Annexure A – BOQ

iThemba LABS HVAC Upgrade BOQ Summary

Ref.	Description		
1	P&G's	R	
2	Air Handling Units	R	
3	Extraction Systems	R	
4	Referenced Lists	R	
5	Chilled Water Piping	R	
6	Removal of Equipment	R	
7	Builders Work	R	
8	Ducting	R	
9	Testing & Qualification	R	
10	MCC	R	
11	Automation	R	
12	Instrument Cabling	R	
13	LV reticulation	R	
14	Cable Ways	R	
15	Health & Safety	R	
16	Sundries	R	
	Sub Total excluding VAT		
	Total excluding VAT	R	
	Add 15% for Value Added Tax	R	
	Total Carried to Form of Offer and Acceptance	R	

	Section 1: Preliminary and General				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
	General requirements and conditions.				
	Allow for all costs and expenses in connection with the following:				
1.1	Providing performance security (Performance guarantee)	Item	1		
1.2	Providing Insurances as described in the contract	Item	1		
1.3	Establishment / Disestablishment on Site as per the work sequencing including all re-establishment as necessary	item	1		
1.4	Site security including any fencing	item	1		
1.5	Operation and maintenance of facilities on Site for duration of the Contract	item	1		
1.6	Supervision for duration of the Contract	item	1		
1.7	Cost for advance payment guarantee	item	1		
1.8	Signange board for the site displaying Client, Contractor and Professional Team information	item	1		
1.9	Allow 3 days for design review clarifications with the consulting team	Item	1		
1.1	Other general expenses incurred in complying with the requirements of the Scope of Work not included above (Specify):		1		
	a)	item			
	b)	item			
	c)	item			
	TOTAL CARRIED TO SUMMARY PAGE				

	SECTION 2 : Air Handling Units				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**AHU 1 - Ground Floor - Blue Zone**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
1.1	AHU as per W1986-53001	No	1		
1.2	Assembly at factory & FAT	No	1		
1.3	Delivery to site to location accessible to overhead crane	No	1		
1.4	Steel Support Frame, anchored in place as per W1986-56001	No	1		
1.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (1200mm x 1000mm)	No	1		
2.0	**AHU 2 - Cleanrooms 1, 2 & 3**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
2.1	AHU as per W1986-53002	No	1		
2.2	Assembly at factory & FAT	No	1		
2.3	Delivery to site to location accessible to overhead crane	No	1		
2.4	Steel Support Frame, anchored in place as per W1986-56002	No	1		
2.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (1000mm x 800mm)	No	1		
3.0	**AHU 3 - Cleanrooms 4 & 5**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
3.1	AHU as per W1986-53003	No	1		
3.2	Assembly at factory & FAT	No	1		
3.3	Delivery to site to location accessible to overhead crane	No	1		
3.4	Steel Support Frame, anchored in place as per W1986-56003	No	1		
3.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (600mm x 400mm)	No	1		
4.0	**AHU 4 - Red Zone Ground Floor**				
4	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
4.1	AHU as per W1986-53004	No	1		
4.2	Assembly at factory & FAT	No	1		
4.3	Delivery to site to location accessible to overhead crane	No	1		
4.4	Steel Support Frame, anchored in place as per W1986-56004	No	1		
4.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (600mm x 1000mm)	No	1		

5.0	**AHU 5 - Red Zone Basement**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
5.1	AHU as per W1986-53005	No	1		
5.2	Assembly at factory & FAT	No	1		
5.3	Delivery to site to location accessible to overhead crane	No	1		
5.4	Steel Support Frame, anchored in place as per W1986-55001	No	1		
5.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (1300mm x 1000mm)	No	1		
6.0	**AHU 6 - Cyclotron**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
6.1	AHU as per W1986-53006	No	1		
6.2	Assembly at factory & FAT	No	1		
6.3	Delivery to site to location accessible to overhead crane	No	1		
6.4	Steel Support Frame, anchored in place as per W1986-56006	No	1		
6.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (350mm x 400mm)	No	1		
7.0	**AHU 7 - Elephant & VBTS Vault**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
7.1	AHU as per W1986-53007	No	1		
7.2	Assembly at factory & FAT	No	1		
7.3	Delivery to site to location accessible to overhead crane	No	1		
7.4	Steel Support Frame, anchored in place as per W1986-55001	No	1		
7.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (250mm x 250mm)	No	1		
7.6	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting (350mm x 350mm)	No	1		
8.0	**AHU 8 - Hot Cells**				
	Supply and installation of one new Air Handling Unit complete with air filters, fans, isolation dampers, cooling coil, heating element, integral steel frame and vibration dampers as per respective AHU datasheet. AHU shall have integral electrical control panel complete with all wiring.				
8.1	AHU as per W1986-53008	No	1		
8.2	Assembly at factory & FAT	No	1		
8.3	Delivery to site to location accessible to overhead crane	No	1		
8.4	Steel Support Frame, anchored in place as per W1986-55001	No	1		
8.5	Supply and install "AMS" or equal SOUND ATTENUATION in the supply air ducting Ø380mm	No	1		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 3 : Extraction Fans				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**Extraction system E4 - Red Zone Ground Floor & Basement**				
1.1	Disconnect & Remove E4 A & B extract fans and base frames	No	2		
1.2	Supply and Install new E4 fans as per datasheet W1986-53008	No	2		
1.3	Supply and install suction side transition ducting on each Fan (Fan suction - Ø800mm to Ø1000mm x 1200mm Lg)	No	2		
1.4	Supply and install discharge side transition ducting on each Fan (Fan discharge reducer - Ø800mm to Ø1000mm x 1200mm Lg)	No	2		
1.5	New steel base frame for mounting E4 A&B onto existing plinth including S/S anchors and vibration dampers	No	2		
2.0	**Extraction system E5 - Blue Zone general areas**				
2.1	Disconnect & Remove E5 A & B extract fans and base frames	No	2		
2.2	Supply and Install new E5 fans as per datasheet W1986-53009	No	2		
2.3	Supply and install suction side transition ducting on each Fan (Fan suction - Ø800mm to Ø1000mm x 1200mm Lg)	No	2		
2.4	Supply and install discharge side transition ducting on each Fan (Fan discharge reducer - Ø800mm to Ø1000mm x 1200mm Lg)	No	2		
2.5	New steel base frame for mounting E5 A&B onto existing plinth including S/S anchors and vibration dampers	No	2		
3.0	**Extraction system E6 -Elephant Vault & VBTS Vault**				
3.1.	Disconnect & Remove E6 A & B extract fans and base frames	No	2		
3.2	Supply and Install new E6 fans as per datasheet W1986-53010	No	2		
3.3	Supply and install suction side transition ducting on each Fan (Fan suction - 500mm lg x Ø300mm to Ø400)	No	2		
3.4	Supply and install discharge side transition ducting on each Fan (Fan discharge reducer - 500mm lg x Ø300mm to Ø400)	No	2		
3.5	New steel base frame for mounting E6 A&B onto existing plinth including S/S anchors and vibration dampers	No	2		
4.0	**Extraction system E7 - Hot Cells**				
4.1	Disconnect & Remove E7 A & B extract fans and base frames	No	2		
4.2	Supply and Install new E7 fan as per datasheet W1986-53011	No	2		
4.3	Supply and install suction side transition ducting on each Fan (Fan suction - 500mm lg x Ø120mm to Ø400)	No	2		
4.4	Supply and install discharge side transition ducting on each Fan (Fan discharge reducer - 500mm lg x Ø120mm to Ø400)	No	2		
4.5	New steel base frame for mounting E7 A&B onto existing plinth including S/S anchors and vibration dampers	No	2		

