

Stage 4 : TECHNICAL DESIGN

RIBA summary of Stage 4

“The architectural, building services and structural engineering designs are now further refined to provide technical definition of the project and the design work of specialist subcontractors is developed and concluded. The level of detail produced by each designer will depend on whether the construction on site will be built in accordance with the information produced by the design team or based on information developed by a specialist subcontractor. The Design Responsibility Matrix sets out how these key design interfaces will be managed.

Using the design coordinated during the previous stage, the designers should now be able to develop their Technical Designs independently, with a degree of autonomy. The lead designer will provide input to certain aspects, including a review of each designer’s work.

Once the work of the design team has been progressed to the appropriate level of detail, as defined in the Design Responsibility Matrix and the Design Programme, specialist subcontractors and/or suppliers undertaking design work will be able to progress their design work. The lead designer and other designers, where required as part of their Schedule of Services, may have duties to review this design information and to ensure that specialist subcontractor design work is integrated with the coordinated design.

By the end of this stage, all aspects of the design will be completed, apart from minor queries arising from the site during the construction stage. In many projects, Stage 4 and 5 work occurs concurrently, particularly the specialist subcontractor design aspects.”

BSRIA summary of proforma 4

Proforma 4 covers the whole of the building services technical design. This is advanced through detailed calculations or modelling to arrive at an engineering design and layout for each service from which coordination and installation are feasible. The building service design is then/also coordinated to remove all critical clashes (see definition in section 2.5). Where there is no building services contractor selected, the design will use generic or typical components, that may be substituted during equipment procurement, or specified components where no such “equal or equivalent” substitution is to be permitted. Where a building services contractor has been appointed, it is likely that final coordination will take place using plant and components that have been or are going to be procured by the building services contractor during Stage 5. Section 2.4 provides additional guidance. Proforma 4 also covers technical design by specialists/ trade contractors and this is likely to run in parallel with Stage 5. If changes are made after Stage 5 has started then the coordination of the design has to be re-checked. Depending on the procurement route being used, it may not be necessary or appropriate to produce all the different model/drawing deliverables listed in the proforma.

PROFORMA 4: TECHNICAL DESIGN (RIBA STAGE 4)								
Some activities in RIBA Stage 4 may continue after the start of the project's construction stage.								
Ref	Design activity in connection with building services	Allocated to ...						Comments
		L=Lead, S=Support, R=Review						
		A	B	C	D	E	Z	
	General obligations, external liaison (statutory bodies, utilities)							
4.1.1	Carry out ongoing checks for compliance with regulations.							
4.1.2	Advise on impact of any changes from scheme used to calculate the Building Emissions Rate for Building Regulations energy compliance and (if relevant) EPC.						Could be same party that led earlier calculation	
4.1.3	Provide information for pre-site building control approval.							
4.1.4	Obtain final quotations for incoming services based on final agreed building loads.						Define extent of incoming services	
4.1.5	Seek utility company comments on the spatial requirements and builders' work associated with the provision of incoming services.							
	Client liaison (briefing, handover, surveys)							
4.2.1	Prepare the building services Employers Information Requirements in accordance with PAS 1192-2.						As per PAS 1192-2	
4.2.2	Prepare pre-contract BIM Execution Plan for building services installation (as required by procurement route).						As per PAS 1192-2	
4.2.3	Advise on an appropriate method of procuring maintenance expertise.							
4.2.4	Define the scope and content of operating and maintenance manuals appropriate for the project.							
4.2.5	Review the design against operational design targets, involving the future building manager(s) and update/reissue design reports, specifications and/or Soft Landings reports.							
4.2.6	Define the requirement for handover information.							
4.2.7	Specify form of delivery and method of production of handover information.						Take account of any phased handover or partial possession	
4.2.8	Prior to commencement of works, prepare method statement for the maintenance of existing services.							
	Team liaison (builders' work, spatial coordination, energy targeting)							
4.3.1	Undertake checks in relation to Building Regulations energy performance compliance and (if relevant) EPC criteria.							
4.3.2	Review proposals from others in relation to Building Regulations energy performance compliance and (if relevant) EPC criteria.							
4.3.3	Review dimensional and other numerical tolerances to be applied to building services design and deliverables at different project stages.							

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4.3.4	Make submissions to obtain Building Regulations approval in relation to energy performance.							
4.3.5	Design weatherproofing details for all services passing through external elements of the building.							
4.3.6	Provide typical details for all acoustic stopping for services penetrating builders' work elements.							
4.3.7	Develop and update BIM Execution Plan during project.							As per PAS 1192-2
4.3.8	Develop and update building services Task Information Delivery Plan.							As per PAS 1192-2
4.3.9	Develop and update Master Information Delivery Plan during project.							As per PAS 1192-2
4.3.10	Federate information models from separate task teams and oversee the clash avoidance process.							As per PAS 1192-2
4.3.11	Carry out project-wide design review of feasible-generic design.							See section 3.8 of BG 6
4.3.12	Agree the principles relating to reflected ceiling plans.							
4.3.13	Carry out Stage 4 coordination between building services, structure and architecture prior to selection or procurement of actual equipment. (Feasible for building services contractor/trade-contractor pricing and installation without major re-routing).							Major spaces: plant rooms, risers, ceiling and floor voids. Removal of critical clashes – see section 2.5 of BG 6
4.3.14	Carry out Stage 4 coordination between different building services prior to selection or procurement of actual equipment. (Feasible for building services contractor/trade contractor pricing and installation without major re-routing).							Removal of critical clashes – see section 2.5 of BG 6
4.3.15	Consider requirements for cable pulling (routes and anchor points).							
4.3.16	Review design risk assessments incorporating specialist design input.							Specify extent of risk assessments (H&S, technical, commercial)
4.3.17	Check the provision for and adequacy of builders' work information provided for specialist elements (including CDP).							
4.3.18	Select and detail sleeves, inserts, frames, and fixing anchors, and any other items required to be cast or built into the structures by others, including coordination of positions to such extent and accuracy to allow structural construction to proceed.							
4.3.19	Detail and coordinate all access platforms, stairs, rails and protection elements required for future maintenance and operation of plant/equipment.							

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		A	B	C	D	E	Z	
4.3.20	Carry out final detailed location and dimensioning of 2nd fix equipment based on architectural information.							State extent (luminaires, control devices, outlets, and grilles)
4.3.21	Determine location of access panels.							For example, rodding eyes and pipework valves
4.3.22	Carry out project-wide design review of coordinated-generic design.							See section 3.8 of BG 6
4.3.23	Confirm builders' work information for specified equipment or materials, or where alternatives to those provisionally or pre-selected are agreed.							Bases, supports and structurally significant holes
4.3.24	Provide final details for all acoustic stopping for services penetrating builders' work elements.							
4.3.25	Carry out Stage 4 coordination between all building services trade contractors after the selection or procurement of actual equipment.							Removal of critical clashes – see section 2.5 of BG 6
4.3.26	Carry out Stage 4 coordination between the building services, structure and architecture after the selection or procurement of actual equipment.							Removal of critical clashes – see section 2.5 of BG 6
4.3.27	Prepare detailed construction programme for installation and remaining design activities.							
4.3.28	Carry out project-wide design review of coordinated-specific design.							See section 3.8 of BG 6
	Selection of plant and specialist designers							
4.4.1	Develop initial technical design for systems to be procured as Contractor Design Portions (where building services contractor not already appointed).							
4.4.2	Advise of significant allowances or constraints incorporated in the main design that may affect the specialist design.							
4.4.3	Obtain indicative quotations for plant not requiring specialist design.							
4.4.4	Review that all plant and equipment incorporated into the works can be safely maintained and accessed in compliance with current legislation.							
4.4.5	Check plant and system sizing once Stage 4 coordination of the works has been undertaken with selected or procured equipment (4.3.25).							Removal of critical clashes – see section 2.5 of BG 6
4.4.6	Select plant, equipment, components and material to meet the specified performance. Where items or manufacturers differ from provisional selections ensure they are fully compatible with all the other system parameters, components and design requirements.							
4.4.7	Advise whether the proposed alternative items or manufacturers comply with the selection criteria.							

