These shall be dedicated to electrical switchgear only. Electrical switch rooms shall not be combined with IT rooms.

Electrical switch rooms shall maintain a minimum of 1200mm of clear space in front of each electrical panel.

All electrical switchgear and control gear shall be located within a one-hour fire rated enclosure.

5.6 DEVICE JUNCTION BOXES

The consultant within his design shall ensure that:

- Junction boxes are a minimum of IP 65 ingress rated 100mm x 100mm x 45mm, uPVC type wall mounted junction boxes which shall be located adjacent to all field mounted instruments/devices such as (but not limited to), actuators, temperature sensors, water leak detectors, pressure sensors, pressure gauges, flowmeters, CO2 sensors, PIR sensors, cooling coils, heater batteries, solenoid valves and for all instruments and devices that are supplied by the contractor with flying leads,

- The junction boxes shall be complete with din-rail mounted terminals, cable glands and wall fixings,

- All cables to be glanded and termination of the cabling into and out of these cabling junction boxes together with the testing and checking of the cable terminations as part of system commissioning; and

- All junction shall be supplied and installed with self-adhesive Engraved Traffolyte labels for each junction box with the text reference of the relevant instrument /

device to which the junction box is associated with and in keeping with the asset register.

5.7 EMERGENCY STAND-BY GENERATOR

In general generators will not be required within UCC's Main Campus, however an external connection point for a potential temporary generator shall be provided to all new buildings. KVA and possibility of load shedding to be agreed with UCC Engineering Maintenance and Utilities Department.

5.7.1 Fuel Source to Generators.

Fuel oil will be provided to supply the back-up generators. In principal the back-up generator shall have self-contained fuel storage.

Local supply chain arrangement and ease of delivery and access shall be assessed when considering location of generators.

5.8 UNINTERRUPTIBLE POWER SUPPLY

A suitably sized Uninterruptible Power Supply (UPS) system will be provided to supply 100% of the IT/Comms load for 1hour.

All motorised corridor doors shall be provided with UPS backup for a minimum of 30 mins.

The VOIP telephone system and security and access control systems are considered critical services and will be supported by the UPS system.

The UPS system will include a future growth allowance of 30%.

The UPS system shall be located in a dedicated location with adequate cooling to ensure that the operating temperatures of the UPS system are maintained.

5.9 ICT

All ICT is to be Cat 6a (Foil Twisted Pair) FTP cabling.

All Comms Rooms require mechanical cooling for all large installations (> 300 cables).

All workstations to have a minimum of 2 data points.

All WIFI AP's to have a minimum of 2 data points.

No wet services to be routed through IT comms rooms.

Refer to UCC Structural Cabling System Standard Operating Procedure.

5.9.1 UCC Assigned IP Addresses.

Where ICT equipment requires a UCC assigned IP address for commissioning and operations please note the following:

- All equipment is to be in place and the MAC address of the equipment supplied to UCC,
- From receipt of request to provision of IP address will take approximately 4 weeks; and
- The DT is to ensure that the main contractor via the tender documentation is aware of this restraint.

5.10 LIGHTING

The lighting installation will be designed and installed in accordance with the following standards and approved guidance documents:

- EN 12464,
- IS3217 Emergency Lighting,
- CIBSE Lighting Guides LG2, LG3 & LG7,
- IEC 60929,
- Society of Light & Lighting (SLL) Guides,
- SEAI Lighting Guides; and
- Darksky Ireland policy and guidance documents.

5.10.1 Internal Lighting

The lighting installation will use energy efficient LED light fittings. General illumination and emergency lighting levels will be as per IS3217, CIBSE Guides and HACCP guidelines. Lighting levels and uniformity of illumination will be suitable for the task to be carried out.

The lighting control philosophy shall be designed in detail by the design team and agreed with UCC end users, Engineering Services and Utilities departments at detailed design stage.

There shall be no computer network-based (smart lighting) lighting control solution that incorporates communication between various system inputs and outputs related to lighting control with the use of one or more central computing devices.

Simple, standalone lighting control systems are preferred.

The lighting system philology shall consist of a zone / room which will consist of modular light fixture(s) complete DALI dimmable ballast(s), controlled by a local standalone DALI

PIR sensor(s) together with a local master light switch and where appropriate local daylight sensor(s).

UCC's preferred lighting philosophy is as follows:

Building Circulation Areas	A bank of switches is to be provided at main reception to allow for the turning off of all public area lighting.
Offices	Lux level 350Lux. Manually switched on and off via new retractor switch(es). Will operate at max output of 100% on detection of occupancy. Will operate at 25% of output when no occupancy is detected after 10 minutes. Will switch off automatically when no occupancy is detected for a further 5 minutes. Will switch back on to 100% of output when occupancy is detected when operating at 25% of output. Will automatically dim to maintain 350 lux on the working plane.
Corridors	Lux level 200Lux. Manually switched on and off via new retractor switch(es). Will operate at max output of 100% on detection of occupancy. Will operate at 25% of output when no occupancy is detected after 10 minutes. Will switch back on to 100% of output when occupancy is detected. Will switch off automatically after no occupancy is detected for 30 minutes.
Toilets	Lux level 200Lux. Manually switched on and off via new retractor switch(es). Will operate at max output of 100% on detection of occupancy. Will operate at 25% of output when no occupancy is detected after 10 minutes. Will switch back on to 100% of output when occupancy is detected. Will switch off automatically after no occupancy is detected for 30 minutes.
Stairwells	Lux level 200Lux. Manually switched on and off via new retractor switch(es). Sensors prevent the fixtures from operating or will switch off the fixtures when natural light levels are sufficient. Will operate at max output of 100% on detection of occupancy (unless natural light levels are sufficient). Will operate at 25% of output when

	no occupancy is detected after 5 minutes (unless natural light levels are sufficient). Will switch back on to 100% of output when occupancy is detected. Will switch off automatically after no occupancy is detected for 5 minutes. The location of all lights within stairwells, is to be carefully considered and to take account of access for maintenance purposes.
Labs	Lux level 500Lux. Manually switched on and off via new retractor switches. Will operate at max output of 100% on detection of occupancy. Will operate at 25% of output when no occupancy is detected after 15 minutes. Will switch back on to 100% of output when occupancy is detected. Will switch off automatically after no occupancy is detected for 30 minutes. Will automatically dim to maintain 300 lux (or otherwise specified) on the working plane.
Stores	Lux level 200Lux. Manually switched on and off via new retractor switches. Will operate at max output of 100% on detection of occupancy. Will switch off automatically after no occupancy is detected for 5 minutes. All time settings to be user adjusted either through handheld controller.

Where identified the standalone sensors shall be locally programmed to dim the luminaires to an agreed set level on automatic detection of sufficient daylight.

To prevent nuisance dimming the daylight sensor will be located a minimum of 2.5 metres from any window.

Sensors shall be sighted so as to maximise the coverage and to ensure no “blind spots”. All sensors shall be selected to ensure appropriate detections for persons in a seated low movement environment.

Sensors shall be programmed to operate in absence detection mode i.e. activation of the lighting is manual by pressing the retractor switch. The lighting will stay on during occupancy of the room. After no occupancy is detected and a predetermined time period has elapsed the luminaires shall switch off.

Training session shall be provided by electrical contractor to the onsite maintenance personnel prior to project handover.

In Administration areas and areas where computer monitors are used the lighting installation will comply with CIBSE LG 7.

Simple, modular lighting control systems are preferred. Lighting control philosophy shall be designed in detail by the design team and agreed with UCC end users, Engineering Services and Utilities departments at detailed design stage.

5.10.2 External Lighting

External lighting will be selected to minimise light pollution and effects on neighbouring properties and wildlife. All design is to incorporate UCC's Biodiversity plan. https://greencampus.ucc.ie/wp-content/uploads/2018/11/UCC-Biodiversity-Action-Plan-2018-2023.pdf.

"In general, artificial light creates a barrier to commuting bats so onsite lighting should be minimised during the active bat season from March to the end of September as it deters some bat species. Where lighting is required, directional lighting (i.e. lighting which only shines on access roads and not nearby countryside) should be used to prevent overspill. This can be achieved by the design of the luminaire and by using accessories such as hoods, cowls, louvres and shields to direct the light to the intended area only."

Is general all external lighting:

- use energy efficient LED luminaires, **operating below 2700K.**
- are each supplied with factory fitted motion sensor.
- will be wired on multiple circuits (A, B, C, etc) to avoid loss of light to an entire area in the event of a mains/circuit failure.
- All external lighting circuits will be controlled by a photocell/timeclock arrangement. Photocell to be suitably located.

Example of UCC's preferred External lighting philosophy is as follows:

Public Areas	Max Colour Temperature 2700K. All fittings are also to be on a central photocell together with a 7-day time switch controlled by the BEMS, to enable the occupants to schedule the operation of the light fittings and also to turn off when the building is closed.
Car parks	Max Colour Temperature 2700K. The fixtures are to operate at 100% of output on detection of an occupant and shall remain at 100% of output for 5 minutes after the person has left the detection distance. The fitting is to then dim to operate at 30% of output while still achieving the minimum required light levels for a carpark.

Security Lighting	Max Colour Temperature 2700K. External lighting which forms part of the security lighting to be controlled by photocells only. Lighting to form part of the security lighting to be agreed with UCC General Services department.
External plant, Roof areas, Services areas.	Max Colour Temperature 2700K. Lighting in service yards, delivery bays etc. will be PIR or photocell controlled to ensure lights do not remain on when an area is unoccupied or not in use.

5.10.3 Emergency Lighting

Emergency lighting will be provided throughout the building and ancillary spaces including all external emergency routes and muster points in accordance with IS 3217 latest revision.

Combined general lighting and emergency lighting luminaires are prohibited in all internal and external locations.

The emergency lighting system shall consist of dedicated emergency luminaires only. Central battery systems are preferred for larger installations. Standalone emergency luminaires are acceptable for smaller installations.

Central battery systems batteries shall be installed in a dedicated location within a 2-hour fire rated compartment. Adequate ventilation shall be provided to ensure that the optimum operating temperature of the batteries is maintained.

Central battery system cabling shall be 2-hour fire rated white cable installed on dedicated containment.

All central battery luminaires shall be labelled with their address to allow for ease of fault finding. All central battery emergency lighting circuits shall be designed with 20% spare addresses to allow for future expansion.

All central battery emergency lighting shall be designed as ‘A’ and ‘B’ circuits such that a circuit failure will not result in the complete loss of emergency lighting within an area.

5.11 FIRE DETECTION SYSTEMS

The proposed fire alarm detection system will be an L1 addressable fire alarm system and will comply with IS 3218, Building Regulations TGD Part B, and local Fire officer conditions.

The final L1 Certificate shall be submitted to UCC condition free.

Fire alarm cabling shall be installed on dedicated containment.

The main fire alarm panel will be located at the main reception desk or other permanently manned location. Fire alarm repeater panels will be located to suit operational requirements.

Front end fire graphics panel to be supplied and location to be agreed with UCC Engineering Maintenance Department at early stage design review meetings.

Aspirated systems are to be provided for ceilings greater than 4m, ceiling voids greater than 600mm, lift shafts and difficult to access areas. Heat detection is the preferred detection in all plant room areas.

Audio-visual alarms will be provided throughout the building in accordance with the Disability Act, Part M 2015, for the hearing impaired. Visual beacon flash rates will be installed so as not to introduce risks of epileptic seizure.

Fire doors on corridors will align with fire compartment strategy and will be held open on automatic door releases and interfaced with the fire alarm system to facilitate closure in the event of an alarm.

All access control systems will be controlled such that in the event of a fire the door will automatically unlock in accordance with the agreed fire alarm cause and effect matrix.

The design team shall produce a detailed fire alarm cause and effect matrix This cause, and effect matrix shall detail all operations of the fire alarm system, i.e. each I/O operation. Generalisations to system operations e.g. automatic doors are not acceptable.

All fire alarm system components shall be installed in easily accessible locations. This includes I/Os, door release systems, power supplies.

All panels associated with the final alarm system is to be a maximum of 2m from floor level to the top of the panel.