5.0	**Extraction system E8 - Red Zone Fume Hoods**				
5.1	Disconnect & Remove E8 A & B extract fans and base frames	No	2		
5.2	Supply and Install new E8 fan as per datasheet W1986-53012	No	2		
5.3	Supply and install suction side transition ducting on each Fan (Fan suction - 500mm lg x Ø300mm to Ø400)	No	2		
5.4	Supply and install discharge side transition ducting on each Fan (Fan discharge reducer - 500mm lg x Ø300mm to Ø400)	No	2		
5.5	New steel base frame for mounting E8 A&B onto existing plinth including S/S anchors and vibration dampers	No	2		
6.0	**Extraction system E9 - Blue Zone Fume Hoods**				
6.1	Disconnect & Remove E9 A & B extract fans	No	2		
6.2	Supply and Install new E9 fan as per datasheet W1986-53013	No	2		
6.3	Supply and install suction side transition ducting on each Fan (Fan suction - 500mm lg x Ø300mm to Ø400)	No	4		
6.4	Supply and install discharge side transition ducting on each Fan (Fan discharge reducer - 500mm lg x Ø300mm to Ø400)	No	4		
6.5	New steel base frame for mounting E9 A&B onto existing plinth including S/S anchors and vibration dampers	No	2		
6.6	New Structural steel platform for E8B and E9B. Costing shall include Supply and installation as per drawing W1986-56011	Item	1		
6.7	Supply and installation of ducting for E8B & E9B				
	Ø 400 x 20 000mm	No.	2		
	Ø400 - 45DEG bend	No.	6		
	Ø400 - 90DEG bend	No.	2		
	Ø400 - END CAP	No.	1		
6.8	E8 & E9 Automated, pneumatically operated, Ø400mm shut off ducting dampers to isolate as required when duty fans are operating versus the standby fans	No.	8		
7.0	**Extraction system E10 - Cyclotron**				
7.1	Supply and Install new E10A&B fans as per datasheet W1986-53014	No	2		
7.2	Supply and install suction side ducting Ø400mm between Cyclotron area and Fan as per drawing W1986-55002	m	70		
7.3	Supply and install discharge side ducting (Ø400) between Fan and existing ducting tie-in as per drawing W1986-55002	m	10		
7.4	Supply and install Ø400mm T-pieces	No	4		
7.5	Supply and install Ø40mm 90DEG Bends	No	16		
7.6	Allow for tie-in into existing E6 extract ducting as per layout drawing W1986-55002	Item	1		
7.7	Automated, pneumatically actuated, Ø400mm shut off ducting dampers to restrict backflow	No.	4		
7.8	Removal of asbestos side cladding to install new ducting and replace sheeting with matching fibre cement sheeting.	m^2	6		
7.9	Filter bank, including support frame for E10 fans	No	1		
8	**Extraction Sound Attenuation - Supply and install "AMS" or equal SOUND ATTENUATION in all the extract air ducting (E4 - E10) as required.**				
8.1	Ø800mm E4	No	1		
8.2	Ø800mm E5	No	1		
8.3	Ø300mm E6	No	1		
8.4	Ø120mm E7	No	1		
8.5	Ø300mm E8	No	1		
8.6	Ø300mm E9	No	1		
8.7	Ø400mm E10	No	1		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

SECTION 4 : Valves, Control Valves, Filters & Dampers

Ref.	Description	UNIT	QTY	UNIT RATE	TOTAL
1.0	Supply and installation of all valves listed on the valve list W1986-61003. Valves are to be priced individually on the valve list schedule and the total value listed here on this schedule.	Lot	1		
2.0	Supply and installation of all control valves listed on the control valve list W1986-61004. Valves are to be priced individually on the valve list schedule and the total value listed here on this schedule.	Lot	1		
3.0	Supply and installation of all filters listed on the filter list W1986-61002. Filters are to be priced individually on the filter list schedule and the total value listed here on this schedule.	Lot	1		
4.0	Supply and installation of all dampers listed on the damper list W1986-47002. Dampers are to be priced individually on the damper list schedule and the total value listed here on this schedule.	Lot	1		
5.0	Supply and installation of all diffusers and grilles listed on the list W1986-61006. Items are to be priced individually on the list schedule and the total value listed on this schedule.	Lot	1		
6.0	Supply and installation of all instrumentation listed on the list W1986-61001. Instrumentation are to be priced individually on the instrumentation list schedule and the total value listed on this schedule.	Lot	1		
7.0	Allow provisional sum to be used as directed by the Engineer	PC Sum	1	R100 000.00	R 100 000.00
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 5 : Chilled Water Piping				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
	Supply and install BLACK STEEL CHILLED water piping, C/W PIC insulation with painted fibre glass reinforcement and vapour barrier, fittings, bracketing, hangers and painting and labelling as per drawings - P&IDs (W1986-45009 & W1986-45010 and Layouts (W1986-55001 SHT1 & SHT2). Costing shall include all fabrication of piping as per drawings.				
1.0	CHW Supply Piping - Supply and Install:				
1.1	NB150 Butterfly valve	No.	1		
1.2	Reducing T-Piece NB125 x NB100	No.	1		
1.3	Reducing T-Piece NB125 x NB50	No.	3		
1.4	Reducing T-Piece NB125 x NB32	No.	1		
1.5	Reducing T-Piece NB125 x NB80	No.	1		
1.6	Reducing T-Piece NB125 x NB20	No.	2		
1.7	90DEG long radius Elbow NB125	No.	2		
1.8	Reducer NB150 x NB125	No.	1		
1.9	NB120 Piping	m	40		
1.10	NB100 Piping	m	12		
1.11	NB50 Piping	m	20		
1.12	NB32 Piping	m	40		
1.13	NB80 Piping	m	12		
1.14	NB20 Piping	m	12		
1.15	NB 150 Piping	m	10		
1.16	90DEG long radius Elbow NB100	No.	4		
1.17	90DEG long radius Elbow NB80	No.	4		
1.18	90DEG long radius Elbow NB50	No.	12		
1.19	90DEG long radius Elbow NB32	No.	4		
1.20	90DEG long radius Elbow NB20	No.	12		
2.0	Supports:				
	Supply and install support frames as per drawing W1986-56009. Supports shall be fabricated from MS and painted as per drawings and chemically anchored with S/S anchors, including clamps as shown.				
2.1	Support Type S1	No.	7		
2.2	Support Type S2	No.	3		
2.3	Support Type S3	No.	1		
2.4	Support Type S4	No.	4		
2.5	Support Type S5	No.	5		
2.6	Support Type S6	No.	3		
2.7	Support Type S7	No.	8		
2.8	Support Type S8	No.	3		
2.9	Support Type S9	No.	5		
2.10.	Support Type S10	No.	200		
2.11	Support Type S11	No.	5		