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		A	B	C	D	E	Z	
4.4.8	Advise whether the proposed alternative items or manufacturers are acceptable.							
4.4.9	Re-evaluate all parts of the services design which may be affected by acceptance of alternative items or manufacturers.							
4.4.10	Re-evaluate all parts of the architectural or structural design which may be affected by acceptance of alternative items or manufacturers.							
4.4.11	Amend the building services design to incorporate agreed alternative items or manufacturers.							
4.4.12	Prior to confirming agreed final fixed costs with the client, agree final equipment selections and manufacturers.							
4.4.13	Monitor the specialist design input for compliance with the design intent.							
4.4.14	Evaluate the impact of the specialist design on those parts of the overall design that are provisional.							
4.4.15	Monitor the ongoing progress of the procurement, manufacture, installation and commissioning of all plant items.							
4.4.16	Review all plant and equipment incorporated into the works with respect to safe maintenance and access in compliance with current legislation.							
	Mechanical design							
4.5.1	Determine parameters of flues to incorporate the requirements of the plant manufacturer, building control, environmental health officer and current legislation such as the Clean Air Act.							
4.5.2	Finalise detailed design calculations for all mechanical services being included in the technical design in accordance with recognised national standards.							See Appendix B for specific services
4.5.3	Determine detailed flue, duct and pipe sizes and routes.							
4.5.4	Following equipment procurement, modify distribution systems and equipment capacities as may be required as a result of coordination (4.3.25).							
4.5.5	Design all necessary facilities for flushing, and commissioning.							
4.5.6	Size, select and determine final locations of commissioning sets based on coordination of procured equipment (4.3.25).							
4.5.7	Carry out final sizing of sections of ductwork between terminal units and diffusers to ensure the specified acoustic criteria and duct velocities.							

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4.5.8	Carry out final detailing and confirm the location and sizes of duct connections to external louvres.							
4.5.9	Carry out detailed design of anchors, guides and other provision for movement of services and systems due to thermal expansion and contraction and building movement.							
4.5.10	Check fan and pump system resistances based on coordination of procured equipment (4.3.25).							Suggest checker is independent person from selector
4.5.11	Check system water capacities and quantities of chemical additives based on the final equipment selection.							Suggest checker is independent person from selector
4.5.12	Carry out final detailing of drain and vent points.							
4.5.13	Carry out final selection of all terminal devices.							
4.5.14	Carry out final selection of pressurisation units and expansion vessels.							
4.5.15	Detailed design and sizing of refrigerant pipework between items of equipment provided under the contract works based on the final equipment selection and coordinated working drawings.							
4.5.16	Select and confirm location of fire dampers and any other fire-stopping for mechanical systems.							
4.5.17	Select and confirm location of control dampers and control valves to achieve the specified function and to suit the characteristics of items served and final system configurations based on the final equipment selection and coordinated working drawings.							
4.5.18	Carry out final selection of control valves to suit pipework and authority of controls based on final installation drawings.							
4.5.19	Carry out final selection of all anti-vibration mountings.							
4.5.20	Design review.							See section 3.8 of BG 6
	Electrical design							
4.6.1	Finalise detailed design calculations for all electrical services being included in the technical design in accordance with recognised national standards.							See Appendix B for specific services
4.6.2	Determine detailed cable and containment sizes, switchgear sizes and locations, control panel locations, user equipment sizes and locations, and sensor locations for small power, lighting, high voltage systems, and metering.							

PROFORMA 4: TECHNICAL DESIGN (RIBA STAGE 4)

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		A	B	C	D	E	Z	
4.6.3	Determine approximate sensor locations, control panel locations for fire safety and security systems.							
4.6.4	Design automatic controls systems as required to meet the operational, functional and spatial requirements of the specification.							
4.6.5	Determine control strategy for lighting.							
4.6.6	Design fixing, connection, earthing and bonding details as required for final installation of lightning protection systems.							
4.6.7	Modify distribution systems and equipment capacities as may be required as a result of Stage 4 coordination with intended or procured equipment.							
4.6.8	Verify spatial requirements for cable pulling and installation.							
4.6.9	Verify cable sizes for primary electrical supply based on coordination of procured equipment (4.3.25) and cable lengths.							
4.6.10	Verify cable sizes for specialist systems based on coordination of procured equipment (4.3.25) and cable lengths.							Such as fire alarm, datacomms, CCTV, and access control
4.6.11	Select and confirm location of fire-stopping for electrical systems.							
4.6.12	Check control panel cable entry and exits are possible in the final location and that safe operating and maintenance clearances are provided.							
4.6.13	Check compatibility of building services plant and equipment with the controls systems.							
4.6.14	Carry out design and incorporation of all interfaces (including relays or other devices or modifications to hardware or software).							
4.6.15	Incorporate final information for electrical systems into the design via schedules or BIM objects, including control addresses for lighting and fire alarm systems, BMS points.							
4.6.16	Design review.							See section 3.8 of BG 6
	Public health design							
4.7.1	Finalise detailed design calculations for all public health services being included in the technical design in accordance with recognised national standards.							See Appendix B for specific services
4.7.2	Determine detailed pipe sizes and routes for gravity and pumped drainage systems.							
4.7.3	Determine final positions of cast-in drainage gullies ensuring coordination with structural design and final mechanical plant locations.							

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		A	B	C	D	E	Z	
4.7.4	Finalise vent termination locations to coordinate around final AHU and air vent intake positions.							
4.7.5	Determine final power, BMS and Controls interface requirements from equipment.							
4.7.6	Coordinate all surface water domestic and waste water pipework rodding eye locations with other services, structural and architectural elements to ensure suitable maintenance access can be provided.							
4.7.7	Verify storm water discharge flow rate satisfies planning and statutory authority requirements including SuDS.							
4.7.8	Determine detailed routing of pipework and drainage to/from risers.							
4.7.9	Carry out detailed design of pipework gradients for builders' work and coordination.						Includes domestic and waste drainage (gravity/pumped), surface drainage and condensate runs	
4.7.10	Modify distribution systems and equipment capacities as may be required based on coordination of procured equipment (4.3.25).							
4.7.11	Make allowance for anchors, guides and provision for movement of services and systems due to thermal expansion and contraction and building movement.							
4.7.12	Select and confirm location of fire collars and any other fire-stopping for public health systems.							
4.7.13	Check all surface water, domestic and waste drainage discharge flow rates with external civils interface package.							
4.7.14	Check all utility interface details (locations, pipe sizes and invert levels) with civils package to ensure internal and external services coordinate.							
4.7.15	Design review.						See section 3.8 of BG 6	
	Commissioning							
4.8.1	Review all designs to ensure that systems are commissionable.							
4.8.2	Determine witnessing and commissioning requirements for items installed on site.						Other than those covered by 3.8.2	
4.8.3	Identify and incorporate into system designs the essential components and features necessary to enable the proper commissioning of building services (including preparation).						For example, including test points	
4.8.4	Review the commissioning plan.							
4.8.5	Update the commissioning plan.							
4.8.6	Review proposals and method statements from prospective commissioning specialist(s).							

PROFORMA 4: TECHNICAL DESIGN (RIBA STAGE 4)

Some activities in RIBA Stage 4 may continue after the start of the project's construction stage.

Ref	Design activity in connection with building services	Allocated to ... L=Lead, S=Support, R=Review						Comments
		A	B	C	D	E	Z	
4.8.7	Finalise location of test points.							
4.8.8	Appoint an independent specialist commissioning contractor responsible for testing and commissioning.							See also 3.8.4
	Deliverables – including drawings, specifications, reports							
4.9.1	Provide a technical design report up to the level of feasible-generic components and equipment, as an update to the Developed Design Stage 3 report							
4.9.2	Provide health and safety risk assessments for the design.							
4.9.3	Provide an approximate cost plan using feasible-generic components and equipment for mechanical, electrical and public health services based on floor area, building type and typical system type or other agreed approximate methodology.							
4.9.4	Provide any information that is required in connection with any application for planning permission including reviews and/or appeals where applicable.							
4.9.5	Provide updated estimate of regulated [RP] in-use energy consumption.							
4.9.6	Provide updated assessment of comfort conditions and overheating risk							
4.9.7	Provide updated report on adequacy of existing mechanical, electrical and public health services to incorporate extended or refurbished works.							Agree level of further intrusion and physical testing if applicable
4.9.8	Provide technical design or performance information and specifications to modify, refurbish or replace existing mechanical, electrical and public health engineering services and plant to incorporate new and extended engineering services.							
4.9.9	Provide tender documentation for inclusion in a tender package if the procurement method requires it.							See also 2.9.6 and 3.9.24
4.9.10	Provide report on proposals or agreed outcomes following participation in any Soft Landings process.							
4.9.11	Provide information for detailed whole-life cost studies.							
4.9.12	Provide information to the Environmental Assessment Method Assessor to allow credits to be checked and awarded.							
4.9.13	Provide specifications for final commissioning and handover.							
4.9.14	Provide detailed commissioning plan.							
4.9.15	Provide information for Construction Phase Plan as per CDM Regulations.							

PROFORMA 4: TECHNICAL DESIGN (RIBA STAGE 4)

Some activities in RIBA Stage 4 may continue after the start of the project's construction stage.