The Notifier brand system of fire detection and alarm systems is used by UCC campus wide. All fire detection alarm systems are to be compatible with the existing notifier network.

Notifier panel in main fire board at entrance location, Blue box UCC supplied, with power spur provided by contractor.

5.11.1 Fire Suppression System

The Design Team will consider and report on the cost and space planning implications for a sprinkler installation if required, including all central plant, pipework, tanks, interlocks and additional ceiling coordination required as a result of incorporating sprinkler design into the development.

5.11.2 Disabled Persons WC Alarm and Refuge Alarm

The disabled persons WC alarm system will be part of the UCC Call system. A disabled persons WC call system will be provided in all resident accessible WCs, shower rooms, bathrooms etc. and will consist of pull chord.

Where pull chords are used these will be of the anti-ligature type and be wipeable/cleanable.

Activation of a WC Alarm will be notified to the nearest staff base or sub-staff base.

5.12 INDUCTION LOOP

Audio frequency induction loops will be required to comply with Building Regulation Part M.

Induction loops will be provided at a minimum in the following locations:

- Main reception,
- Waiting areas; and
- Lift cars.

The M&E consultant is to investigate the use of Bluetooth / Wi-Fi Induction loops rather than 'hard' wired solutions, whilst still complying with Part M.

Hard wired induction loop has proven to be very problematic from a maintenance perspective within UCC.

5.13 CCTV

To be read in conjunction with UCC CCTV Project Specification Document.

The CCTV system will be a TCP / IP based system Internal CCTV cameras will be provided to cover the main entrance and reception desk, all entry and exit points, public waiting area, back of house entrance and exit points and 'communal street' corridors.

External CCTV will be provided to cover all elevations of the building, all building access points and landscaped areas.

All CCTV internal cameras require a 1nr. dedicated Cat6a data point.

There is no requirement for a dedicated PC station, as CCTV software can be installed on any UCC networked PC but the designers should allow for a CCTV server to be installed in the local IT coms room for every 60 cameras installed.

External camera locations require a dedicated power & data point. (exterior Cat6a) for each external camera. Max. distances using data cable from camera to the nearest IT COMMS room is 100 metres. External cameras should be fitted on a dedicated post that can be lowered to facilitate service / cleaning. A dedicated for a weathered

enclosure should be included to fit the associated switches, LV PSU's etc. Stuffing' all components into lamp posts will not be permitted. Each external camera should have lightning protection devices fitted at the comms cabinet.

All external CCTV cameras That are not installed onto a building, must be installed on dedicated CCTV poles. The CCTV pole(s) are to have a metal lockable mini pillar incorporated beside it. The pole must have the facility to be raised / lowered from the ground, hinged mechanism with manual winch.

Additional data cables required at various exterior camera locations, evenly spread out in the carpark(s). This is to allow for live audio to be broadcasted. Locations can be confirmed with UCC building office.

Where there is to staff bike storage area(s), a camera is to be located.

5.14 ACCESS CONTROL SYSTEM

To be read in conjunction with UCC ACCESS CONTROL Project Specification Document.

The access control system will be flexible and suitable for multiples occupant's types and varying secure access control requirements.

ONITY Card Systems is the preferred access system for all UCC plant rooms on main campus only.

Off Main campus, all doors leading onto roofs and plantrooms are to have a standard submaster key access.

5.14.1 Specification for Access Control System

UCC ACCESS CONTROL SYSTEM

UCC currently utilises an agreed procurement framework with Time & Data Systems for its access control systems. The access control system resides on the UCC IT network.

Given the high capital and ongoing servicing costs associated with access control it is imperative that access control requirements are challenged and justified as part of the overall project design process and access control should only be installed when fully justifiable.

For each door that requires access control the following services and hardware are required:

- Access control module, typically located in an adjacent coms room, service duct or plant room. Each controller can manage up to 8 access card readers,
- A swipe card reader located at the access entry point; and
- A 24V strike lock fitted into the door frame of the door to be access controlled.

Note that all access control door locks should be electro / mechanical, i.e. the use of magnetic locks not permitted and there must always be a mechanical override in place on the point of exit.

Access control System Architecture:

For ease of design and construction the project design team is to treat the access control installation in 2 distinct phases:

Phase 1: Design and first fix:

For each door that requires access control the following services and hardware are required:

- Access control module typically located in an adjacent service duct or plant room. Each controller can manage up to 8 access card readers,
- Each access control module requires,
- 13-amp fused spur,
- fire I/O,
- Data (Cat6a) point,
- A swipe card reader located at the access entry point (secure side),
- 4 pair belden cable from the control module to each card reader location,
- A 24V strike lock fitted into the door frame of the door to be access controlled,
- 4 pair belden cable from the control module to each strike lock location,
- Allowance for design and co-ordination with the appointed UCC access control specialist; and
- Installation of free issue control modules, back boxes and strike locks.

Note: All access control door locks should be electro / mechanical, **i.e. Magnetic locks not permitted or Emergency Green Break Glass units.** There must always be a manual override in place on the point of exit (i.e. handle or crash barrier dedicated external exit doors).

Phase 2: Cost Allowance for installation and commissioning.

Upon completion of phase 1 UCC's access control specialist will install the components of the control module and card readers and commission same.

It is expected that the access control system will be installed once the certificate of substantial completion is issued for the project.

Cost Allowances

Designers should allow for the following in the project cost plan, under the Electrical scope of works:

- Installation, termination and testing of data points, fire IO and spur outlets for each control module,
- Installation of belden cables from the control module to the doors that require access control; and
- Installation of free issue control modules, back boxes, strike locks and cable channels.

Designers should allow for the following in the project cost plan, under access control requirements:

- Cost of access control hardware; and
- Commissioning of the access control system.

Costs for the above items can be obtained from the UCC Capital Projects Officer, once the scope is known.

Once agreed these costs must be ringfenced for the access control element of the project.

Utilising UCC's existing framework agreement UCC Estates will procure the access control hardware and commissioning via the Capital Project Cost book.

Intercoms will be provided at goods delivery doors etc. The intercom will be both visual and audible. Intercoms will be answerable at the nearest staff base or sub-staff base and main reception desk with door release functionality. This will facilitate a 'See, speak, swipe' system monitoring method of front door access by staff during work times when the reception area may be unattended.

All electronic access control systems will be controlled such that in the event of fire alarm activation the doors will automatically unlock in accordance with the agreed fire alarm cause and effect matrix.

5.15 EARTHING AND BONDING

A complete earthing and bonding network will be provided to comply with IS10101, ISEN 62305 and BS7430. Main earth bars shall be provided in the main LV switch room and any generator switch rooms.

A dedicated clean earth bar will be provided in all comms room to provide a clean earth for IT systems

The earthing system will also comprise circuit protective conductors, equipotential bonding to all incoming services, bonding to all extraneous metal work, ventilation

ducts, kitchen cabinetry, mechanical services pipework and bonding to the lightning protection system.

Low voltage electrical distribution systems shall be provided with a Tera Neutral Combined Separate (TNCS) earthing arrangement.

Low voltage electrical distribution cabling shall have 'full sized' earth and neutral cabling.

An earth bar shall be provided externally at each main distribution board, sub-distribution board and MCC.

5.16 LIGHTNING PROTECTION

The lighting protection and surge protection systems shall be designed and installed to IS EN 62305. Additional surge protection shall be provided to sensitive loads e.g. comms rooms, research equipment etc.

5.17 LIFTS

Where lifts are being provided the design, team is to review the possibility of providing a fire evacuation lift, within the overall budget constraints. Should the provision of a fire evacuation lift exceed the budget, then the design team leader in conjunction with the design team is to provide a report to UCC outlining the various options considered and the associated additional costs.

The voice commands on the lift are to be provided in both Irish and English, with Irish provided first.

A hard-wired phone line is to be provided to the lift to allow for outward communications and connected to the nearest UCC telephone exchange hub.

The outward communication is as follows:

- .First Communication to UCC Main Reception; and
- Second to Lift Supplier 24hr monitoring station.

Call buttons are to be in compliance with Part M and be provided to both the right and left hand side of the lift, to facilitate accessibility for all users.

In the case of a fire alarm activation, the lift shall drop to ground floor level, unless directed otherwise by the fire strategy.

Lifts must be machine room less, traction type units.

Lifts should have idle / standby modes that reduce the energy consumption of the lift when not in use.

Emergency lighting within the lift shall be the responsibility of the lift supplier.

6.0 PUBLIC HEALTH SERVICES

The Public Health building services brief will include (list is non-exhaustive):

- Incoming mains water supply,
- Cold water storage, treatment and distribution,
- Hot water generation, storage and distribution; and
- Plumbing to sanitary ware fittings.

6.1 DESIGN CRITERIA

The Public Health installation will be designed and installed in accordance with the following standards and approved guidance documents:

- HSE UK L8 - The Control of Legionella Bacteria in Water Systems,
- HPSC/HSE - Guidelines for the Prevention and Control of Infection from Water System in Healthcare Facilities,
- National Guidelines for the Control of Legionellosis in Ireland 2009,
- IS EN806 Specifications for Installations Inside Buildings Conveying Water for Human Consumption,
- HTM 04-01 The Control of Legionella, Hygiene, “safe” hot and cold water and drinking Water systems,
- HTM:07-04 Water Management & Water Efficiency,
- HBN: 00-09 Infection Control in the Built Environment,
- CIBSE Guide,
- CIBSE TM13; and
- BSRIA Legionella guidance documents.

6.2 MAINS WATER SUPPLY

Mains water distribution equipment and appropriate instrumentation shall be connected back to the BEMS. Examples of instrumentation required include:

- Temperature,
- Pressure,
- Flowrate; and
- Large abnormal flow rates.

All excess water flow shall be monitored and alarmed back to the BEMS with a facility to shut off that water supply.

6.2.1 Domestic Cold Water

The mechanical and electrical consultant shall consider the inclusion of either grey water or well water for use on WC's. The M&E consultant shall also consider recycling of the discharge water from suitable plant sources.

The incoming mains supply will feed a cold-water storage tank. The cold-water storage tank will be sized for 12 or 24hour storage, Irish Water guidance will be sought in this regard.

Additional future capacity will be included in the overall tank size.

The cold-water storage tank will be a split tank arrangement to allow maintenance of one half of the tank whilst the other half remains operational. Adequate access shall be provided along with means of extraction from confined spaces.

If required water booster sets duty/standby arrangement will ensure sufficient pressure and flow at outlets.

A water treatment system will be provided to prevent scale build up and bacterial growth within the whole of the water system.

Cold water will be provided to all non-drinking water outlets, including WCs, showers, wash hand basins, baths and cleaners sink etc.

The cold-water services installation will be fully drainable throughout the whole of the system.

The water distribution strategy will be designed and installed to reduce stagnation occurring in any part of the system.

Sub-meters, connected to the BEMS, will be provided on supplies to specific building areas such as DI plant, CWS tanks, DHW plant, cafes, etc and third-party retail or medical areas.

The cold-water system shall be designed with 'double valve and bleed' isolation in mind. This shall allow for two valves in series to be closed to provide isolation to a work area and a drain point between the valves to proof the valves are holding. This is in line with UCC SOPs.

Toilets are to have dual flush cisterns; urinals are to be controlled by a flushing control system. TMV-3's to be fitted on all sinks.

Drinking fountains shall be touchless bottle filling type. Each station will be fitted with a solenoid valve, controlled by the BEMS, to allow for periodic flushing of the station.

The location of all drinking fountains shall be agreed with UCC, and as a minimum shall be located in publicly accessible areas (i.e. foyer / corridors).

6.2.2 Domestic Hot Water Supplies

Domestic hot water will be provided indirectly or directly. The suitability of each method will be assessed, and the most suitable system adopted. The domestic hot water generator arrangement will be N+1.

Separation of hot water generation will be for general hot water demand and catering demand, where it is applicable and deemed economically and operationally advantageous.

Hot water supplies will be delivered to the point of use at a suitable pressure for the sanitary appliance. Fixed flow limiting controls will be provided at the point of discharge to ensure economic use of water.

Where the public have access to hot water the discharge temperature will not exceed 41C. Thermostatic mixing valves (TMV3 scheme) will be fitted to all public points of use.