3.0	CHW Return Piping:				
3.1	NB150 Butterfly valve	No.	1		
3.2	T-Piece NB125 x NB100	No.	1		
3.3	T-Piece NB125 x NB50	No.	3		
3.4	T-Piece NB125 x NB32	No.	1		
3.5	T-Piece NB125 x NB80	No.	1		
3.6	T-Piece NB125 x NB20	No.	2		
3.7	90DEG Elbow NB125	No.	2		
3.8	Reducer NB150 x NB125	No.	1		
3.9	NB120 Piping	m	40		
3.10	NB100 Piping	m	12		
3.11	NB50 Piping	m	20		
3.12	NB32 Piping	m	40		
3.13	NB80 Piping	m	12		
3.14	NB20 Piping	m	12		
3.15	NB 150 Piping	m	10		
3.16	90DEG Elbow NB100	No.	4		
3.17	90DEG Elbow NB80	No.	4		
3.18	90DEG Elbow NB50	No.	12		
3.19	90DEG Elbow NB32	No.	4		
3.20	90DEG Elbow NB20	No.	12		
4.0	SABS 1123/1000 slip on Flanges CW gaskets, washers, nuts and 150mm lg bolts - Supply & Install				
4.1	NB150	No.	16		
4.2	NB125	No.	16		
4.3	NB100	No.	16		
4.4	NB80	No.	16		
4.5	NB50	No.	16		
4.6	NB32	No.	16		
4.7	NB20	No.	16		
5.0	Wafer type rubber lined, cast iron body, S/S disc Butterfly valves:				
5.1	NB120	No.	4		
5.2	NB100	No.	4		
5.3	NB50	No.	4		
5.4	NB32	No.	4		
5.5	NB80	No.	4		
5.6	NB20	No.	4		
5.7	NB150	No.	4		
6.0	Other - Supply and Install				
6.1	15NB threaded both end galv nipples	No	22		
6.2	15NB threaded sockets	No	22		
6.3	15NB S/S 3-piece threaded ball valves	No	22		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 6 : Removal of Existing Equipment				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	Refer to drawing W1986-FSK001 HVAC Layout of the 6m slab. AHU's as indicated below are to be completely removed from the 6m slab as well as it's associated ducting, including supports, up to the penetration of the actual 6m slab. The area has an existing gantry crane that can be used to physically remove the units from the slab, but costing shall include removal from the area to an area on the site identified by the Client.				
1.1	AHU No10 - Entire unit, including the supply ducting up to the plenum chamber and the supply & return chilled water and hot water piping up to the new tie-in point.	Lot	1		
1.2	AHU No2 - Entire unit, including the supply ducting up to the plenum chamber and the supply & return chilled water and hot water piping up to the new tie-in point.	Lot	1		
1.3	AHU No1 - Entire unit, including the supply ducting (both branches) up to the plenum chamber and the supply & return chilled water and hot water piping up to the new tie-in point.	Lot	1		
1.4	AHU No3 - Entire unit, including the supply ducting (both branches) up to the plenum chamber and the supply & return chilled water and hot water piping up to the new tie-in point.	Lot	1		
1.5	Removal of the existing HVAC systems supplying the Cleanrooms 1 to 5 as per drawings attached to this tender. The complete system will be replaced as stated in the specification, only the terminal HEPA filter housing shall remain in place, where the new system will tie-in. Existing ducting is above the ceiling, allowance shall therefore be made to remove ceiling tiles / boards as necessary to remove the ducting and replace the ceiling as required. See drawings marked "Cleanrooms Sketch - 10 Pages")				
1.5.1	Cleanroom 1 (including changeroom and airlock)	Sum	1		
1.5.2	Cleanroom 2 (including changeroom and airlock)	Sum	1		
1.5.3	Cleanroom 3 (including changeroom and airlock)	Sum	1		
1.5.4	Cleanroom 4 (including changeroom and airlock)	Sum	1		
1.5.5	Cleanroom 5 (including changeroom and airlock)	Sum	1		
1.6	Removal of ducting section above the ceiling in the general red zone. Supply and installation of ducting to reroute air supply and extraction, and plug the remaining duct. Allowance shall therefore be made to remove ceiling tiles / boards as necessary to remove the ducting and replace ceiling as required.				
1.6.1	820mm x 550mm	m	10		
1.6.2	250mm x 150mm	m	10		
1.7	Removal of all the MCC / control electrical panels supplying the AHU's as described above from the 6m slab, including all cabling to and from the respective panels.	Sum	1		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 7 : Builders Work				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	Concrete Repair				
	Rates shall include (but not limited to) the removal of all spalled and loose material, thorough cleaning of surfaces, treatment of exposed reinforcement, application, floating and curing of repair material, all to manufacturer's specifications				
1.1	spalled and damaged concrete (200mm x 200mm surface area)	No.	50		
1.2	spalled and damaged concrete (500mm x 500mm surface area)	No.	20		
1.3	Cracks less than 5mm wide	m	50		
1.3	Cracks between 5mm - 15mm wide	m	50		
2.0	Builders openings (Masonry)				
	Rates shall include (but not limited to) the breakout of 230mm brick walls, for ducting installation (or similar), cleaning all surfaces and making good by plastering and painting to match existing.				
2.1	800mm x 500mm Opening	No.	5		
2.2	600mm x 600mm Opening	No.	5		
2.3	500mm x 500mm Opening	No.	5		
2.4	300mm x 300mm Opening	No.	5		
2.5	250mm x 250mm Opening	No.	5		
2.6	1000mm x 800mm Opening	No.	2		
3.0	Builders openings (Isopanel or drywall)				
	Rates shall include (but not limited to) the breakout of 100mm THK (or less) Isopanel or drywall walls, for ducting installation (or similar), cleaning all surfaces and making good by capping with aluminium anodised equal angle capping				
3.1	350mm x 200mm	No.	10		
3.2	500mm x 250mm	No.	10		
3.3	400mm x 250mm	No.	10		
3.4	300mm x 250mm	No.	10		
3.5	300mm x 200mm	No.	10		
4.0	Builders openings (Masonry) by Coredrilling				
	Rates shall include (but not limited to) the coredrilling of 230mm brick walls or up to 300mm concrete, for ducting installation (or similar), cleaning all surfaces, treatment of exposed reinforcement and grouting after ducting, conduit or piping installation				
4.2	Ø300mm Opening	No.	5		
4.3	Ø200mm Opening	No.	5		