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		A	B	C	D	E	Z	
4.9.16	Provide calculations and/or software files as evidence of Technical Design model and/or drawings.							Agree format
4.9.17	Provide schedules to cross-reference cables to containment systems.							
4.9.18	Provide technical design model in line with defined level of clash resolution and agreed tolerances.							Using generic objects, feasible to price and to install without major re-routing
4.9.19	Provide Technical Design drawings.							
4.9.20	Provide Technical Design schematics.							
4.9.21	Provide updated schedule/drawings of builders' work information based on technical design information.							
4.9.22	Produce materials and workmanship specifications.							
4.9.23	Produce performance specifications for specialist designed elements of the works.							
4.9.24	Produce equipment schedules.							
4.9.25	Provide design stage information towards log book and/or building user guide(s).							
4.9.26	Provide mechanical, electrical and public health information necessary to obtain statutory approvals.							
4.9.27	Provide detailed specifications for mechanical, electrical, public health services, if relevant.							
4.9.28	Sign off detailed specifications.							
4.9.29	Contribute to draft construction programme for the project.							
4.9.30	Produce Construction Phase Plan before work starts on site, as per CDM Regulations.							
4.9.31	Provide updated Technical Design model.							Using generic objects and coordinated to demonstrate resolution of clashes between architecture, structure and services in line with level of clash resolution and agreed tolerances.
4.9.32	Provide building services coordinated working drawings.							State whether for generic or specific (agreed/procured) equipment.
4.9.33	Provide coordinated reflected ceiling plans based on agreed architectural information for all components.							
4.9.34	Provide coordinated room elevations based on agreed architectural information for all components.							

PROFORMA 4: TECHNICAL DESIGN (RIBA STAGE 4)								
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4.9.35	Provide detailed cost plan.							
4.9.36	Provide final construction programme.							
4.9.37	Provide detailed commissioning programme.							
4.9.38	Provide updated Technical Design model with revised or new design details.							Using specific objects and coordinated to demonstrate resolution of clashes between architecture, structure and services in line with level of clash resolution and agreed tolerances.
4.9.39	Provide report on the specialist designers' proposals within the main contract.							
4.9.40	Provide a report in consideration of any alternative plant, equipment, and component selections.							
4.9.41	Provide calculations and/or software files in support of specialist design proposals.							
	Amended and additional activity descriptions							
4.10.1	<insert text here>							

Model definition: Technical Design model

The technical design model can be developed to one or more levels of definition during Stage 4, to suit the chosen procurement route. If a client wishes a designer to deliver a coordinated-generic object model but not the preceding feasible-generic object model then this has to be clearly indicated in pro-forma 4 and/or Appendix B.

Tolerances for technical design models should be agreed between the recipient and the author before technical design starts, with reference to other members of the project team as appropriate.

Not all the model variants defined below need to be delivered. This will be decided depending on the procurement route and the client's requirements.

General definition for **feasible-generic Technical Design model**

A model showing detailed building services designs, with locations and sizes of all items of plant, pipes, ducts and cable containment using generic objects in positions that are feasible for building services contractor and trade contractor pricing and for installation without major re-routing. This is analogous to the level of detail in Technical Design drawings using generic objects.

General definition for **coordinated-generic Technical Design model**

A model showing detailed building services designs, with locations and sizes of all items of plant, pipes, ducts and cable containment using generic objects in positions that have been spatially coordinated between separate engineering services and also with architecture and structure. The model will not show hangers or supports apart from builders' work items. This is analogous to the level of detail in Coordinated working drawings, but using generic objects.

General definition for **coordinated-specific Technical Design model**

A model showing detailed building services designs, with precise locations and sizes of all items of plant, pipes, ducts and cable containment using specific objects representing actual intended or procured plant and equipment in positions that have been spatially coordinated between separate engineering services and also with architecture and structure. The model will not show hangers or supports apart from builders' work items but spatial allowances should be included. This is analogous to the level of detail in Coordinated working drawings, but using procured or intended objects.

Typical object parameters to add to or substitute for those from Stages 2 and 3 (for generic or specific objects as appropriate) would include:

- Object type/cross-reference to equipment schedule
- Workmanship and materials specifications
- Builders' work information (holes and pockets to be shown as separate from the services equipment or components that pass through or sit in them)
- Location of object (adjacent equipment references)
- System reference
- Operational inputs (energy, pressure, flow rate)
- Operational outputs (heating, cooling, lighting, pressure drop)
- Access / Maintenance / Removal requirements

Typical uses for the model at this stage:

Analysis	The model may be analysed for performance of selected systems by applying specific criteria to the actual model elements (or detailed generic elements where no selection has yet been made)
Costing	The model may be used to develop cost estimates based on detailed quantities and estimated costs of actual or generic elements (including labour, materials, prelims, overheads and profit)
Programme	The model may be used to show the timescale of installation of detailed systems and components.

Drawing definition: Technical Design drawings

Drawings showing the intended locations of plant items and service routes in such detail as to indicate the design. The main features of detailed design drawings should be as follows:

- Plan layouts should be to a scale of at least 1:100. Plant areas should be to a scale of at least 1:50, and should be accompanied by cross-sections and elevations.
- The drawing will not indicate the precise position of services, but it should nevertheless be feasible to install the services within the general routes indicated. It should be possible to produce coordinated working drawings or installation drawings without major re-routing of the services. The design must also consider procurement and installation methodologies.

Drawing definition: Technical Design schematics

Line diagrams describing the interconnection of all components in a system showing the engineering principles. The main features of a Technical Design schematic drawing should be as follows:

- The drawings should include all the functional, sensing, control and measuring components that are to be installed. This includes main plant, distribution, inline equipment, terminal plant and components, control components.
- Symbols and line conventions should be in accordance either with a recognised standard, such as ISO or BS, or a supplied legend.
- The drawings should be labelled with appropriate pipe, duct, busbar, cable sizes and fault levels, pressures and flow rates. These details may be subject to adjustment during construction stage.
- The major components indicated on the schematic drawing should be identified for cross-referencing purposes.
- Where necessary, control methodologies i.e. load shedding and capacity

Drawing definition: Builders' work information

A drawing to show the provisions required to accommodate the engineering services which significantly affect the design of the building structure, fabric and external works. Also drawings (or schedules) of work to be carried out by building trade, and required to be costed at the design stage, such as plant bases.

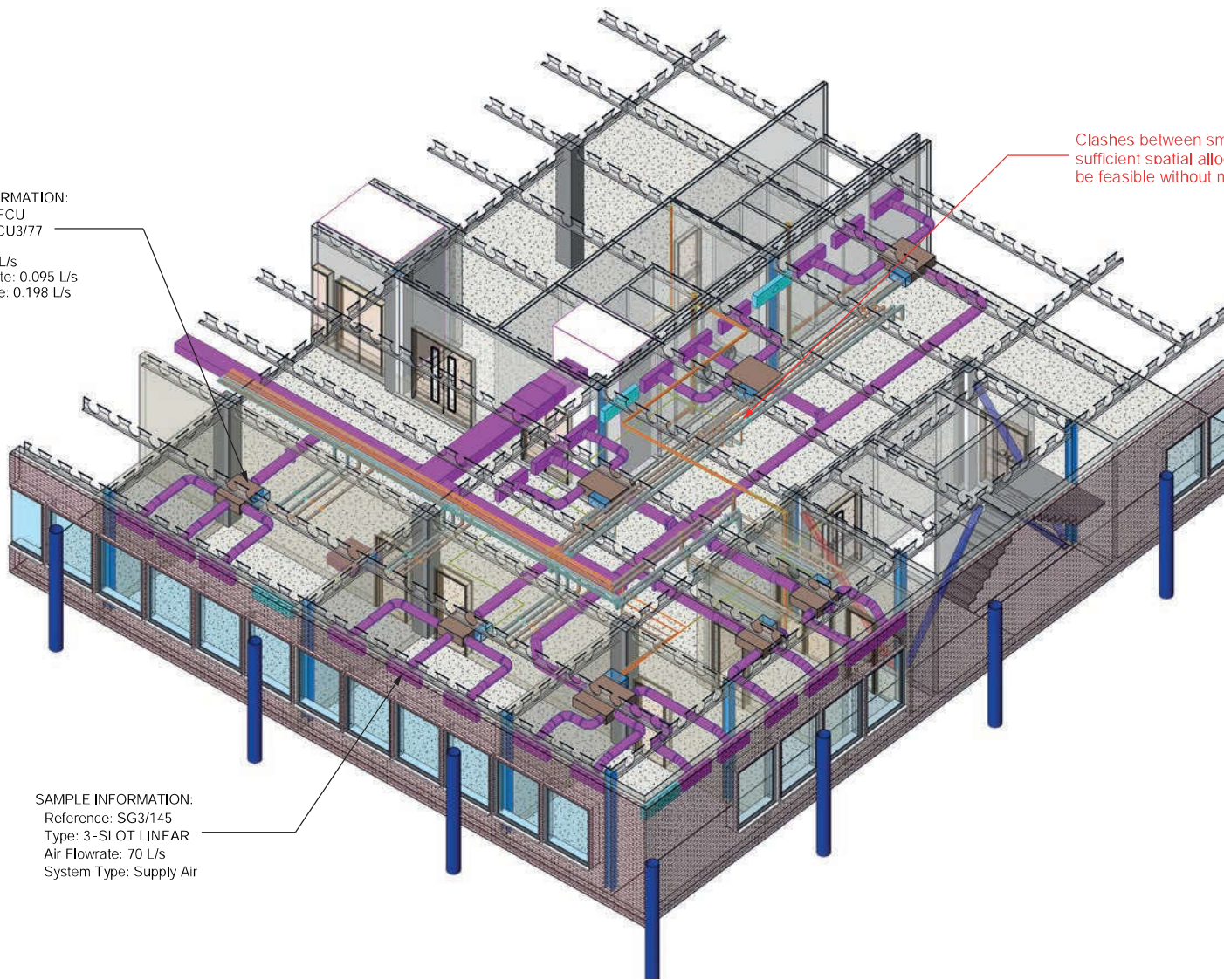
The critical criterion with builders' work information is that it includes all openings (or other provisions) which significantly affect structure, fabric or external works. The minimum dimensions of these openings need to be agreed among the project team.