All hot water outlets including showers shall be fitted with scald protection. The hot and cold-water supply to all mixing outlets shall be fitted with non-return valves.

The hot water distribution temperature will be maintained by a pumped secondary circulation circuit.

The hot water services installation will be fully drainable throughout the whole of the system. Automatic thermally operated hot water return balancing valves will be located throughout the domestic hot water system to allow automatic balancing of the entire system during commissioning.

All water usage within the building will be metered. Sub-meters will be provided to specific building areas e.g. third-party retail or medical areas.

All meters will be BACnet type and linked to the BEMS for monitoring purposes.

For the above; mains water, cold water and hot water systems sentinel points or dedicated flushing units will be included at end of line outlets and or on low use branches to ensure problems with low flow and temperature do not occur. Sentinel points or flushing units will be linked to the BEMS system to ensure frequent operation of the outlets and sufficient turnover of water.

Consideration will also be given to alternative technologies to maintain water quality at the point of use such as Venturi valves, multi circulation valves and forced flow circulation technology.

7.0 BUILDING ENERGY MANAGEMENT SYSTEM

University College Cork is currently moving from a traditional BEMS setup towards an Open System integration. The term Open System refers to integrating multiple services to the Integration Platform then to one uniform front end. The base building BEMS controls will utilise BACnet protocol to communicate via the University's LAN to its respective servers and the integration platform. The University is aware of multiple vendors providing BACnet control systems but requires systems installed that are consistent and common to existing systems and components. These systems will provide maintenance staff, building managers and laboratory managers visibility to their building systems to assist in building management and energy usage monitoring.

System Architecture

The BEMS system in UCC is currently transitioning from closed protocol to open protocol BACnet.

The BTL approved BAAC & field controllers will communicate with the BTL approved BACnet Communications Controller via BACnet MSTP for each network. The Communications Controller will communicate with the BACnet Operators Workstation by BACnet/IP.

The supervisory software is a virtual server based Cylon Aspect system housed on campus.

Roaming PCs with client software to access Main Server graphics is not permitted.

Multiple users must be able to access the Main Server graphics at once. Power Users must be able to block certain users from viewing certain buildings and commanding certain points.

UCC must be informed about all license costs in the tender pricing document. Enterprise licenses shall not be on any external hardware, USB Dongle for example.

UCC must always remain in control of the software . All software to be kept on UCC secure servers and to be checked in and out as required. Documentation to be completed by the BEMS company verifying the software is a direct match for the software on the controllers, on return of the software to UCC post maintenance/project completion.

Trending logs- Trend logs must be captured in an SQL or My SQL database

Note at a high level UCC IT will:

- Create a separate network path for the BEMS systems on the UCC network,
- Provide server IP address to gain access from within the UCC network,

- Provide 2 step authentication through a secure VPN to gain access from outside the UCC network,
- Provide access to system integrators by opening a VPN session for an agreed timeslot; and
- The University is also open to the deployment of IOT devices to control the BEMS via LoRa WAN or equivalent network protocols.

8.0 TESTING, ADJUSTING AND BALANCING

8.1 HVAC / DUCTWORK

Seal, patch, and repair ductwork, piping, and equipment that has been drilled, cut or modified for testing purposes.

Instrument test ports in ductwork systems and equipment housings shall be capped. Seal ports where attached to system using sealants in accordance with the reference specifications. Test ports similar to Ventlock 699 Instrument Test Holes.

Piping shall be capped with the same materials as the piping system.

Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

Operating tests of heating and cooling coils, fans, and other equipment shall be of no less than 4 hours duration after stabilized operating conditions have been established. Base capacities on temperatures and air and water quantities measured during such tests.

Method of application of instruments shall be in accordance with the approved agenda, and standard procedures as specified in the BSRIA and CIBSE codes and manuals.

8.1.1 Ductwork Leakage Testing.

- Ductwork specified to HVCA Specification DW/144 leakage classes C or D shall be leak tested in accordance with HVCA Specification DW/143. Ductwork of leakage Class A shall not be leak tested. Class B ductwork shall be tested in accordance with DV/143.

8.2 AIR SYSTEMS COMMISSIONING AND SETTING TO WORK

Commissioning and setting to work of air systems shall be carried out in accordance with the recommendations of BSRIA Application Guide AG 3/89, CIBSE Commissioning Code A and in accordance with the following:

- Cleanliness,
- Adjustments,
- Balance,
- Fan Adjustment,
- Air Measurement,
- Test Holes,
- Air Terminal Balancing,
- Air Motion,
- Pressurisation,
- HEPA Filter Testing; and

- Clean Room Particulate Testing.

8.3 AIR SYSTEMS COMMISSIONING REPORT

For each air handling system, the certified report shall include the data listed below.

- Equipment (Fan).
  - Installation data,
  - Manufacturer and model,
  - Size,
  - Arrangement, discharge, and class,
  - Motor kW, voltage, phase, cycles, and full load amps,
  - Location and local identification data; and
  - Fan Curve.
- Design data:
  - Data listed in contract drawing schedules and specifications,
  - Fan recorded (test) data,
  - Volume (m3/hr),
  - Static pressure,
  - RPM,
  - Motor operating amps; motor operating kW,
  - VFD setting where applicable; and
  - Fan Curve.
- Duct Systems
  - Duct air quantities (minimum and maximum) –main, sub-mains, branches, outdoor air, return air, relief air, recirculating air, total air, and exhaust air,
  - Duct sizes,
  - Number of Pitot tube (pressure measurements),
  - Sum of velocity measurements. (Note!!! Do not add pressure measurements.),
  - Average velocity,
  - Recorded test volume, design volume; and
  - System air leakage - supply air, return air, recirculating air, exhaust air, total air.
- Room Pressurisation:
  - Target pressurisation data as indicated in the contract documents,
  - Actual room pressurisation including differential pressure between room and all adjacent rooms,
  - General Specification for Testing, Adjusting and Balancing; and
  - Directional airflow.
- Individual air terminals:
  - Terminal identification (supply, transfer, or exhaust), location and number designation. Indicate Manufacturer's Serial No. for HEPA filter,

- Type, size, manufacturer, and catalogue identification applicable factor for application, velocity, area, and designated area,
- Design and recorded velocities - m/s (state core, inlet, as applicable),
- Design and recorded quantities - m3/hr deflector vane or diffusion cone settings,
- Provide clearly marked HVAC plan drawings indicating Manufacturer's Serial number associated with each terminal HEPA filter,
- Average face velocity and velocity profiles for all HEPA terminals filters; and
- Integrity testing results for each HEPA filter.

8.4 WATER SYSTEMS COMMISSIONING AND SETTING TO WORK

Water and steam/condensate systems shall be balanced, commissioned, and set to work in accordance with BSRIA Application Guide AG 2/89.1, CIBSE Commissioning Code W and in accordance with the following:

- Adjustment,
  - Adjust heating hot water, steam, and chilled water-cooling systems to provide required quantity to or through each component.
- Metering,
  - Measure water quantities and pressures with calibrated meters.
- Automatic Controls
  - Position automatic control valves for full flow through the heat transfer equipment of the system during balancing and tests.
- Flow
  - Adjust flow through bypass circuits at 3-way valves to equal flow through the supply circuit, when the valve is in the bypass position.
- Distribution
  - Adjust distribution by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided; do not use service valves; and
  - Wherever automatic flow control valves are utilized in lieu of Venturi tubes or Orifice plates, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.
- Special Procedures
  - Where available pump capacity, as designed, is less than total flow requirements of individual heat transfer units of system served, simulate full flow by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda,
  - On completion of testing and cleaning, the systems shall be protected from corrosion and freezing until put into service; and
  - All strainers in any water and steam systems shall be cleaned immediately prior to the handover of that system.

8.5 WATER SYSTEMS COMMISSIONING REPORT

The certified report for each water system shall include the data listed below.

- Pumps:
  - Installation data,
  - Manufacturer and model,
  - Size,
  - Type drive,
  - Motor kW, voltage, phase, and full load amps; and
  - Location and local identification data.
- Design data:
  - Volume Flow Rate (l/s),
  - Head; and
  - RPM, kW, and amps.
- Recorded data:
  - Discharge pressures (full-flow and no-flow),
  - Suction pressures (full-flow and no-flow) operating head,
  - Operating volume flow rate (l/s) (from pump curves if metering is not provided),
  - No-load amps (wherever possible),
  - Full-flow amps; and
  - No-flow amps.
- Heat Exchangers
  - Installation data,
  - Manufacturer, model, and type,
  - Volume flow rate (l/s),
  - Inlet (entering) and outlet (leaving) temperatures,
  - Water pressure drop,
  - Entering steam pressure; and
  - Location and local identification data.
- Recorded data:
  - Volume flow rate (if metered),
  - Entering and leaving water temperatures – system,
  - Water pressure drop,
  - Heating or cooling media (conditions) - steam pressure and condensate temperature, or entering and leaving water temperature; and
  - Heating or cooling media - flow (l/s or kg/hr).
- Air Heating and Cooling Equipment
  - Design data,
  - Load in kW,
  - Water Volume flow rate (l/s),
  - Entering and leaving water temperature,
  - Entering and leaving air conditions (DB and WB),
  - Entering steam pressure,

- Air Volume flow rate (m3/hr); and
- Water pressure drop.

- Recorded data:
  - Type of equipment and identification (location and number designation)
  - Entering and leaving air conditions (DB and WB),
  - Entering and leaving water temperatures,
  - Entering steam pressure,
  - Water Volume Flow Rate (l/s if metered),
  - Air Volume flow rate (m3/hr if metered),
  - Temperature rise or drop; and
  - Water pressure drop.

8.6 HEAT EXCHANGER CAPACITY VERIFICATION

Verify air coil capacities from airside measurement data. Capacities of coils shall be the difference of the energy carried by the air between the upstream and downstream of the coils.

Use the measured airflow rate for the fan or the air coil capacity calculations providing no ducted bypassing of coil is occurring.

Verify water/water heat exchanger equipment capacity by measuring the flow rate and temperature differential of the water.

Verify steam/water heat exchanger capacity by measuring the flow rate and temperature differential of the water.

Perform capacity verifications after air and water systems have been balanced. Heat exchangers using steam as the exchange medium shall have the steam measured and adjusted to the specified pressure.

Apply false load if the upstream air or water does not meet the specified conditions at the time of test.

8.7 CERTIFIED REPORTS

Submit three copies of all reports described herein, covering air and water system performance, air motion, pressurisation, particulate, and sound pressure levels before final tests and inspection.

Include type, serial numbers, and dates of calibration of all instruments.

Reports shall clearly identify obvious malfunctions and design deficiencies as well as items not conforming to Contract requirements.

8.8 FINAL COMMISSIONING TESTS, INSPECTIONS, AND ACCEPTANCE

Test shall demonstrate that capacities and performance of air and water systems comply with Contract requirements.

- At the time of final inspection, the client shall recheck a random selection of the data (water and air quantities, air motion, and sound levels) recorded in the certified report. Laboratories shall be rechecked for satisfactory airflow and motion in vicinity of and through fume hoods,
- The commissioning team shall select points and areas for recheck,
- Measurement and test procedures shall be the same as approved for work forming basis of certified report; and
- Selections for recheck (specific plus random), in general, shall not exceed 25 percent of the total number tabulated in the report, except that systems that require validation shall require a complete recheck.

8.8.1 Retests

If for 10 percent or more of the rechecked selections the random tests elicit a measured flow deviation of 10 percent or more from that recorded in the certified report listings, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and a new inspection tests made, at no additional cost.

8.9 DEMONSTRATIONS AND TRAINING

Training and demonstration of all mechanical and electrical system shall be included in the project tender. These shall include at a minimum:

- Electrical distribution,
- BEMS,
- Hot & cold-water generation and distribution,
- Fire alarm,
- Emergency lighting,
- Automatic doors,
- Intruder alarm,
- Access control,
- CCTV,
- HVAC,
- Smoke ventilation,
- Fire dampers; and
- Window operators.

Adequate time shall be allowed for detailed demonstrations of all systems, as deemed by UCC. No mechanical or electrical systems shall be demonstrated in parallel.