4.4	Ø100mm Opening	No.	5		
4.5	Ø150mm Opening	No.	5		
5.0	Brick up 230mm redundant openings, including making good by plastering and painting to match existing				
5.1	1300mm x 1300mm	No.	5		
6.0	Demolish existing 200mm THK concrete plinths and make good on 6m slab				
6.1	Exsiting AHU No.10	m^2	5		
6.2	Exsiting AHU No.1	m^2	10		
6.3	Exsiting AHU No.2	m^2	10		
6.4	Exsiting AHU No.3	m^2	5		
7.0	Seal around existing penetrations through 6m slab with suitable water tight material - membrane installation with suitable Flexible acrylic emulsion				
7.1	1300mm x 1300mm	No.	1		
7.2	1200mm x 12000mm	No.	1		
7.3	1000mm x 1000mm	No.	1		
8.0	Allow PC Sum for builders work as instructed by the Engineer	Lot	1	R 150 000.00	R 150 000.00
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 8 : Ducting				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	Supply and installation of new externally insulated GALVANISED MILD STEEL SHEET METAL SUPPLY AIR ducting and fittings complete with all hangers and supports as specified (50 mm external lagging). Ducting shall be supplied in maximum 2500mm long sections with Mezz type flanged connections sealed tight.				
1.1	AHU No1:				
1.1.1	1000mm x 1200mm	m	15		
1.1.2	90DEG bends 1000mm x 1200mm	No.	4		
1.1.3	950mm x 650mm	m	10		
1.1.4	400mm x 350mm	m	8		
1.1.5	90DEG bends 950mm x 650mm	No.	4		
1.1.6	90DEG bends 550mm x 400mm	No.	3		
1.1.7	90DEG bends 650mm x 450mm	No.	5		
1.2	AHU No2 Straight Duct:				
1.2.1	1000mm x 800mm	m	25		
1.2.2	550mm x 500mm	m	5		
1.2.3	550mm x 400mm	m	6		
1.2.4	280mm x 180mm	m	10		
1.2.5	400mm x 110mm	m	10		
1.2.6	250mm x 200mm	m	10		
1.2.7	300mm x 200mm	m	10		
1.2.8	200mm x 150mm	m	10		
1.2.9	900mm x 650mm	m	15		
1.2.10	650mm x 310mm	m	15		
1.2.11	300mm x 250mm	m	15		
1.2.12	400mm x 310mm	m	15		
1.2.13	350mm x 150mm	m	15		
1.2.14	180mm x 150mm	m	20		
1.2.15	200mm x 150mm	m	20		
1.2.16	750mm x 500mm	m	20		
1.2.17	700mm x 450mm	m	20		
1.2.18	250mm x 180mm	m	20		
1.2.19	300mm x 250mm	m	25		
1.2.20	450mm x 300mm	m	25		
1.2.21	350mm x 250mm	m	25		
1.2.22	280mm x 200mm	m	25		
1.2.23	180mm x 180mm	m	25		
1.2.24	600mm x 400mm	m	10		
1.2.25	500mm x 400mm	m	10		
1.2.26	250mm x 150mm	m	10		
1.2.27	Ø250mm flexible ducting x 300mm	No.	35		

	AHU No2 Reducers:				
1.2.28	1000mm x 800mm → 550mm x 500mm	No	1		
1.2.29	1000mm x 800mm → 900mm x 650mm	No	1		
1.2.30	900mm x 650mm → 750mm x 500mm	No	1		
1.2.31	550mm x 500mm → 550mm x 400mm	No	1		
1.2.32	550mm x 400mm → 280mm x 180mm	No	2		
1.2.33	550mm x 400mm → 400mm x 110mm	No	1		
1.2.34	400mm x 110mm → 250mm x 200mm	No	2		
1.2.35	550mm x 500mm → 300mm x 200mm	No	1		
1.2.36	300mm x 200mm → 200mm x 150mm	No	1		
1.2.37	900mm x 650mm → 650mm x 310mm	No	1		
1.2.38	650mm x 310mm → 300mm x 250mm	No	1		
1.2.39	650mm x 310mm → 400mm x 310mm	No	1		
1.2.40	400mm x 310mm → 350mm x 150mm	No	1		
1.2.41	350mm x 150mm → 180mm x 150mm	No	1		
1.2.42	350mm x 150mm → 200mm x 150mm	No	1		
1.2.43	750mm x 500mm → 700mm x 450mm	No	1		
1.2.44	700mm x 450mm → 250mm x 180mm	No	1		
1.2.45	700mm x 450mm → 600mm x 400mm	No	1		
1.2.46	600mm x 400mm → 250mm x 180mm	No	1		
1.2.47	600mm x 400mm → 500mm x 400mm	No	1		
1.2.48	500mm x 400mm → 250mm x 150mm	No	1		
1.2.49	500mm x 400mm → 450mm x 350mm	No	1		
1.2.50	450mm x 350mm → 250mm x 180mm	No	2		
1.2.51	450mm x 350mm → 250mm x 180mm	No	1		
1.2.52	450mm x 350mm → 300mm x 250mm	No	1		
1.2.53	300mm x 250mm → 250mm x 180mm	No	2		
1.2.54	750mm x 500mm → 450mm x 300mm	No	1		
1.2.55	450mm x 300mm → 250mm x 180mm	No	1		
1.2.56	450mm x 300mm → 350mm x 250mm	No	1		
1.2.57	350mm x 250mm → 250mm x 180mm	No	1		
1.2.58	350mm x 250mm → 280mm x 200mm	No	1		
1.2.59	280mm x 200mm → 180mm x 180mm	No	2		
	AHU No2 90DEG Elbows/Bends:				
1.2.60	1000mm x 800mm	No.	4		
1.2.61	550mm x 500mm	No.	1		
1.2.62	300mm x 200mm	No.	1		
1.2.63	750mm x 500mm	No.	2		
1.2.64	350mm x 250mm	No.	2		