Drawing definition: Coordinated working drawings

Drawings showing the inter-relationship of two or more engineering services and their relation to the structure, associated specialists and building fabric. The main features of coordinated working drawings should be as follows:

- Plan layouts should be to a scale of at least 1:50 and be accompanied by cross-sections to a scale of at least 1:20 for all congested areas.
- The drawing should make allowance for installation, commissioning, maintenance and replacement working space and methodologies.
- The drawings should be spatially coordinated and there should be no physical clashes between the system components when installed. Critical dimensions, datum levels and invert levels should be provided.
- The spaces between pipe and duct runs shown on the drawing should make allowance for the service at its widest point. Insulation, standard fitting dimensions and joint widths should therefore have been allowed for on the drawing.
- The drawing should indicate positions of main fixing points and supports where they have significance to the structural design or spatial constraints.

SAMPLE INFORMATION:
 Type: A type FCU
 Reference: FCU3/77
 Duty: 8 kW
 Fresh Air: 80 L/s
 LTHW Flowrate: 0.095 L/s
 CHW Flowrate: 0.198 L/s

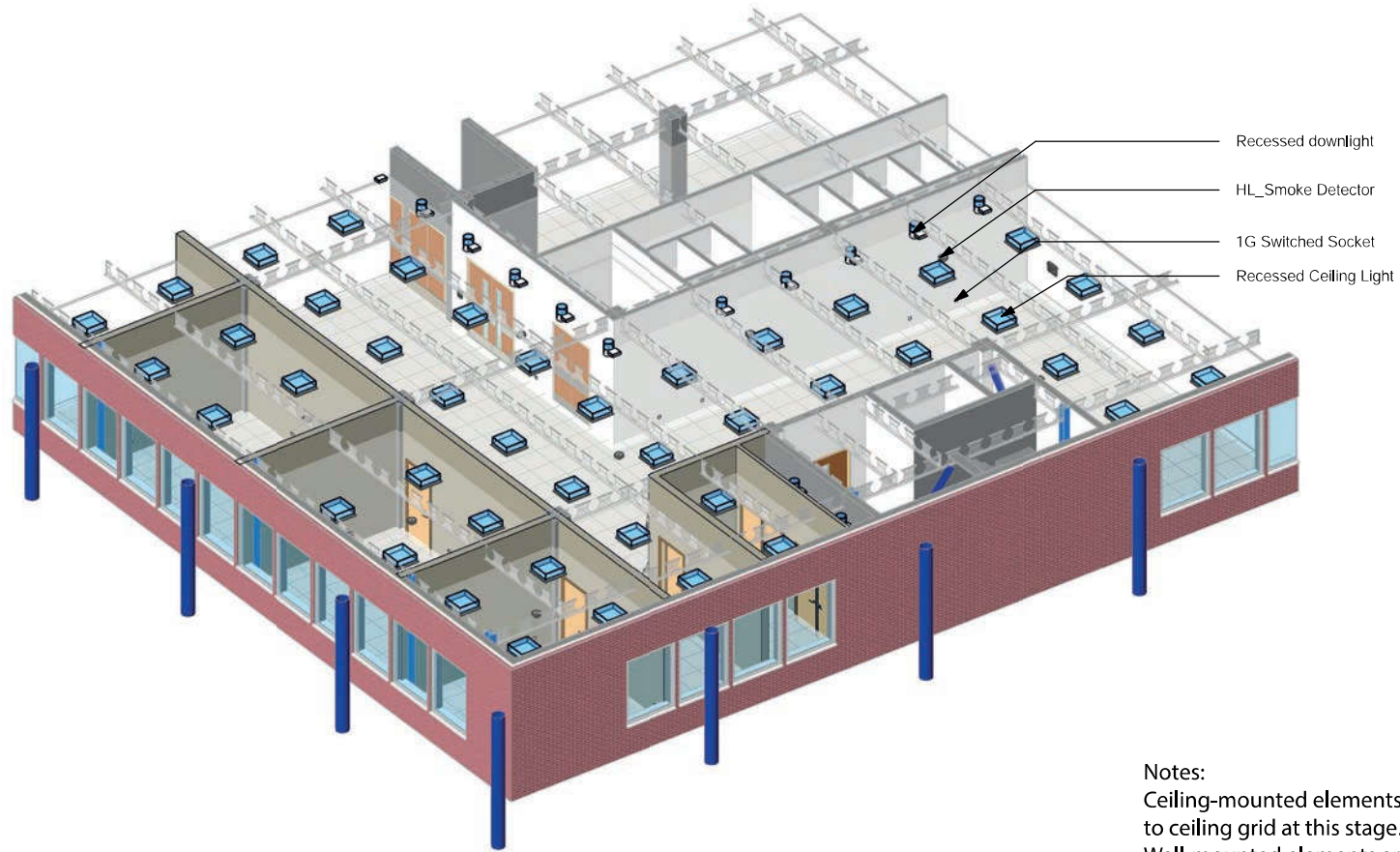


Clashes between small pipework may exist, provided sufficient spatial allocation is proven. Installation must be feasible without major re-routing

SAMPLE INFORMATION:
 Reference: SG3/145
 Type: 3-SLOT LINEAR
 Air Flowrate: 70 L/s
 System Type: Supply Air