The full fire alarm cause & effect matrix shall be demonstrated.

Emergency lighting shall be demonstrated via a three-hour battery test witnessed by UCC Buildings & Estates staff.

UCC shall be given a minimum of ten working days' notice of all demonstrations. In all cases, the design team shall have performed a full demonstration of each system prior to any demonstrations to UCC.

Factory acceptance testing shall be performed on all major elements of the electrical distribution and building management systems. This will include MV and LV main distribution boards, MV/LV transformers, BEMS panels, large sub-distribution boards etc. UCC Buildings and Estates maintenance staff shall be in attendance at all factory acceptance testing. A minimum of eight weeks' notice shall be provided for all factory acceptance testing.

APPENDIX A DESIGN PHILOSOPHY CHECKLIST

The following checklist must be completed and agreed at stage 2A of the design and again in advance of the 95% Design Complete M&E Design Review with UCC's Engineering Maintenance and Utilities Departments.

M&E Design Philosophy Checklist

Project Name:	Click or tap here to enter text.
Design Team Lead	Click or tap here to enter text.
M&E Consultant	Click or tap here to enter text.
Date	Click or tap to enter a date.

STANDARDS AND RESPONSIBILITY		**Compliant**	**Non-Compliant**
1.0	Standards	☐	☐
1.1	Responsibilities	☐	☐
1.2	Maintenance Philosophy	☐	☐
1.3	Deviations from the Philosophy Guidelines	☐	☐
1.4	12 Months Defects Period/Soft Landings and Seasonal Commissioning	☐	☐
1.5	12 Months Servicing and Maintenance Agreement	☐	☐
1.6	Control of Access to Plant Areas	☐	☐
1.7	Utility Supplies	☐	☐
1.8	Use of Dynamic Simulation Models For Part L	☐	☐
1.9	Redundant Installations	☐	☐
1.10	Draining of Hot and Cold Water Systems	☐	☐
1.11	Handover of Water Systems	☐	☐

1.12	Effect of Additional Installations of Existing Services	☐	☐
1.13	ATEX Risk Assessment	☐	☐
1.14	EPD Document.	☐	☐
End Section 1			
2.0	**Mechanical Services Installation**	**Compliant**	**Non-Compliant**
2.1	General	☐	☐
2.2	Plant Rooms including Boiler Rooms	☐	☐
2.1.1	General	☐	☐
2.1.2	Roof Plant Rooms	☐	☐
2.1.3	Low Level Plant Rooms	☐	☐
2.1.4	Equipment Located in Ceiling and Roof Spaces	☐	☐
2.2	Hazardous Areas	☐	☐
2.3	Distribution of Piped Services	☐	☐
2.3.2	Horizontal Distribution	☐	☐
2.3.2	Vertical Distribution	☐	☐
2.4	Low Pressure Hot Water Heating Systems	☐	☐

2.5	Laboratory and Domestic Hot and Cold Water Systems	☐	☐
2.5.1	General	☐	☐
2.5.2	Hot Water Systems	☐	☐
2.5.3	Cold Water Systems	☐	☐
2.5.4	Handover of Water Systems	☐	☐
2.6	Natural Gas Service	☐	☐
2.7	Steam Systems	☐	☐
2.8	Isolation Valves	☐	☐
2.9	Air Conditioning and Ventilation	☐	☐
2.10	Fume Cupboards	☐	☐
2.11	Lift Installations	☐	☐
2.12	BMS Section relocated	☐	☐
2.13	Asbestos	☐	☐
2.14	Thermal Insulation	☐	☐
2.15	Stand-by Plant	☐	☐
2.16	Energy Efficiency	☐	☐

2.17	Frost Protecting and Freezing	☐	☐
2.18	Sustainable Laboratory Design	☐	☐
2.19	Water Treatment	☐	☐
2.20	Identification and Labelling	☐	☐
2.21	Flexible Connections and Inertia Bases	☐	☐
2.22	Cold Water Booster Pumps	☐	☐
2.23	Sump, Storm Water and Sewage Pumps	☐	☐
2.24	Biomass, CHP	☐	☐
2.25	Boiler Installations	☐	☐
2.26	Rainwater Harvesting Systems	☐	☐
2.26.1	Rainwater Collection	☐	☐
2.26.2	Filtration and Treatment	☐	☐
2.26.3	Rainwater Storage	☐	☐
2.26.4	Back-up Water Supply	☐	☐
2.27	Dedicated Ventilated Chemical Fire-rated Storage Cabinets (After Fume Cupboard)	☐	☐
End Section 2			

3.0	Electrical Services Installation	Compliant	Non-Compliant
3.1	General	☐	☐
3.2	External Network General	☐	☐
3.3	HV Cable Networks	☐	☐
3.4	LV Cable Networks	☐	☐
3.5	Building Supply Cables	☐	☐
3.6	Substations General	☐	☐
3.7	High Voltage Switchgear	☐	☐
3.8	Transformers	☐	☐
3.9	Trip Batteries	☐	☐
3.10	Earthing General	☐	☐
3.11	Low Voltage Switchboards	☐	☐
3.11.1	General Requirements	☐	☐
3.11.1.1	Construction	☐	☐
3.11.1.2	Busbars	☐	☐
3.11.1.3	Switching Devices	☐	☐

3.11.1.4	Metering/Instrumentation	☐	☐
3.11.1.5	Labelling	☐	☐
3.11.2	Substation LV Switchboards	☐	☐
3.11.2.1	General	☐	☐
3.11.2.2	Busbars	☐	☐
3.11.2.3	Switching Devices	☐	☐
3.11.2.4	Metering/Instrumentation	☐	☐
3.11.3.3	Switching Devices	☐	☐
3.11.3.4	Metering/Instrumentation	☐	☐
3.11.4	Final Distribution Switchboards	☐	☐
3.11.4.1	General	☐	☐
3.11.4.2	Busbars	☐	☐
3.11.4.3	Switching Devices	☐	☐
3.11.4.4	Metering/Instrumentation	☐	☐
3.12	Building Distribution Systems	☐	☐
3.12.1	Vertical Distribution	☐	☐

3.12.2	Horizontal Sub-Distribution	☐	☐
3.12.3	Final Circuit Wiring	☐	☐
3.12.4	RCD Protection	☐	☐
3.12.5	Essential Services Switchboard	☐	☐
3.12.6	Inter-floor Services	☐	☐
3.12.7	Supplies to the Lift Installations	☐	☐
3.12.8	Electrical Supplies to Mechanical Services Equipment	☐	☐
3.12.9	External Sockets	☐	☐
3.13	Lighting	☐	☐
3.13.1	General Requirements	☐	☐
3.13.3	Target Energy Parameters	☐	☐
3.13.3	Control System	☐	☐
3.13.4	Design Criteria	☐	☐
3.13.5	Luminaire Selection	☐	☐
3.13.6	Historic Building	☐	☐
3.13.7	Examples	☐	☐

3.13.7.1	Typical Corridor	☐	☐
3.13.7.2	Typical Office	☐	☐
3.14	Fire Alarm and Detection Systems/Emergency Lighting	☐	☐
3.14.1	Fire Alarm Installation Criteria	☐	☐
3.14.2	Lift Shafts	☐	☐
3.14.3	Electronic Locks	☐	☐
3.14.4	Disabled Person Refuges/Facilities	☐	☐
3.14.5	Fire Alarm Cause and Effect	☐	☐
3.14.6	Building Conservation	☐	☐
3.14.7	Fume Cupboards	☐	☐
3.14.8	Fireman's Switch for Photovoltaic Systems	☐	☐
3.14.9	Other Items	☐	☐
3.14.10	Labelling	☐	☐
3.15	Emergency Lighting	☐	☐
3.15.1	General	☐	☐
3.15.2	System Design	☐	☐

3.15.3	Building Conservation	☐	☐
3.15.4	Labelling	☐	☐
3.16	Generators	☐	☐
3.16.1	General Requirements	☐	☐
3.16.2	Panel Construction	☐	☐
3.16.3	Switching Devices	☐	☐
3.16.4	Labelling	☐	☐
3.16.5	Metering Type	☐	☐
3.16.6	Change-Over Panel	☐	☐
3.16.7	Synchronisation	☐	☐
3.16.8	Control Principles	☐	☐
3.16.9	Testing Facilities	☐	☐
3.16.10	Restoration	☐	☐
3.16.11	Drawings	☐	☐
3.16.12	Fuel	☐	☐
3.16.12.1	Capacity	☐	☐

3.16.12.2	Fuel Level	☐	☐
3.16.12.3	Maintenance Contract	☐	☐
3.16.12.4	Bunding	☐	☐
3.17	Generator Set	☐	☐
3.17.1	PRP Prime Power Rating	☐	☐
3.17.2	Alternator	☐	☐
3.17.3	Base Frame	☐	☐
3.17.4	Control System	☐	☐
3.17.5	Alarm and Status Signals	☐	☐
3.17.6	Alternator Current Breaker	☐	☐
3.17.7	Control Philosophy	☐	☐
3.17.8	Routine Testing	☐	☐
3.18	Lightning Protection	☐	☐
3.19	Earthing – Special Requirements	☐	☐
3.20	Electromagnetic Compatibility	☐	☐
3.21	Power Factor Correction	☐	☐

3.22	Meters and Instrumentation System	☐	☐
3.23	Labelling	☐	☐
3.23.1	Substation	☐	☐
3.23.2	Compounds/Buildings	☐	☐
3.23.3	HV Switchgear	☐	☐
3.23.4	Transformers	☐	☐
3.23.5	Substation LV Switchgear	☐	☐
3.23.6	Buildings	☐	☐
3.23.7	Building LV Switchboards	☐	☐
3.23.8	Distribution Boards	☐	☐
3.23.9	Final Circuits	☐	☐
3.23.10	Cable Core Marking	☐	☐
3.23.11	Submain Cables	☐	☐
3.23.12	Emergency Lighting Identification	☐	☐
3.24	Distribution Board Chart	☐	☐
3.25	Cable Management Systems for Data/Telecommunications	☐	☐

3.26	Record Information	☐	☐
3.26.1	Asset Register	☐	☐
3.26.2	Drawings – see also the separate O&M's Philosophy Document	☐	☐
3.27	Photovoltaic Installations (PV)	☐	☐
3.27.1	System Requirements	☐	☐
3.27.2	PV Modules/Arrays	☐	☐
3.27.3	Inverters	☐	☐
3.27.4	Remote Energy Management	☐	☐
3.27.5	Metering	☐	☐
3.27.6	Fire Protection	☐	☐
End Section 3			
4.0	**BEMS AND AUTOMATIC CONTROLS**	**Compliant**	**Non-Compliant**
4.1	General	☐	☐
4.2	Control Panels	☐	☐
4.3	Safety Interlocks	☐	☐
4.4	Connectivity	☐	☐