	AHU No2 T-Piece:				
1.2.65	(1000mm x 800mm) x (900mm x 650mm) → (550mm x 500mm)	No.	1		
1.2.66	(900mm x 650mm) x (750mm x 500mm) → (650mm x 310mm)	No.	1		
1.2.67	(750mm x 500mm) x (700mm x 450mm) → (450mm x 300mm)	No.	1		
1.3	AHU No3:				
1.3.1	600mm x 400mm	m	15		
1.3.2	450mm x 300mm	m	8		
1.3.3	400mm x 250mm	m	5		
1.3.4	300mm x 200mm	m	10		
1.3.5	250mm x 150mm	m	5		
1.3.6	450mm x 300mm	m	10		
1.3.7	400mm x 300mm	m	10		
1.3.8	350mm x 250mm	m	4		
1.3.9	180mm x 150mm	m	4		
1.3.10	Ø200mm flexible ducting x 300mm	No.	10		
1.3.11	Ø250mm flexible ducting x 300mm	No.	10		
1.3.11	90DEG bends 600mm x 400mm	No.	3		
1.3.12	90DEG bends 350mm x 200mm	No.	2		
1.3.13	90DEG bends 450mm x 350mm	No.	2		
1.4	AHU No4:				
1.4.1	1000mm x 600mm	m	5		
1.4.2	90DEG bends 1000mm x 600mm	No.	2		
1.5	AHU No5:				
1.5.1	1300mm x 1000mm	m	15		
1.5.2	90DEG bends 1000mm x 600mm	No.	6		
1.6	AHU No6:				
1.6.1	400mm x 350mm	m	22		
1.6.2	90DEG bends 400mm x 350mm	No.	8		
1.6.3	120mm x 120mmm	m	8		
1.6.4	Ø200mm flexible ducting x 200mm	No.	5		

1.7	AHU No7:				
1.7.1	1300mm x 1000mm	m	15		
1.7.2	90DEG bends 1000mm x 600mm	No.	6		
1.8	AHU No8:				
1.8.1	Ø380mm	m	15		
1.8.2	90DEG bends Ø380mm	No.	4		
.					
1.9	Cleanrooms Low level extraction				
1.9.1	Ø350mm	m	100		
1.9.2	Ø350mm 90DEG Bends	No.	20		
1.9.3	Ø350mm 45DEG Bends	No.	10		
1.9.4	Ø350mm T Pieces	No.	10		
1.10	Supply & install typical isopanel low level ducting - 25mm rockwool insert, chromadek exterior isopanelling as per drawings				
1.10.1	500mm rectangular type - 3000mm high	No.	30		
1.10.2	300mm rectangular type - 3000mm high	No.	20		
1.10.3	500mm Triangular type - 3000mm high	No.	10		
1.10.4	300mm Triangular type - 3000mm high	No.	10		
1.11	Supply and installation of ducting for Extraction System E9A&B				
1.11.1	1000mm x 800mm	m	10		
1.11.2	400mm x 350mm	m	15		
1.11.3	400mm x 200mm	m	15		
1.11.4	900mm x 650mm	m	8		
1.11.5	600mm x 300mm	m	15		
1.11.6	800mm x 600mm	m	7		
1.11.7	600mm x 500mm	m	10		
1.11.8	600mm x 350mm	m	8		
1.11.9	400mm x 250mm	m	10		
1.11.10	500mm x 260mm	m	25		
1.11.11	400mm x 150mm	m	4		
1.11.12	200mm x 150mm	m	8		
1.11.13	400mm x 180mm	m	12		
1.11.14	250mm x 150mm	m	5		
1.12	Allow provisional sum to be used as directed by the Engineer	PC Sum	1	R250 000.00	R 250 000.00
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 9 : Testing				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	Perform installation qualification for all HVAC systems installed in this contract. Allow for a team of 2 personnel to run through the installation qualification with the project team on site for each system.				
1.1	AHU No.1 system	Hours	8		
1.2	AHU No.2 system	Hours	12		
1.3	AHU No.3 system	Hours	12		
1.4	AHU No.4 system	Hours	8		
1.5	AHU No.5 system	Hours	8		
1.6	AHU No.6 system	Hours	8		
1.7	AHU No.7 system	Hours	8		
1.8	AHU No.8 system	Hours	8		
1.9	E4 Fan	Hours	4		
1.10	E5 Fan	Hours	4		
1.11	E6 Fan	Hours	4		
1.12	E7 Fan	Hours	4		
1.13	E8 Fan	Hours	8		
1.14	E9 Fan System	Hours	12		
1.15	E10 System	Hours	12		
2.0	Perform Operational qualification for all HVAC systems installed in this contract. Allow for a team of 2 personnel to run through the Operational qualification with the project team on site for each system.				
2.1	AHU No.1 system	Hours	16		
2.2	AHU No.2 system	Hours	20		
2.3	AHU No.3 system	Hours	20		
2.4	AHU No.4 system	Hours	8		
2.5	AHU No.5 system	Hours	8		
2.6	AHU No.6 system	Hours	8		
2.7	AHU No.7 system	Hours	8		
2.8	AHU No.8 system	Hours	8		
2.9	E4 Fan	Hours	8		
2.10	E5 Fan	Hours	8		
2.11	E6 Fan	Hours	8		
2.12	E7 Fan	Hours	8		
2.13	E8 Fan	Hours	12		
2.14	E9 Fan	Hours	12		
2.15	E10 System	Hours	12		