STAGE 4 TECHNICAL DESIGN MODEL FEASIBLE-GENERIC MECHANICAL 3D VIEW

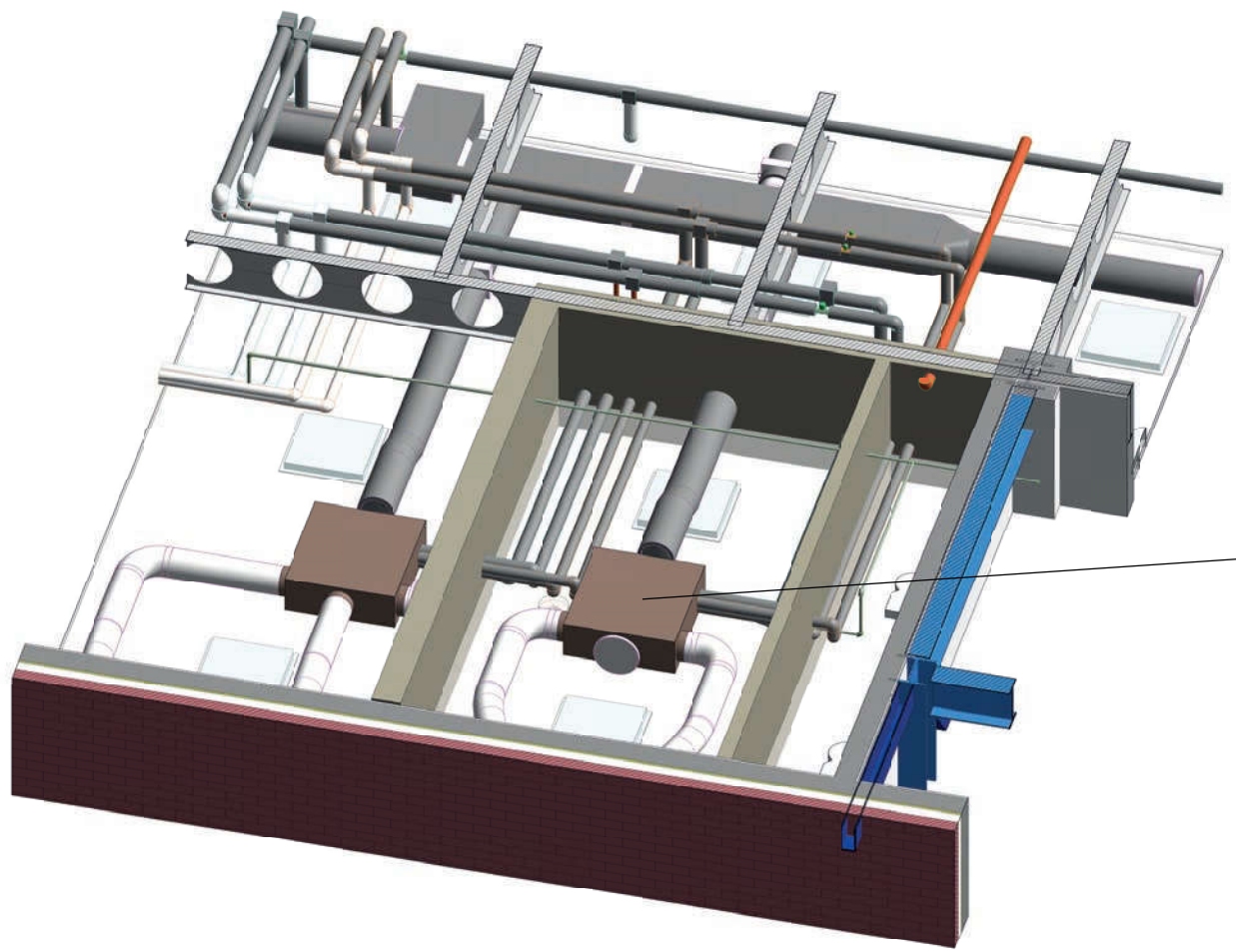




Notes:
Ceiling-mounted elements not aligned to ceiling grid at this stage.
Wall-mounted elements are placed in indicative locations only at this stage.

STAGE 4 TECHNICAL DESIGN MODEL FEASIBLE-GENERIC ELECTRICAL 3D VIEW



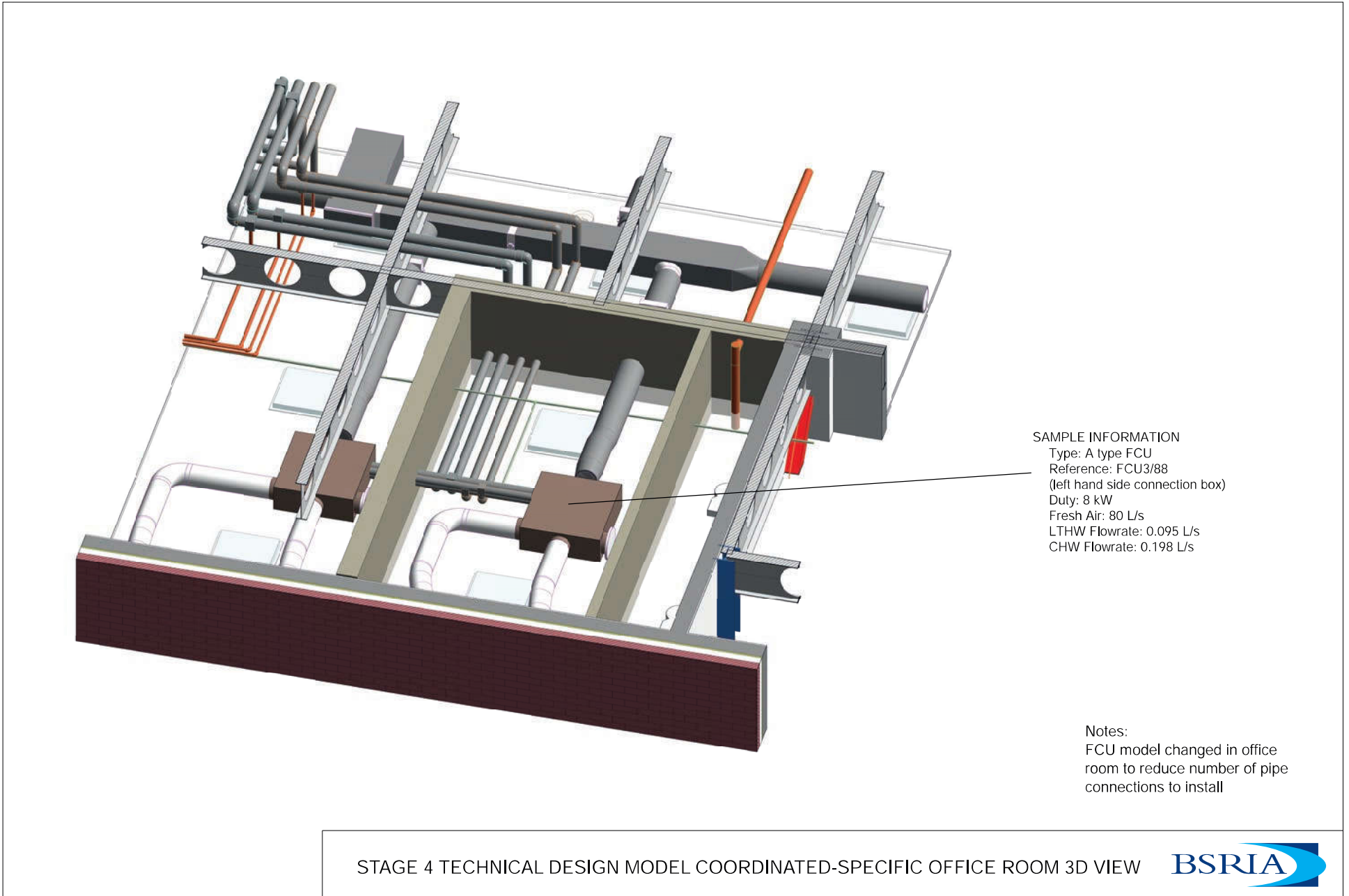


SAMPLE INFORMATION
 Type: A type FCU
 Reference: FCU3/77
 (right hand side connection box)
 Duty: 8 kW
 Fresh Air: 80 L/s
 LTHW Flowrate: 0.095 L/s
 CHW Flowrate: 0.198 L/s

Notes:
 Ceiling mounted elements are aligned to ceiling grid at this stage
 Wall mounted elements are coordinated with wall elevations at this stage