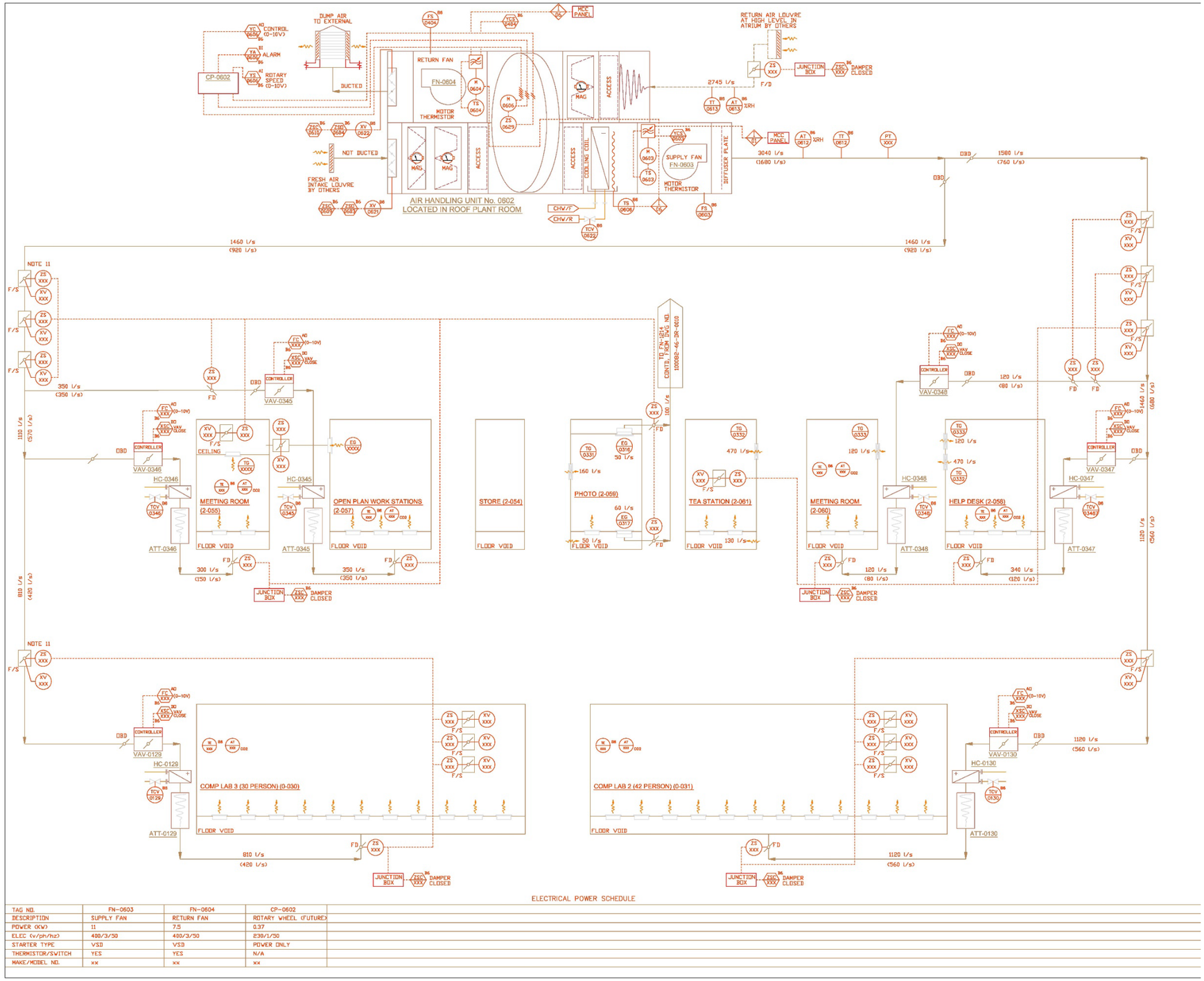
4.5	Head End Supervisory PC	☐	☐
4.6	Metering	☐	☐
4.7	BMS Engineering	☐	☐
4.8	Documentation	☐	☐
End Section 4			
5.0	**METERING STRATEGY**	**Compliant**	**Non-Compliant**
5.1	Strategy Overview	☐	☐
5.2	Electricity Meters and Instrumentation Systems	☐	☐
5.2.1	General	☐	☐
5.2.2	Current Transformer General Arrangements	☐	☐
5.2.3	Voltmeter Monitoring General Arrangements	☐	☐
5.2.4	Meter and Sub Meter Types	☐	☐
5.2.5	Earth Leakage Instrumentation	☐	☐
5.2.6	Meter Networks	☐	☐
5.2.7	Metering - Substations	☐	☐
5.2.7.1	HV Metering	☐	☐

5.2.7.1	LV Metering	☐	☐
5.2.7.1	Substation LV Switchboard Outgoing Circuits	☐	☐
5.2.8	Department/Building Metering	☐	☐
5.2.8.1	Incoming Circuits	☐	☐
5.2.8.1	Outgoing Circuits	☐	☐
5.2.9	Riser/Tap Offs	☐	☐
5.2.10	Sub Distribution Boards	☐	☐
5.2.11	kWh Metering	☐	☐
5.3	Standby Generators	☐	☐
5.4	Photovoltaic Panel Systems	☐	☐
5.5	Combined Heat & Power (CHP) Plants	☐	☐
5.6	Natural Gas Service	☐	☐
5.7	Water	☐	☐
5.7.1	General	☐	☐
5.7.2	Controls and Metering	☐	☐
5.8	Heat Energy Metering	☐	☐

End Section 5

Explanation for Non - Compliance	
Section No. 1 Reference	**Explanation**
Click or tap here to enter text.	Click or tap here to enter text.
Section No. 2 Reference	**Explanation**
Click or tap here to enter text.	Click or tap here to enter text.
Section No. 3 Reference	**Explanation**
Click or tap here to enter text.	Click or tap here to enter text.
Section No. 4 Reference	**Explanation**
Click or tap here to enter text.	Click or tap here to enter text.
Section No. 5 Reference	**Explanation**
Click or tap here to enter text.	Click or tap here to enter text.

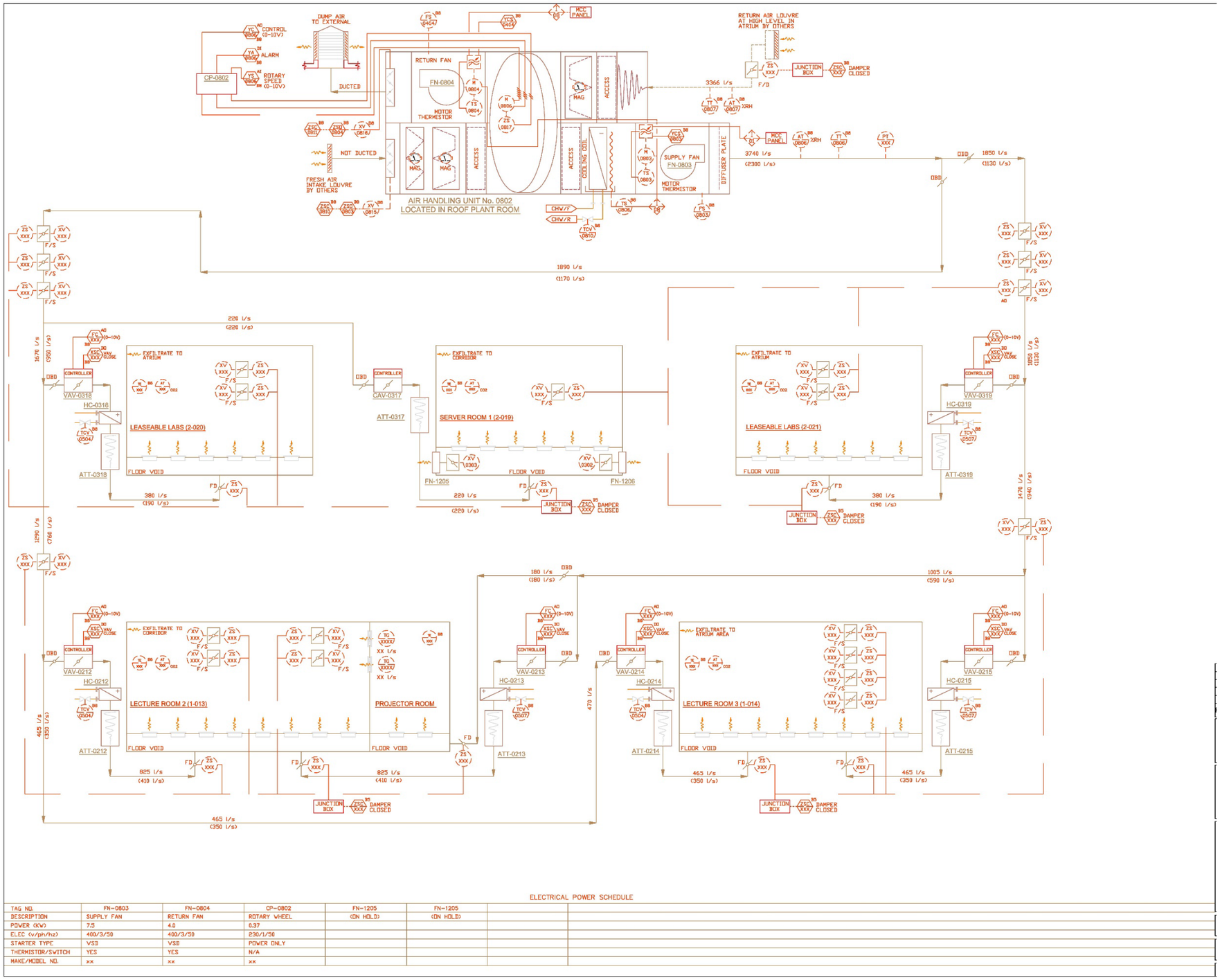
APPENDIX B PROCESS FLOW DIAGRAMS EXAMPLE



ELECTRICAL POWER SCHEDULE

TAG NO.	FN-0603	FN-0604	CP-0602
DESCRIPTION	SUPPLY FAN	RETURN FAN	ROTARY WHEEL (FUTURE)
POWER (KW)	11	7.5	0.37
ELEC (v/ph/hz)	400/3/50	400/3/50	230/1/50
STARTER TYPE	VSD	VSD	POWER ONLY
THERMISTOR/SWITCH	YES	YES	N/A
MAKE/MODEL NO.	xx	xx	xx

Figure B 1 - Air Flow Schematic – AHU System



ELECTRICAL POWER SCHEDULE

TAG NO.	FN-0803	FN-0804	CP-0802	FN-1205	FN-1205		
DESCRIPTION	SUPPLY FAN	RETURN FAN	ROTARY WHEEL	(ON HOLD)	(ON HOLD)		
POWER (KW)	7.5	4.0	0.37				
ELEC (v/ph/hz)	400/3/50	400/3/50	230/1/50				
STARTER TYPE	VSD	VSD	POWER ONLY				
THERMISTOR/SWITCH	YES	YES	N/A				
MAKE/MODEL NO.	xx	xx	xx				