3.0	Perform Performance qualification for all HVAC systems installed in this contract. Allow for a team of 2 personnel to run through the performance qualification with the project team on site for each system.				
3.1	AHU No.1 system	Hours	16		
3.2	AHU No.2 system	Hours	20		
3.3	AHU No.3 system	Hours	20		
3.4	AHU No.4 system	Hours	8		
3.5	AHU No.5 system	Hours	8		
3.6	AHU No.6 system	Hours	8		
3.7	AHU No.7 system	Hours	8		
3.8	AHU No.8 system	Hours	8		
3.9	E4 Fan	Hours	8		
3.10	E5 Fan	Hours	8		
3.11	E6 Fan	Hours	8		
3.12	E7 Fan	Hours	8		
3.13	E8 Fan	Hours	12		
3.14	E9 Fan	Hours	12		
3.15	E10 System	Hours	12		
4.0	Testing of Grade B and Grade C Areas (Cleanrooms & Changerooms). Perform tests in accordance with ISO 14664. Testing to be performed by independent third party				
4.1	Non-viable particle counts (per room) - at rest	Lot	1		
4.2	Non-viable particle counts (per room) - in operation	Lot	1		
4.3	Room recovery tests	Lot	1		
4.4	HEPA filter integrity tests	Lot	1		
4.5	Temperature mapping	Lot	1		
4.6	Pressure cascade verification	Lot	1		
4.7	Air flow pattern test	Lot	1		
4.8	Supply ducting pressure tests (All ducting - New and existing)	Lot	1		
4.9	Extract ducting pressure tests (new ducting only)	Lot	1		
5.0	Testing to be perfomed in all other areas supplied by the AHU's - Grade D. Testing to be performed by independent third party	Lot	1		
5.1	Temperature mapping	Lot	1		
5.2	Pressure cascade verification	Lot	1		
5.3	Air changes verifciation	Lot	1		
5.4	Supply ducting pressure tests (All ducting - New and existing)	Lot	1		
5.5	Extract ducting pressure tests (new ducting only)	Lot	1		

6	Commissioning & Testing				
6.1	Hydrostatic pressure testing of the chilled water piping network @7.5bar	Sum	1		
6.2	AHU pressure test - per unit	Qty	8		
6.3	Balance the air flows to achieve the specified pressure cascades	Sum	1		
6.4	Set up VSDs to achieve the specified air change rates	Sum	1		
6.5	Set up temperature control valves to achieve specified room temperatures	Sum	1		
6.6	Verify operation of shut off dampers	Sum	1		
6.7	DOP testing of the extraction system HEPA filters	Sum	1		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 10 : MCC				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**Motor Control Center (MCC)**				
	Supply & Install MCC Panels complete as per the following drawings: • CT0340-EL-SLD-0100 • CT0340-EL-SLD-0001				
1.1	MCC-100 Supply	sum	1	R0.00	R -
1.2	MCC-100 Installation	sum	1	R0.00	R -
1.3	Supply & Install New LV Extension Panel (by Valley Electrical Contractors) 1250A ACB Feeder	PC sum	1	R237 310.00	R 237 310.00
1.4	Markup on 1250A Extension Panel	%	1	R0.00	R -
2.0	**Project Documentation**				
2.1	Wiring Diagrams	sum	1		R -
2.2	Operational & Maintenance File & As-built Drawings	sum	1		R -
3.0	**Commissioning**				
3.1	Factory Acceptance Test	sum	1		R -
3.2	Pre-commissioning (Dry commissioning)	sum	1		R -
3.3	Commissioning (Wet commissioning)	sum	1		R -
3.4	COC for 1250A supply extension panel	sum	1		R -
3.5	COC for MCC panel	sum	1		R -
4.0	**Additional**				
	Any additional items the Tenderer deems necessary for the successful completion of the installation (specify)				
4.1					R -
4.2					R -
4.3					R -
4.4					R -
4.5					R -
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

	SECTION 11 : AUTOMATION				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**PLC & Network Hardware**				
	Network hardware must include all components necessary to integrate the I/O list into the PLC network with 30% spare I/O capacity. • CT0340-IC-LST-0001 (IO List) • CT0340-EL-SLD-0200 (Automation Architecture)				
1.1	48-Port Managed Industrial Ethernet Switch	sum	1		R -
1.2	Managed 8-port copper, 4 port SFP switch	sum	1		R -
1.3	SIMATIC HMI TP700 Comfort	sum	1		R -
1.4	S7-1500, mounting rail 830 mm (32.7")	sum	1		R -
1.5	S7-1500, PS 25W 24V DC	sum	1		R -
1.6	CPU 1515F-2 PN, 1,5MB Prog.,4,5MB Data	sum	1		R -
1.7	SIMATIC S7 Memory Card, 24 MB	sum	1		R -
1.8	S7-1500, DI 32x24VDC HF	sum	2		R -
1.9	S7-1500, DQ 32x24VDC/0.5A HF	sum	1		R -
1,10	S7-1500, AI 8xU/I/RTD/TC ST	sum	10		R -
1,11	S7-1500, AQ 8xU/I HS	sum	3		R -
1,12	Frontconnector Screw Type (35mm Mod.)	sum	15		R -
1,13	SITOP PSU8200/1ACDC/24VDC/20A	sum	2		R -
1,14	STEP 7 Safety Advanced V19 SW DL	sum	1		R -
1,15	STEP 7 Prof. V19 DL	sum	1		R -
1,16	WinCC Comfort V19 DL	sum	1		R -
2.0	**Programming**				
	Programming of PLC, SCADA Software Packages. This includes the allocation and scaling of all Input and Output signals , PID Loop Control Algorithms, Graphic Displays, Logging of Data, Trending Graphs, Interlocks Functions & Alarms.				
2.1	Automation System & HMI programming according to control philosophy.	sum	1		R -
3.0	**Commissioning**				
3,1	EPLAN or AutoCAD Wiring Diagram	sum	1		R -
3,2	Loop Diagrams	sum	1		R -
3,3	Factory Acceptance Test	sum	1		R -
3,4	Loop Tests on Site	sum	1		R -
3,5	Instrument Commissioning	sum	1		R -
3,6	Wet Commissioning & Qualification - Plant under Load	sum	1		R -
3.7	Site Acceptance Test	sum	1		R -

4.0	**Additional**					
	Any additional items the Tenderer deems necessary for the successful completion of the installation (specify)					
4.1					R	-
4.2					R	-
4.3					R	-
4.4					R	-
4.5					R	-
	TOTAL CARRIED TO FINAL SUMMARY PAGE				R	-