STAGE 4 TECHNICAL DESIGN MODEL COORDINATED-GENERIC OFFICE ROOM 3D VIEW



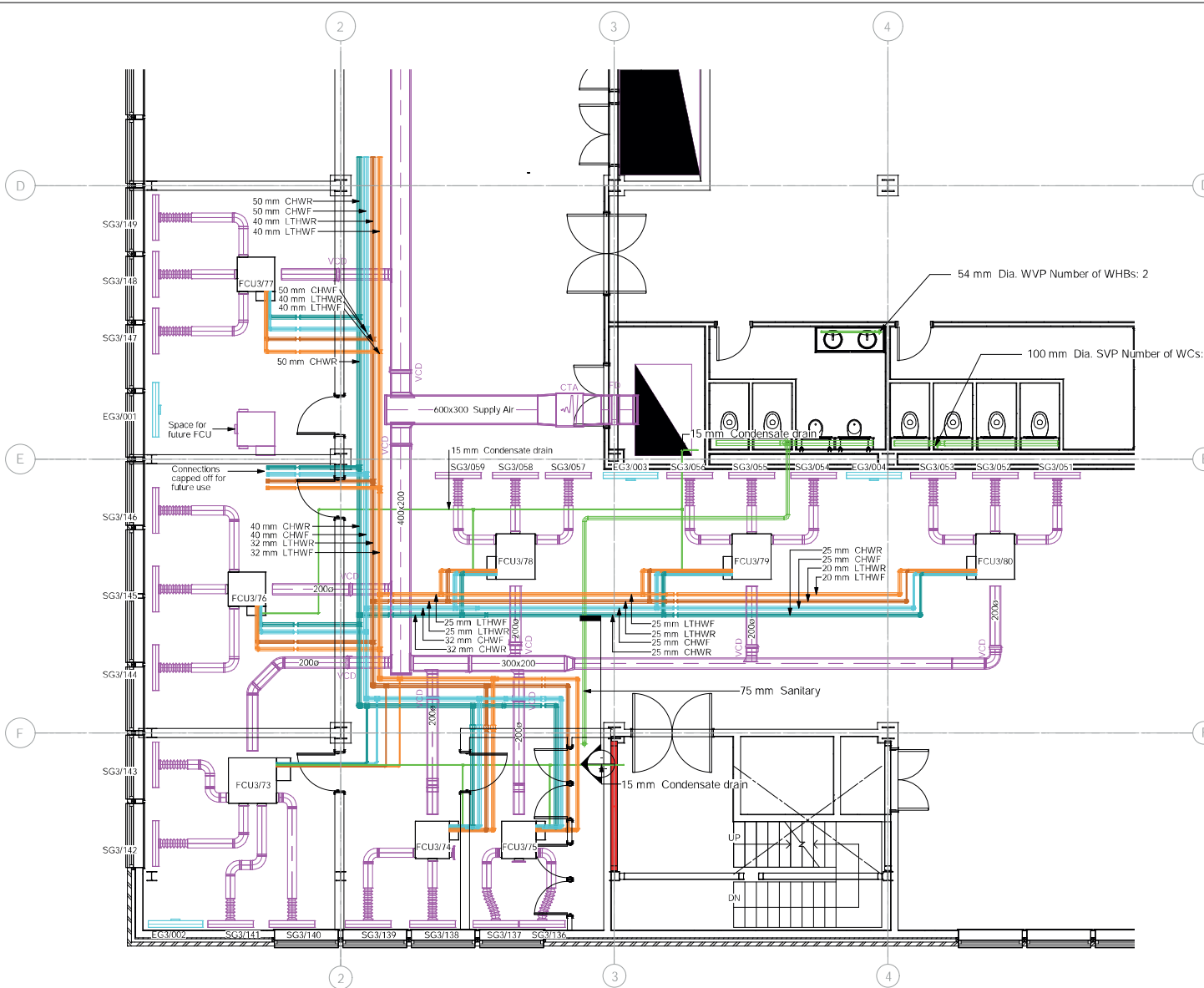


SAMPLE INFORMATION
Type: A type FCU
Reference: FCU3/88
(left hand side connection box)
Duty: 8 kW
Fresh Air: 80 L/s
LTHW Flowrate: 0.095 L/s
CHW Flowrate: 0.198 L/s

Notes:
FCU model changed in office
room to reduce number of pipe
connections to install