Figure B 2 - Air Flow Schematic – AHU System

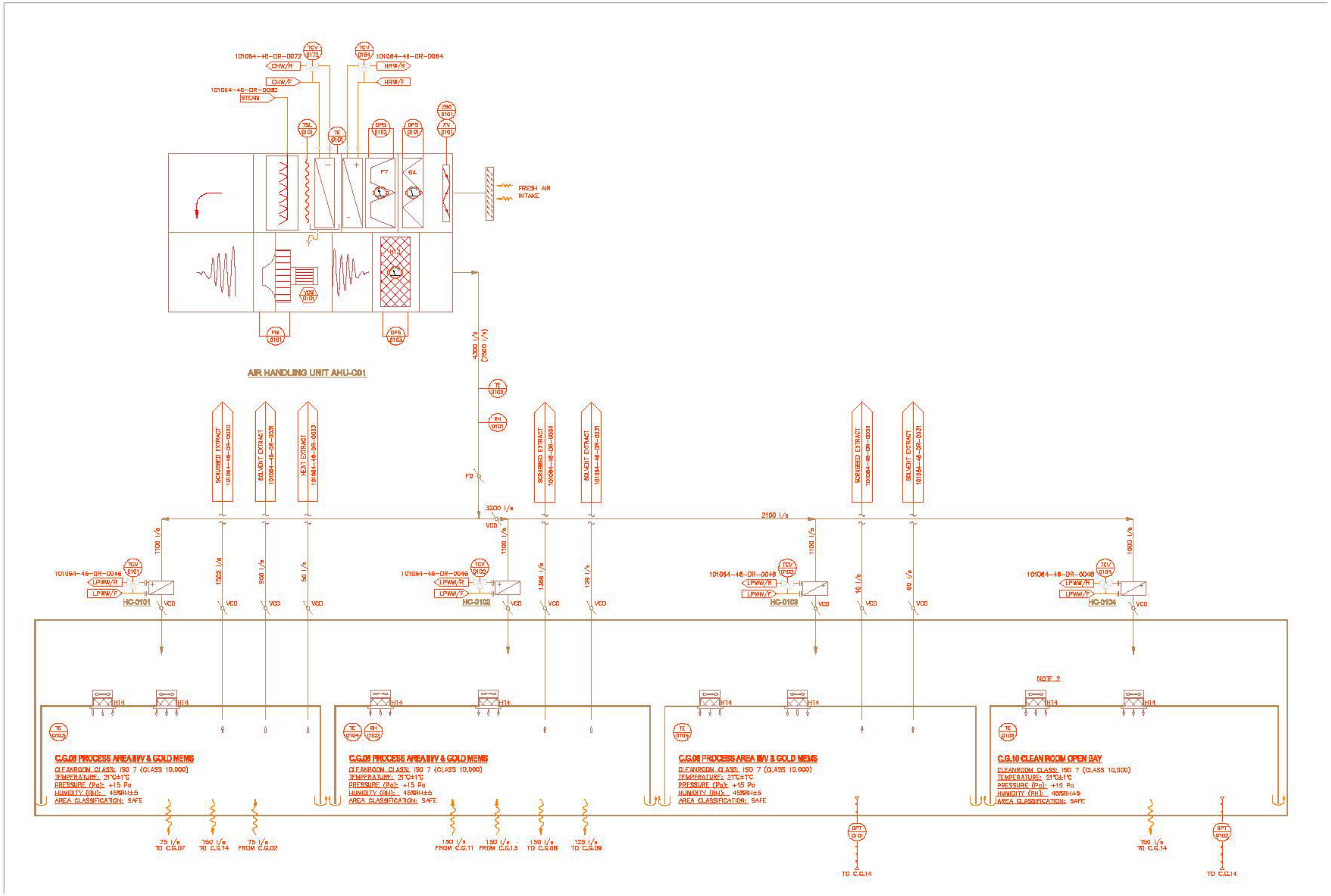


Figure B 3 - Air Flow Schematic – AHU System

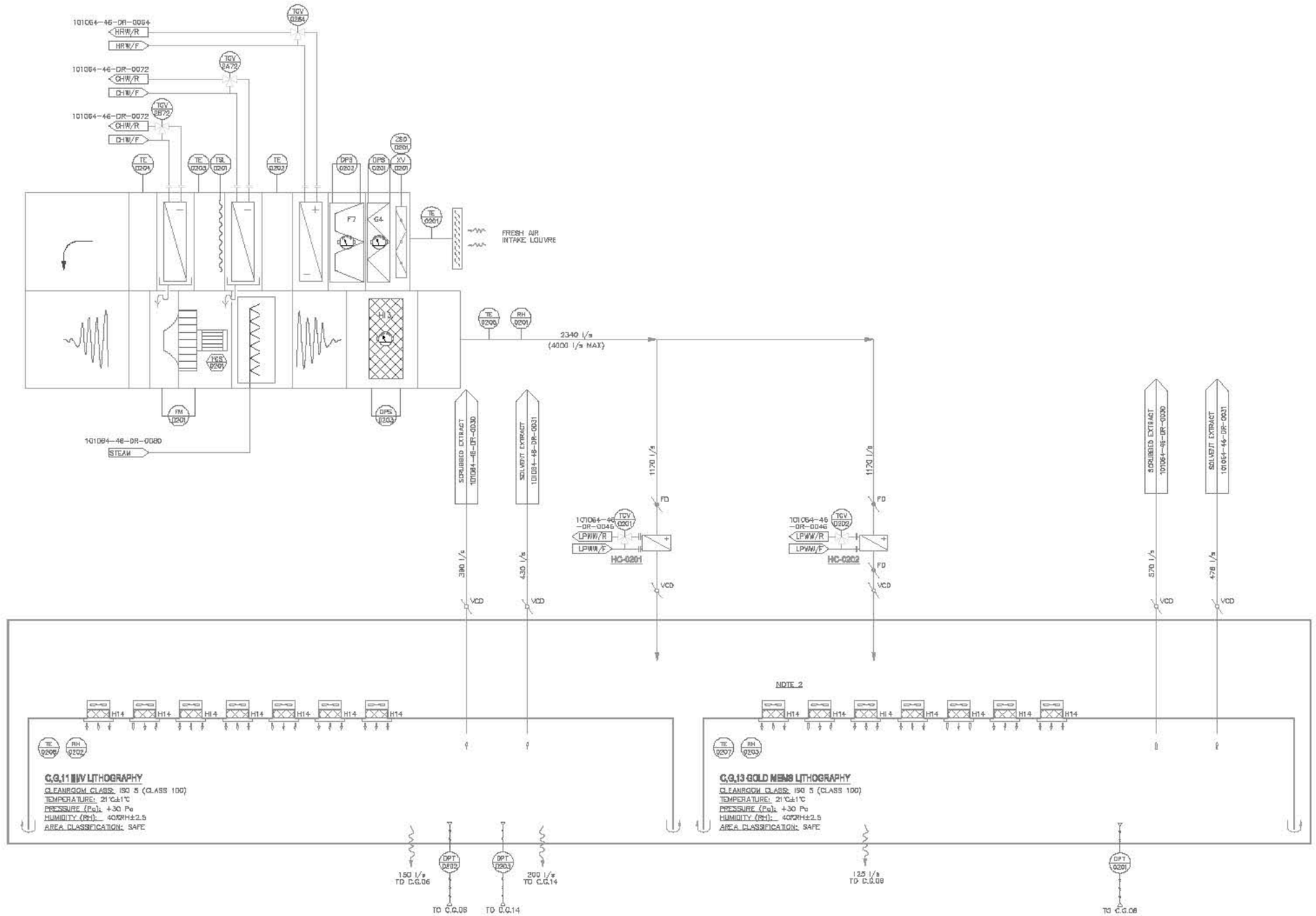


Figure B 4 - Air Flow Schematic – AHU System

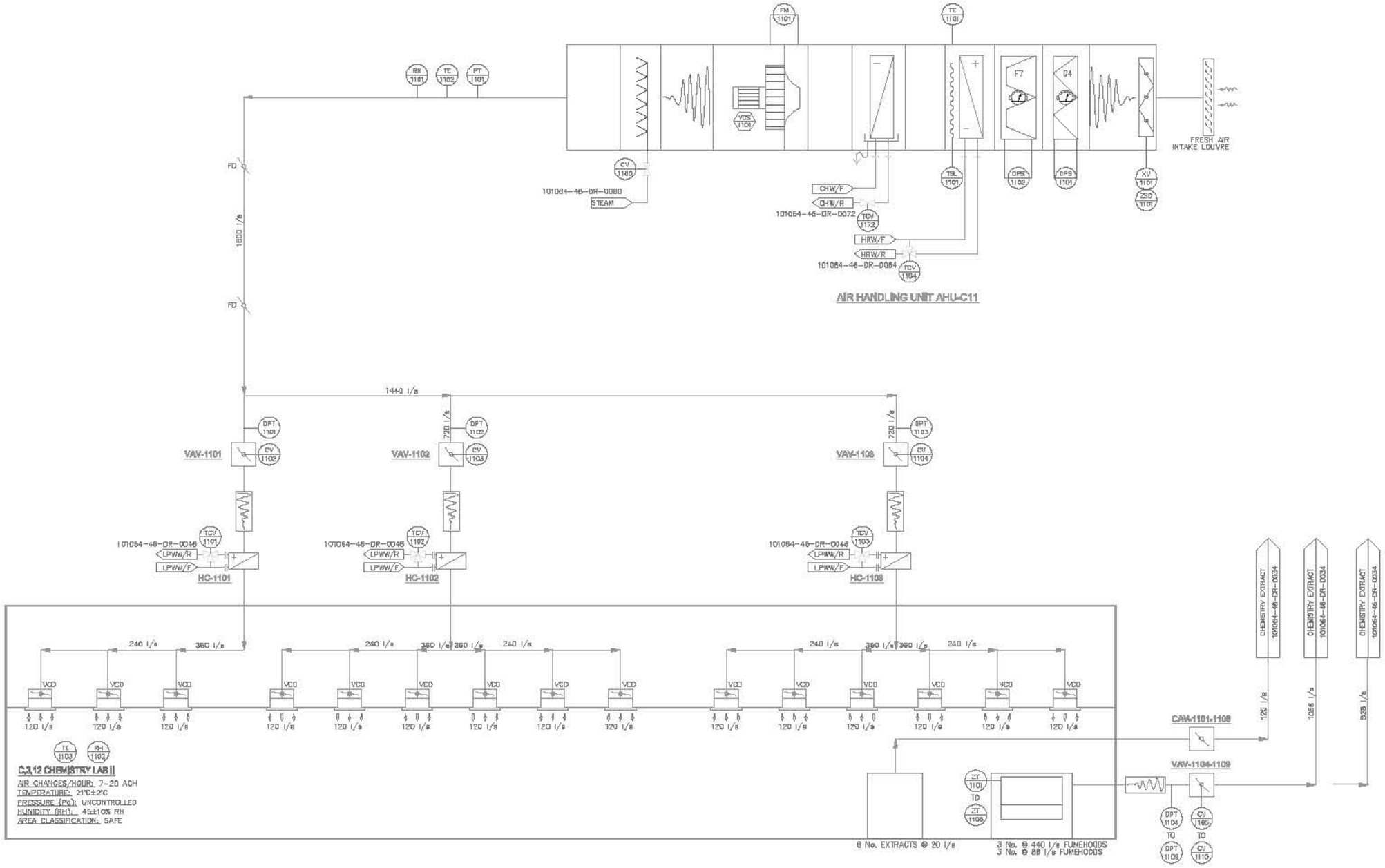


Figure B 5 - Air Flow Schematic – AHU System