	SECTION 12 : INSTRUMENTATION CABLING				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**Field equipment Boxes (FCBs)**				
	Supply and Install Field Equipment / Connection Boxes with all accessories and mounting brackets complete as specified.				
1.1	4-Way FCBs (Equal or similar to Type CCG Size 0 HandiFit or Utility) c/w glands, reducers, terminal rail, terminals, endplates and markers	ea	10		R -
1.2	4-Way FCBs (Equal or similar to Type CCG Size 1 HandiFit or Utility) c/w glands, reducers, terminal rail, terminals, endplates and markers	ea	40		R -
2.0	**Instrumentation Cabling**				
	Supply and install APL (Dekabon) insulated fine stranded Twisted Pair Copper cables on a rack or pulled through sleeves or laid directly in the ground of the following sizes. The twisted pairs should be Black and White alphanumerically numbered. Price should include terminations as well. Note: • OAM = Overall Mylar • IOAM = Individually and Overall Mylar				
2,1	1mm² 1 pair (twisted) Mylar (OAM Black)	m	500		R -
2,2	1mm² 2 pairs (twisted) Mylar (OAM Black)	m	3500		R -
2,3	1mm² 2 pairs (twisted) Mylar (IOAM Black)	m	3500		R -
2,4	1mm² 4 pairs (twisted) Mylar (OAM Black)	m	2000		R -
2,5	1mm² 4 pairs (twisted) Mylar (IOAM Black)	m	2500		R -
2,6	1mm² 8 pairs (twisted) Mylar (OAM Black)	m	500		R -
2,7	1mm² 8 pairs (twisted) Mylar (IOAM Black)	m	500		R -
3.0	**Network Cabling**				
	Supply and install insulated fine stranded Copper cables on a rack or pulled through sleeves or laid directly in the ground of the following sizes:				
3,1	Profinet Network Cables	m	3000		R -
3,2	Ethernet Cable (Cat 6)	m	3000		R -
4.0	**Control Cables**				
	Supply and install Copper control cables complete with terminations on a rack or pulled through sleeves or laid directly in the ground of the following sizes:				
4,1	12-Core 1.5mm² Cable	m	3000		R -
4,2	5-Core 2.5mm² Cable	m	3000		R -
5.0	**Additional**				
	Any additional items the Tenderer deems necessary for the successful completion of the installation (specify)				
5.1					R -
5.2					R -
5.3					R -
5.4					R -
5.5					R -
	TOTAL CARRIED TO FINAL SUMMARY PAGE				R -

	SECTION 13 : LOW VOLTAGE RETICULATION				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**LV Cables**				
	Supply and install PVC/PVC/SWA/PVC Copper cables (SANS 1507; 600V/1000V) on a rack or pulled through sleeves or laid directly in the ground of the following sizes: Note all cables to be of type: • FYRGARD - Flame Retardant Cable: Red Stripe • 4th Core to be used as Earth • CT0340-EL-LST-0100 (Cable List)				
1,1	185 mm² 4 core Cu	m	440		R -
1,2	150 mm² 4 core Cu	m	30		R -
1,3	120 mm² 4 core Cu	m	170		R -
1,4	95 mm² 4 core Cu	m	50		R -
1,5	70 mm² 4 core Cu	m	282		R -
1,6	35 mm² 4 core Cu	m	80		R -
1,7	25 mm² 4 core Cu	m	250		R -
1,8	16 mm² 4 core Cu	m	100		R -
1,9	6 mm² 4 core Cu	m	100		R -
1,10	4 mm² 4 core Cu	m	340		R -
1,11	2,5 mm² 4 core Cu	m	300		R -
1,12	1,5 mm² 4 core Cu	m	750		R -
1,13	95 mm² PVC Insulated Earth Wire	m	220		R -
1,14	70 mm² PVC Insulated Earth Wire	m	200		R -
1,15	35 mm² PVC Insulated Earth Wire	m	200		R -
2.0	**LV Cables**				
	Supply and install cable ends complete with glands, lugs and shrouds of the following sizes:				
2,1	185 mm² 4 core Cu	ea	8		R -
2,2	150 mm² 4 core Cu	ea	2		R -
2,3	120 mm² 4 core Cu	ea	2		R -
2,4	95 mm² 4 core Cu	ea	2		R -
2,5	70 mm² 4 core Cu	ea	8		R -
2,6	35 mm² 4 core Cu	ea	16		R -
2,7	25 mm² 4 core Cu	ea	24		R -
2,8	16 mm² 4 core Cu	ea	8		R -
2,9	6 mm² 4 core Cu	ea	4		R -
2,10	4 mm² 4 core Cu	ea	16		R -
2,11	2,5 mm² 4 core Cu	ea	16		R -
2,12	1,5 mm² 4 core Cu	ea	16		R -
2,13	95 mm² PVC Insulated Earth Wire	ea	4		R -
2,14	70 mm² PVC Insulated Earth Wire	ea	20		R -

2,15	35 mm² PVC Insulated Earth Wire	ea	20		R	-
3.0	**Miscellaneous Items**					
	Supply and Install the following complete as specified:					
3.1	Cable Identification Markers (Engraved Trafolite Labels)	ea	202		R	-
3.2	E-Stop/Start Station Mounted to 3CR12 Backplate	ea	22		R	-
4.0	**Additional**					
	Any additional items the Tenderer deems necessary for the successful completion of the installation (specify)					
4.1					R	-
4.2					R	-
4.3					R	-
4.4					R	-
4.5					R	-
	TOTAL CARRIED TO FINAL SUMMARY PAGE				R	-

	SECTION 14 : CABLEWAYS				
Ref.	**Description**	**UNIT**	**QTY**	**UNIT RATE**	**TOTAL**
1.0	**Cable Ladder (600mm x 75mm) Heavy Duty**				
	Supply and install galvanized steel cable ladder (heavy duty) type complete with all fixing materials of the following sizes:				
1,1	Straight lengths (linear meters)	m	150		R -
1,2	Horizontal bend (90deg)	ea	5		R -
1,3	Internal riser	ea	5		R -
1,4	External dropper	ea	10		R -
1,5	T (600mm to 400mm)	ea	2		R -
1,6	Hangers fixed to soffit, roof structure or walls	ea	40		R -
2.0	**Cable Ladder (400mm x 75mm) Heavy Duty**				
	Supply and install galvanized steel cable ladder (heavy duty) type complete with all fixing materials of the following sizes:				
2,1	Straight lengths (linear meters)	m	200		R -
2,2	Horizontal bend (90deg)	ea	10		R -
2,3	Internal riser	ea	10		R -
2,4	External dropper	ea	5		R -
2,5	T (400mm to 200mm)	ea	5		R -
2,6	Hangers fixed to soffit, roof structure or walls	ea	80		R -
3.0	**Cable Ladder (150mm x 75mm) Heavy Duty**				
	Supply and install galvanized steel cable ladder (heavy duty) type complete with all fixing materials of the following sizes:				
3,1	Straight lengths (linear meters)	m	500		R -
3,2	Horizontal bend (90deg)	ea	15		R -
3,3	Internal riser	ea	10		R -
3,4	External dropper	ea	10		R -
3,5	T (200mm to 200mm)	ea	5		R -
3,6	Hangers fixed to soffit, roof structure or walls	ea	200		R -
4.0	**Cable Tray (200mm) Heavy Duty**				
	Supply and install galvanized steel cable tray (heavy duty) type complete with all fixing materials of the following sizes:				
4,1	Straight lengths (linear meters)	m	500		R -
4,2	Horizontal bend (90deg)	ea	10		R -
4,3	Internal riser	ea	10		R -
4,4	External dropper	ea	5		R -
4,5	Hangers fixed to soffit, roof structure or walls	ea	100		R -