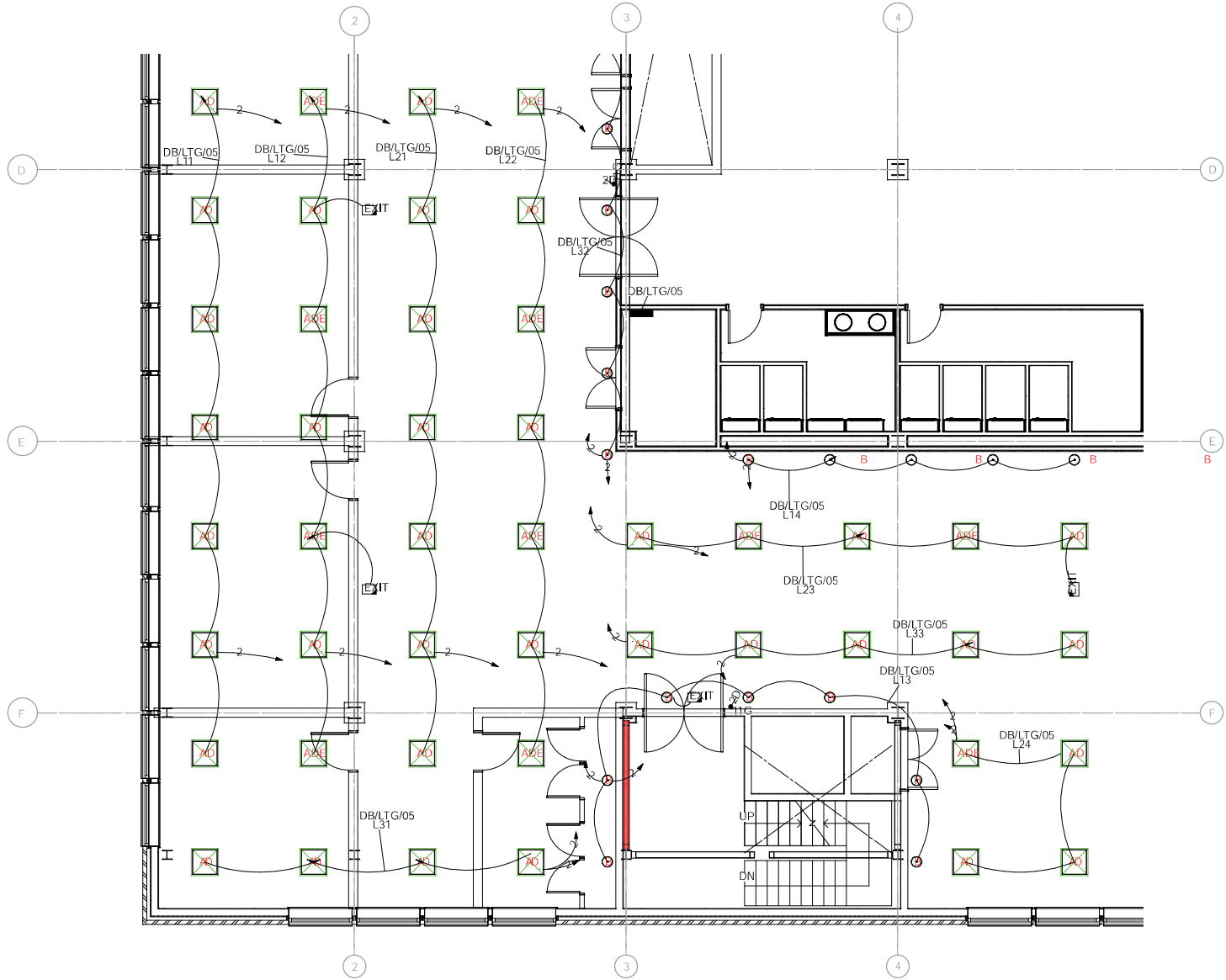
STAGE 4 TECHNICAL DESIGN MODEL COORDINATED-SPECIFIC OFFICE ROOM 3D VIEW





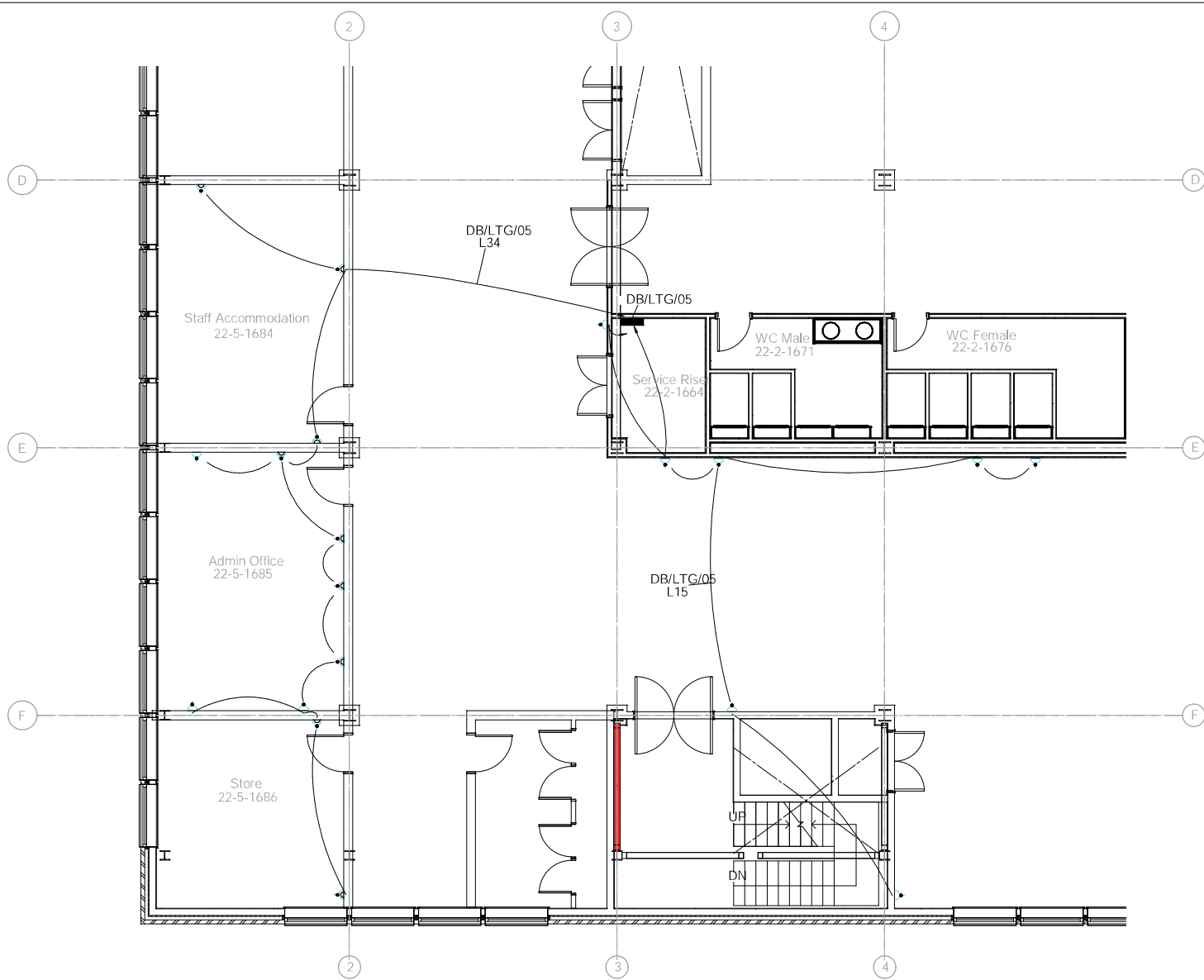
STAGE 4 TECHNICAL DESIGN DRAWING MECHANICAL LAYOUT





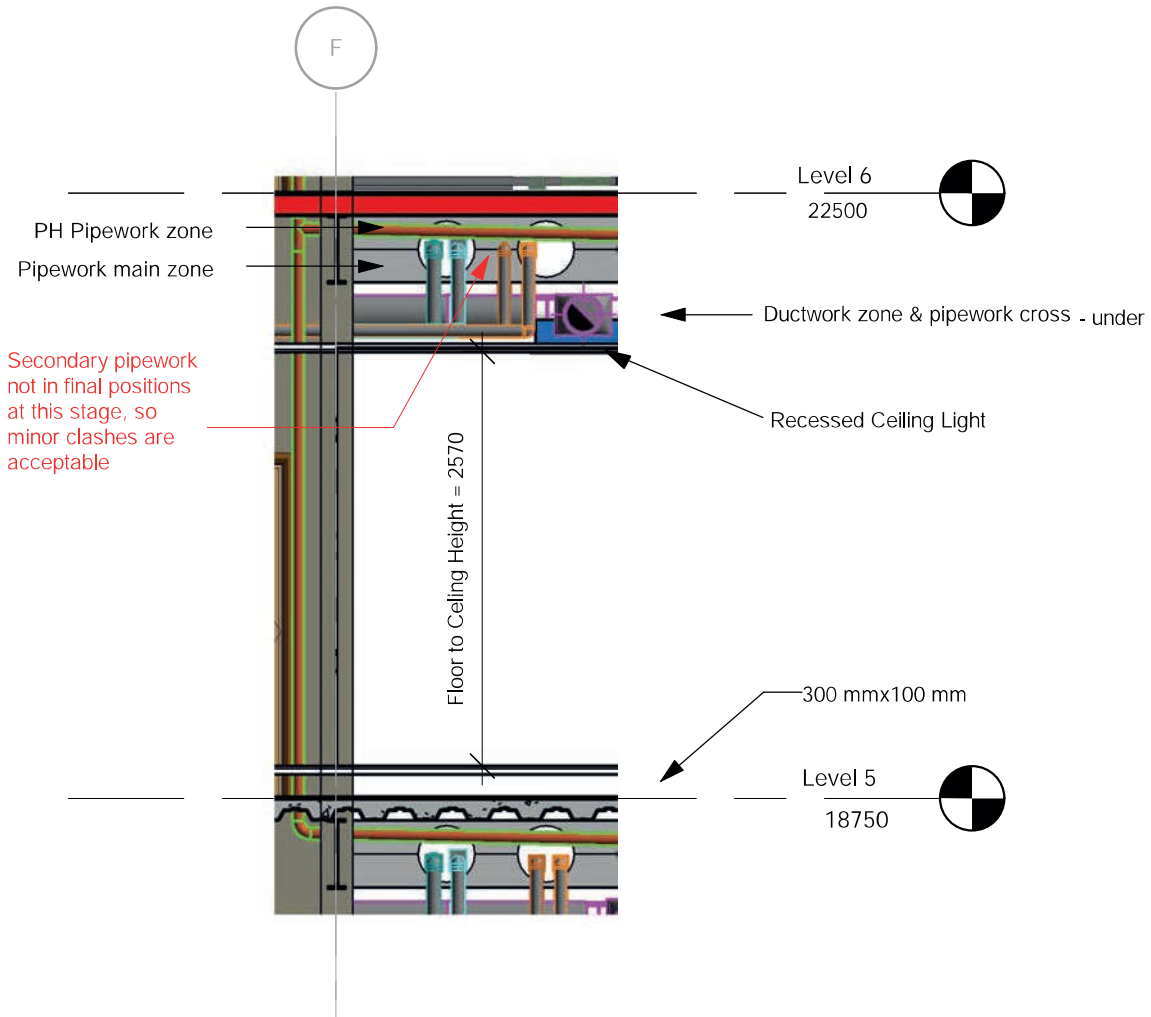
STAGE 4 TECHNICAL DESIGN DRAWING LIGHTING LAYOUT





STAGE 4 TECHNICAL DESIGN DRAWING SMALL POWER LAYOUT

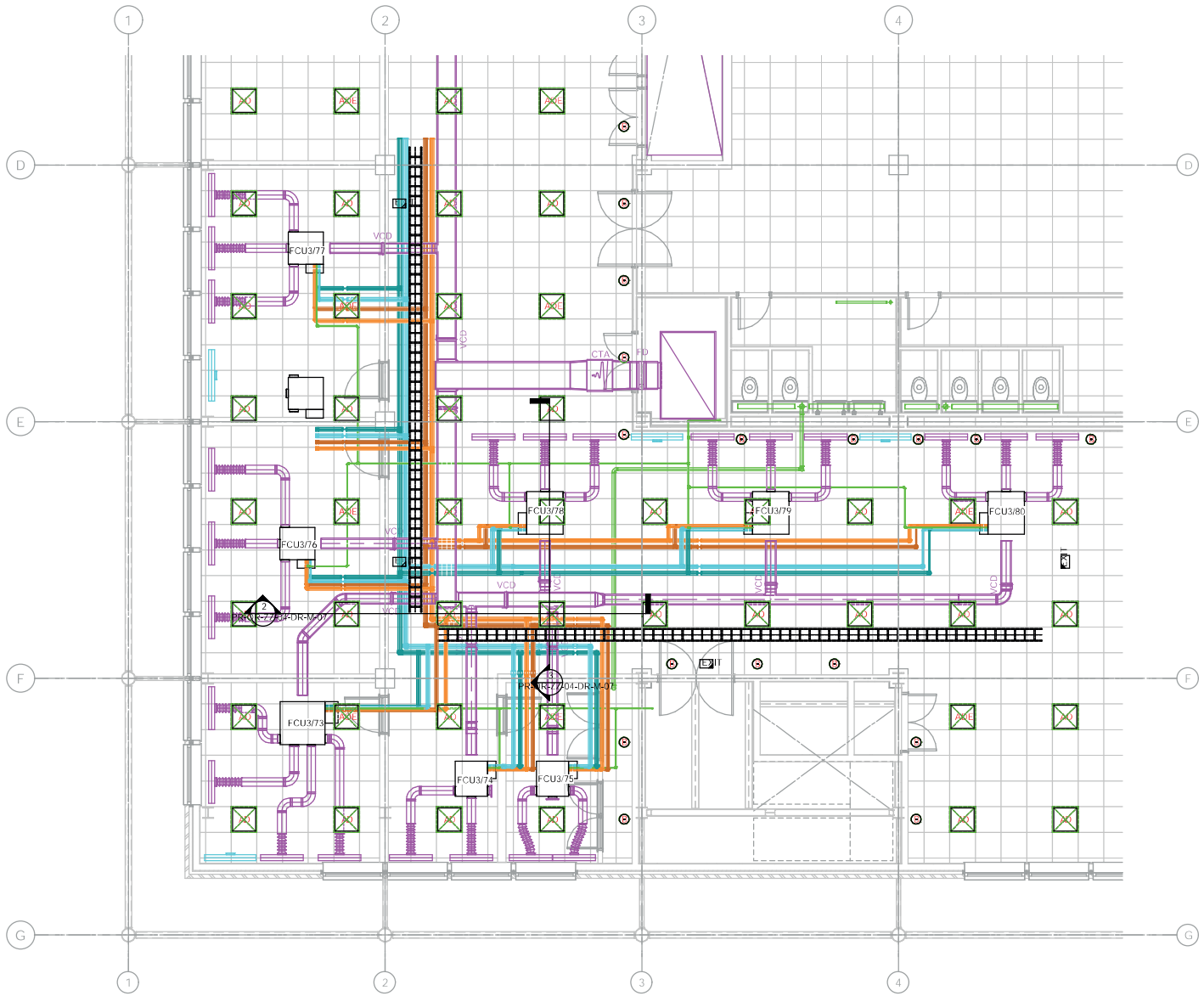