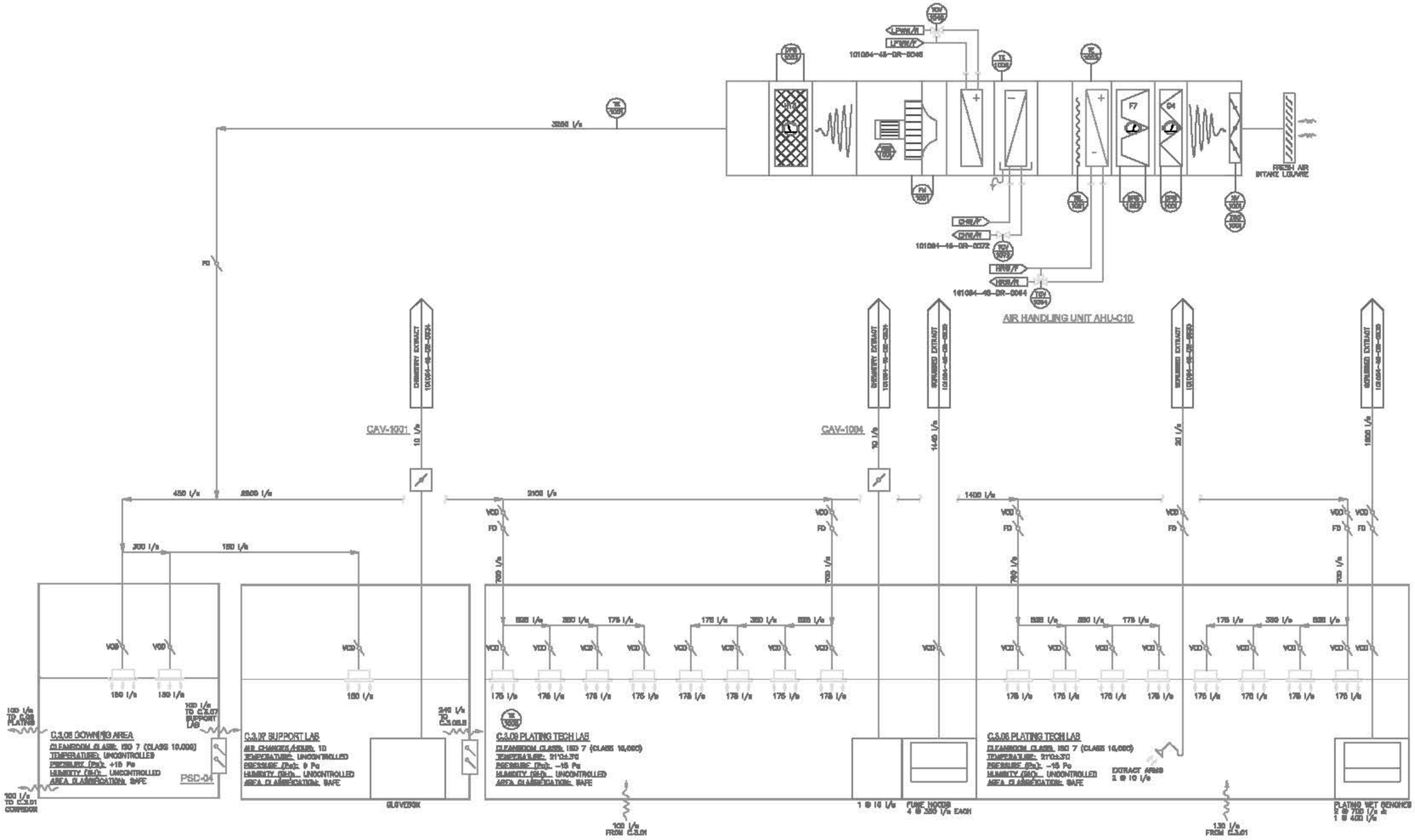


Figure B 6 - Air Flow Schematic – AHU System

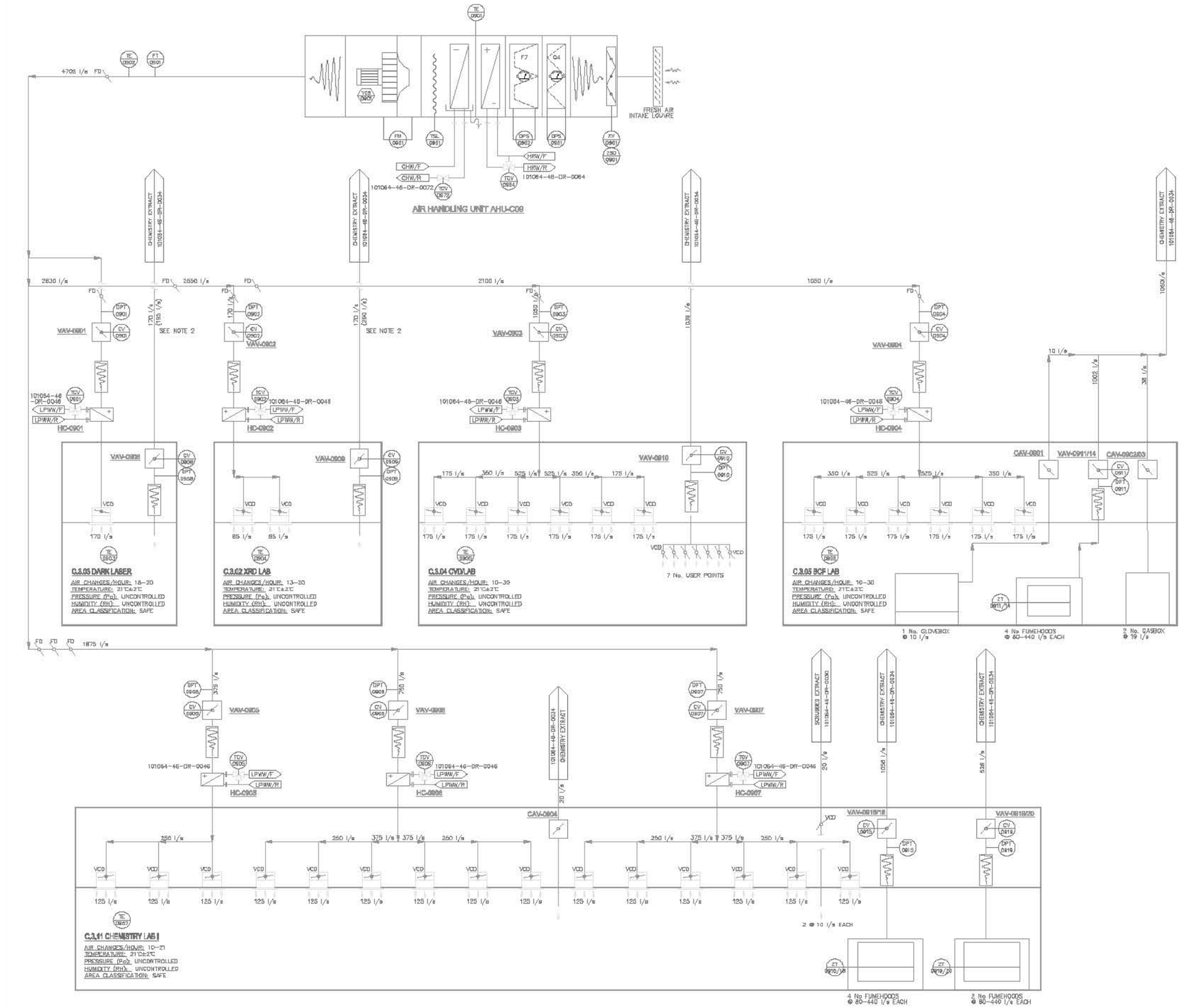


Figure B 7 - Air Flow Schematic – AHU System

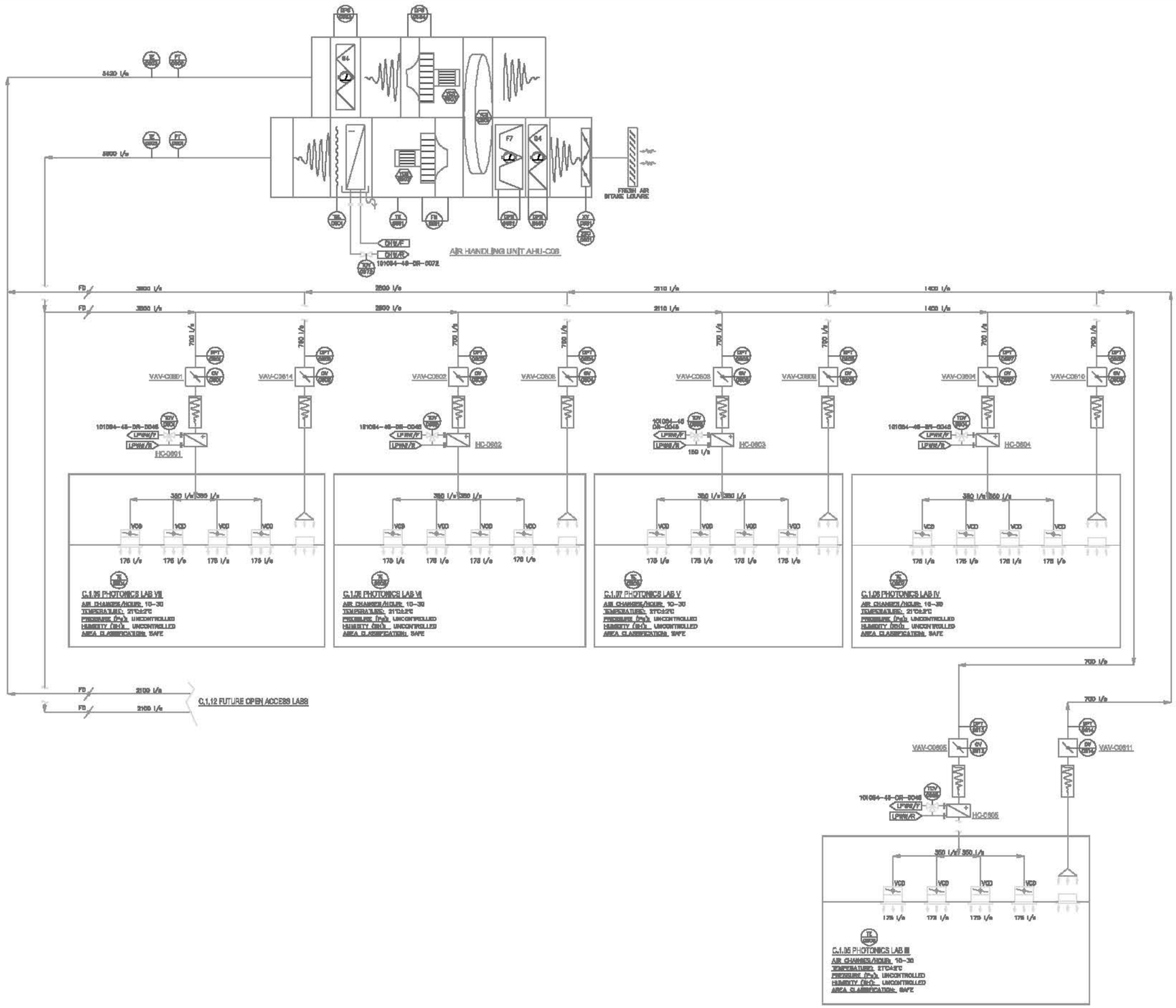


Figure B 8 - Air Flow Schematic – AHU System

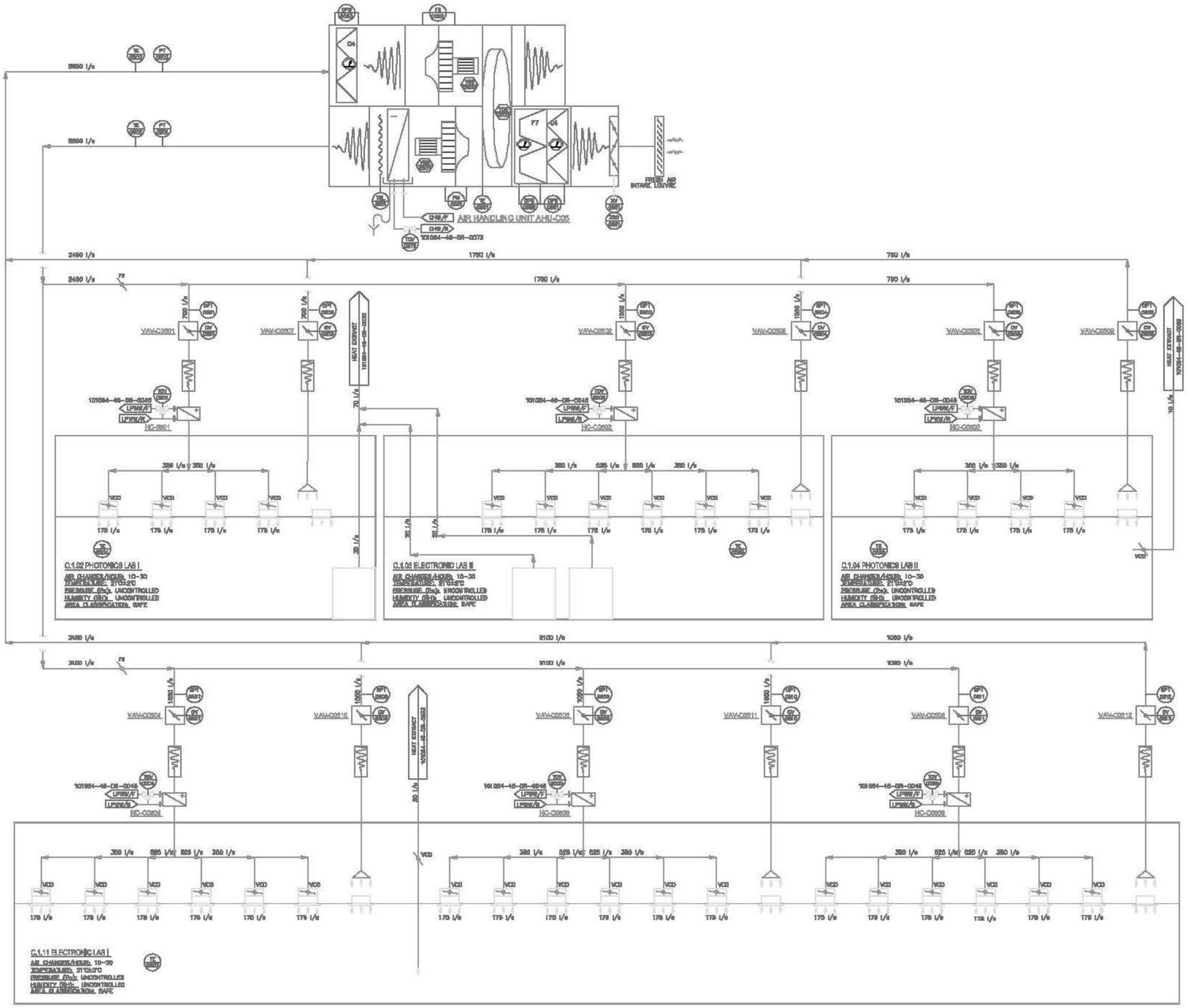