STAGE 4 TECHNICAL DESIGN DRAWING DISTRIBUTION SECTION



STAGE 4

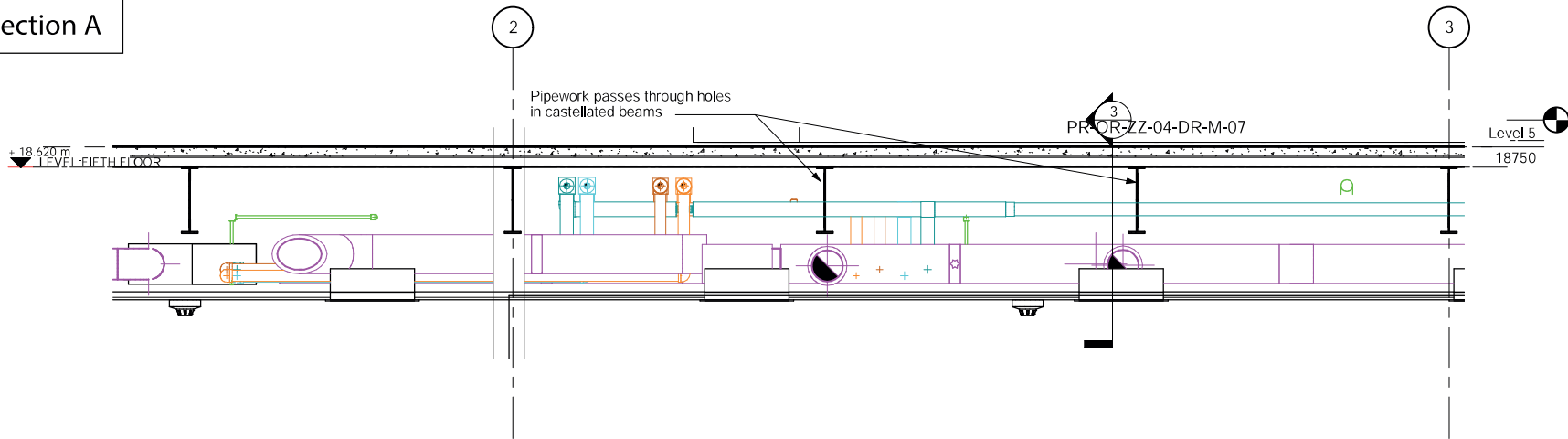


Note:
Cables in ceiling not
shown for readability.

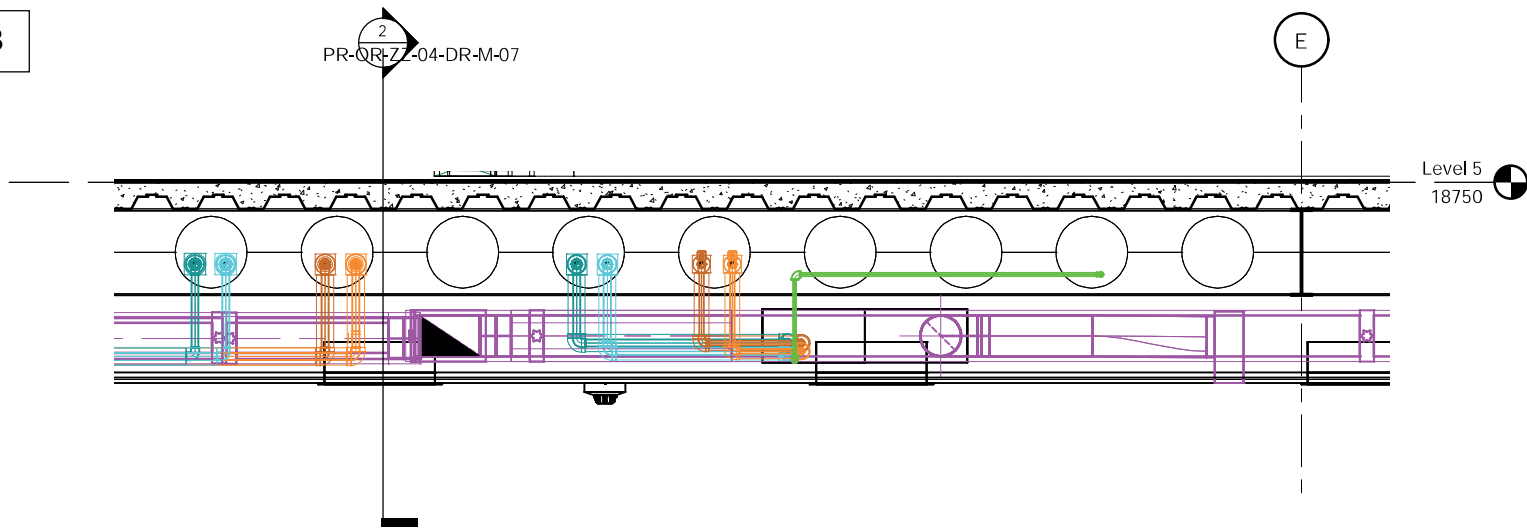
STAGE 4 COORDINATED WORKING DRAWING COMBINED LAYOUT



Section A

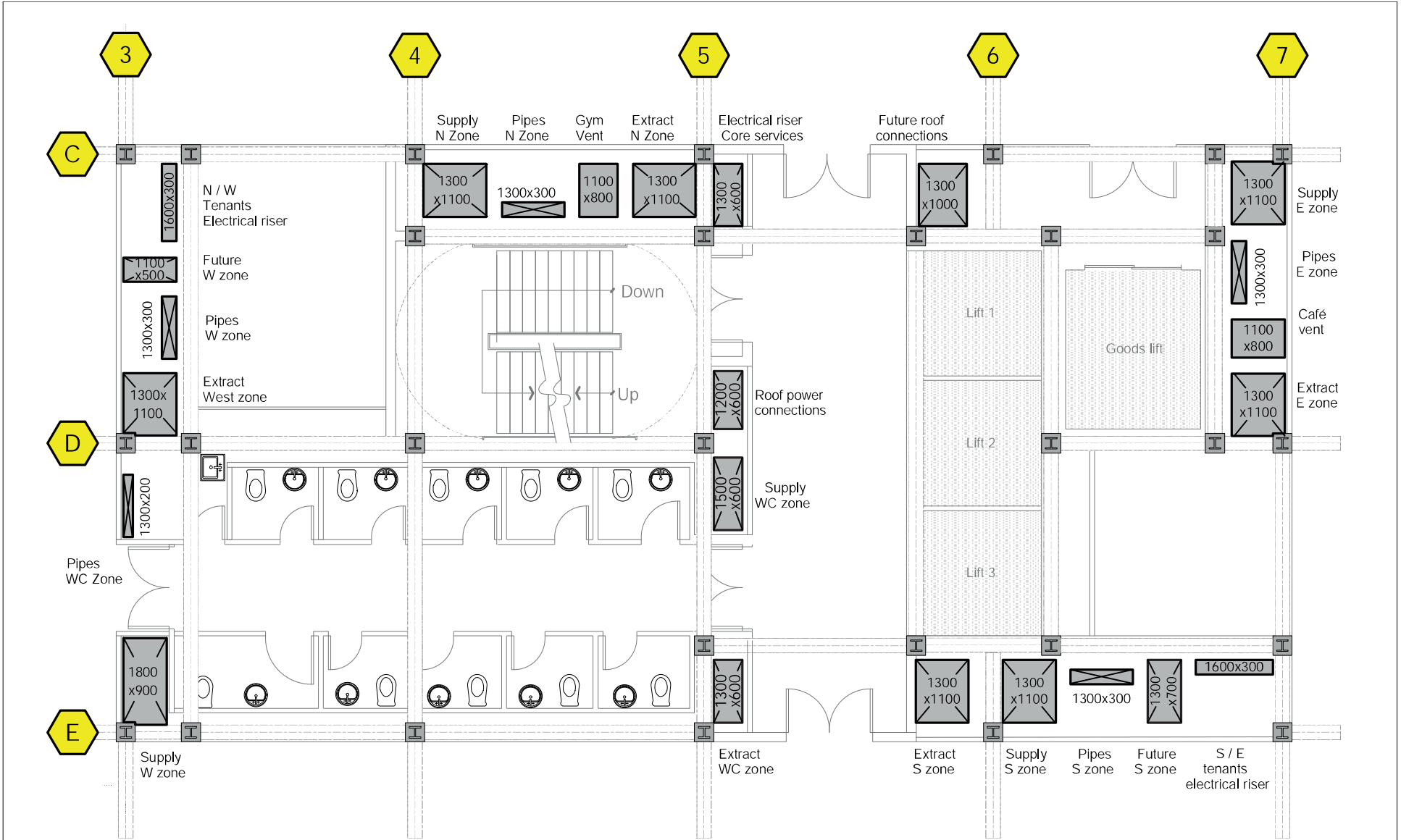


Section B



STAGE 4 COORDINATED WORKING DRAWING SECTIONS A AND B





STAGE 4 BUILDERS' WORK DRAWING STRUCTURALLY SIGNIFICANT INFORMATION