Figure B 9 - Air Flow Schematic – AHU System

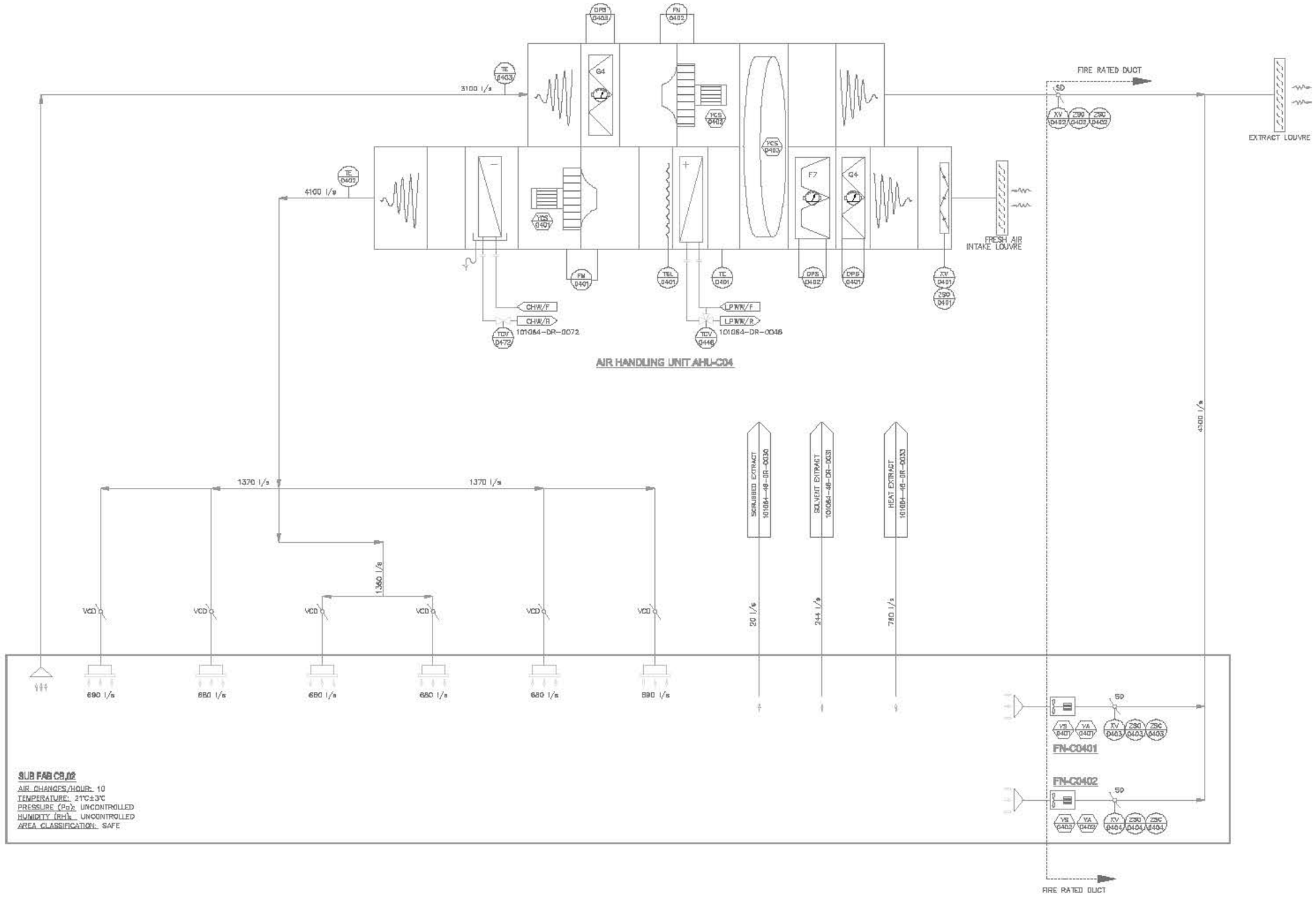


Figure B 10 - Air Flow Schematic – AHU System

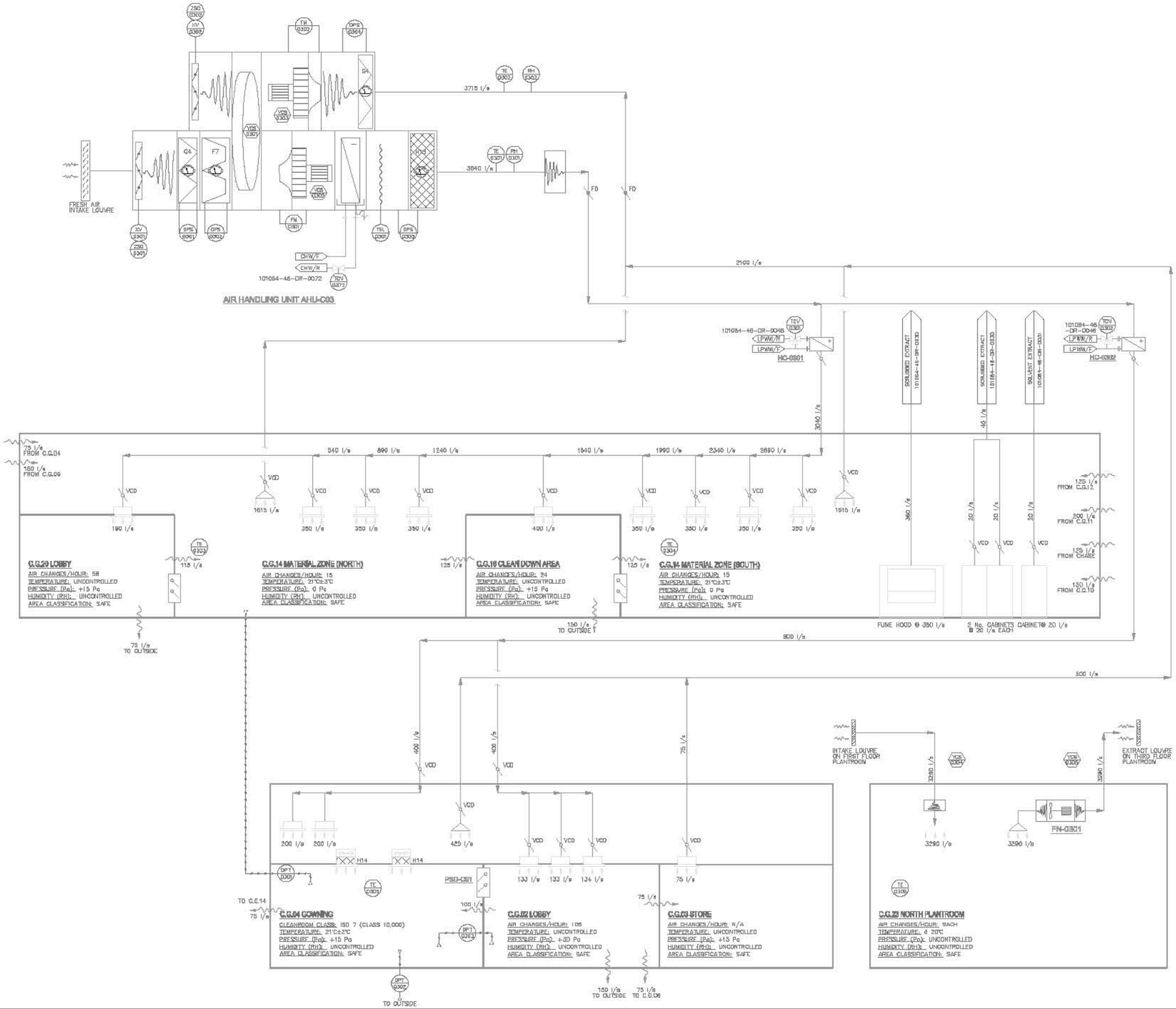


Figure B 11 - Air Flow Schematic – AHU System

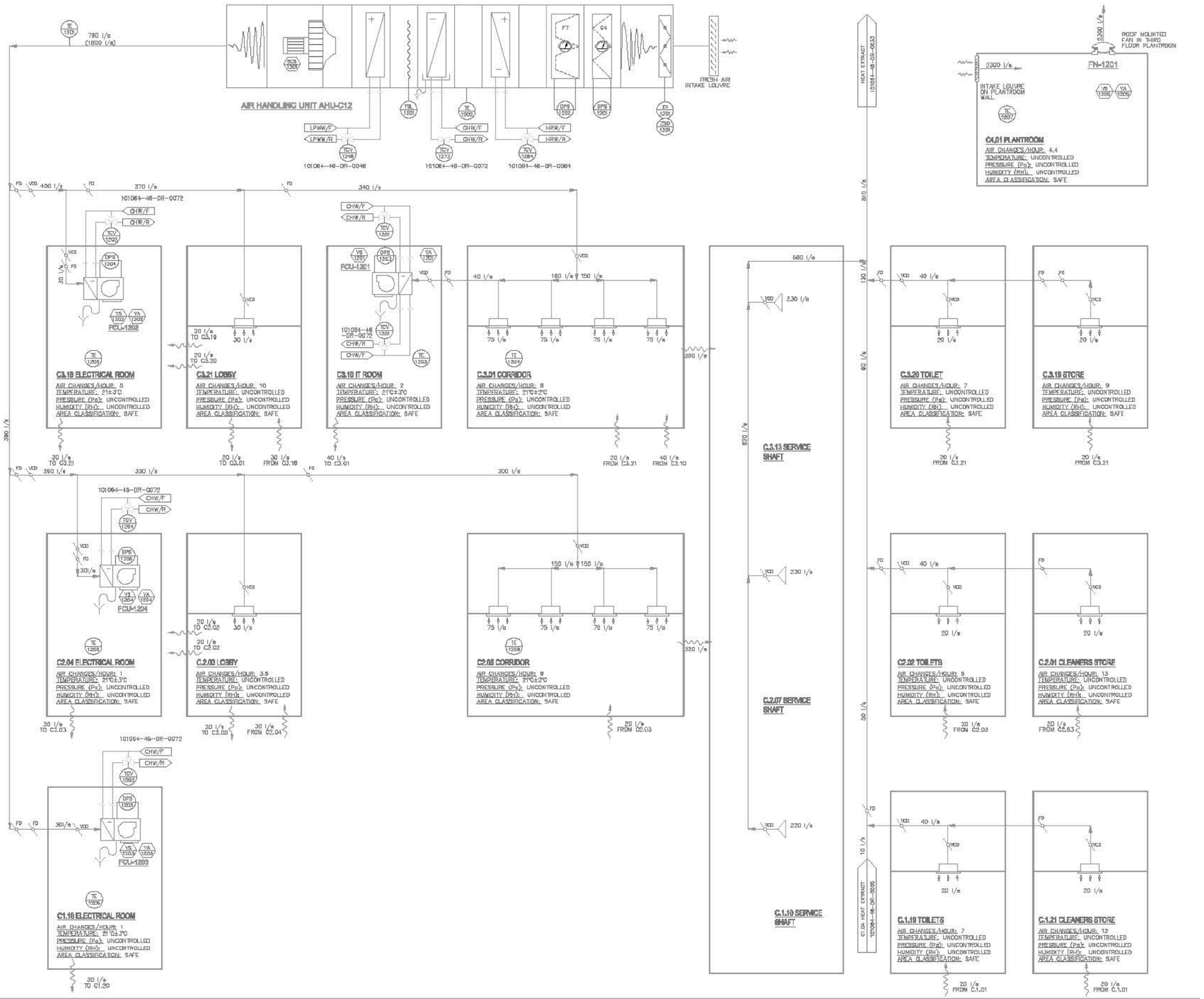


Figure B 12 - Air Flow Schematic – AHU System