5.0	**Bosal Conduit**					
	Supply and install diameter bosal conduit, complete with all fixtures, sadles, bends, end boxes.					
5,1	25mm	m	1000		R	-
5,2	20mm	m	1000		R	-
6.0	**Additional**					
	Any additional items the Tenderer deems necessary for the successful completion of the installation (specify)					
6.1					R	-
6.2					R	-
6.3					R	-
6.4					R	-
6.5					R	-
	TOTAL CARRIED TO FINAL SUMMARY PAGE				R	-

	SECTION 15 : Health & Safety				
Ref.	Description	UNIT	QTY	UNIT RATE	TOTAL
1.0	Compliance with the Health and Safety Specification				
2.0	Compliance with the requirements of the Occupational Health and Safety Act, 85 of 1993 and Construction Regulations, 2014 (for Health and Safety Plan see separate item).	Sum	1		
3.0	Liaison, co-ordination and chairing of meetings in respect of Health and Safety requirements.	Sum	1		
4.0	Contractor's initial obligation in respect to the Occupational Health and Safety Act and Construction Regulations, including the preparation of a Health & Safety Plan.	Sum	1		
5.0	Provision for preparing a Hazard Identification and Risk Assessment (HIRA)	Sum	1		
6.0	Provision for the development of a documented Plan of OH&S Method Statements and/or Safe Work Procedures	Sum	1		
7.0	Provision for occupational health (Medicals – pre and post employment; Physical and Psychological for work at elevated heights; Medical surveillance for hazardous work; Baseline & audiometric screening tests; HIV and AIDS Programme; etc.)	Sum	1		
8.0	Provision for medical certificates of fitness, issued by a registered Occupational Health Practitioner, for all contractor's employees on site	Sum	1		
9.0	Provision for protective equipment, protective clothing and equipment	Sum	1		
10.0	Provision for occupational health and safety signage, pictograms and notices	Sum	1		
11.0	Provision of full time Construction Manager	Sum	1		
12.0	Provision of a competent, part time Safety Officer who will carry out at bi-weekly safety audits of site	Sum	1		
13.0	Provision for ensuring Contractor(s) compliance to statutory requirements, including monitoring and auditing of Contractor(s)				
14.0	Allwance for radiation safety training	Sum	1		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

SECTION 16 : Sundries

Ref.	Description	UNIT	QTY	UNIT RATE	TOTAL
1.0	Providing "as built" drawings (GA's, P&ID's) in the latest AutoCAD version as well as 3 additional hard copies.	Item	1		
2.0	Providing 2 draft copies of the Installation, Operation and Maintenance Manual prior to commissioning of the Works.	Item	1		
3.0	Providing 6 final copies of the Installation, Operation and Maintenance Manual prior to the issue of the Taking -Over Certificate.	Item	1		
4.0	Operating Instructions and Signage, as specified.	Item	1		
5.0	Price for providing an asset list with Tag numbers.	Item	1		
6.0	Provision of all Test Certificates and Certificate of Compliance in terms of the Code of Practice for Wiring of Premises.	Item	1		
7	Operational and Maintenance Training	Item	1		
8.0	Trial Operation Period Obligations.	Item	1		
9.0	Maintaining the Works during the Defects Notification Period.	Item	1		
10.0	Maintenance inspection every 3, 6, 9 and 12 months after take over. Provide a short report to Engineer.	Item	1		
11.0	Provide equipment tag numbers for all equipment and revise tag numbers upon appointment by the Client.	Sum	1		
	TOTAL CARRIED TO FINAL SUMMARY PAGE				

Annexure B – Mechanical Specification

DETAILED TECHNICAL SPECIFICATION	PROJECT ASSIGNMENTS Process & Project Engineers

DOCUMENT TITLE:	**S4 Tender Technical Specification: Mechanical**
DOCUMENT No.	**W1986-21002-00**

Upgrade Of the Heating, Ventilation and Air Conditioning (HVAC) System at D-Block & N-Block

Detailed Mechanical Specification

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS 2
1. GENERAL 4
Background 4
2. DETAILED SCOPE OF WORK 4
3. CONTRACTOR'S RESPONSIBILITY WITH REGARDS TO CIVIL WORK 6
3.1. Material Of Construction 6
3.1.1. Specification For Concrete Work 6
3.1.2. Project Specification 6
3.2. Quality Management 7
3.3. Requirements for General Remedial Civil Works 7
3.3.1. Concrete Repairs 7
3.3.2. Surface Preparation 7
3.3.3. Application 7
3.3.4. Break out Concrete or Brickwork and make good 7
3.4. Concrete Joints 8
3.5. Tolerances 8
3.6. Testing 8
4. SYSTEM OPERATION AND DUTIES 9
4.1. Reference Specifications 9
4.2. System Design 9
4.3. EXTRACTION SYSTEMS 11
5. DESIGN AND MANUFACTURE 13
5.1. Ducting 13
5.2. Diffusers/Grilles 13
5.3. Air Handling Unit - must comprise the following minimum features: 14
5.4. Control Panel and Motor 14
6. QUALITY, INSPECTION AND TESTING 16
7. DELIVERY, INSTALLATION AND COMMISSIONING 17
7.1. The Contractor shall be responsible for the following aspects of Installation Qualification: 17
7.2. The Contractor shall be responsible for the following aspects of Operational Qualification testing: 17
7.3. The Contractor shall be responsible for the following aspects of Performance Qualification testing: 18
8. LIST OF DRAWINGS 19
9. LIST OF DATASHEETS, SCHEDULES AND LISTS 20

LIST OF ILLUSTRATIONS

Table 1:Air Handling Units Design Data 9
Table 2: Existing Extraction System 11
Table 3: New Extraction System 12
Table 4: List of Drawings 19
Table 5: List of Datasheets & Lists 20

1. GENERAL

Background

iThemba LABS is in the process of upgrading and expanding its existing facility for the production of medical radioisotopes and radiopharmaceutical products under Good Manufacturing Practise (GMP) quality requirements.
The radiological controlled general areas and hotcells are in turn supplied with air from an air handling unit (AHU) which filters and cools fresh air with assistance from an existing chiller plant. Air is exhausted from the radiological controlled general areas via extraction fans through separate HEPA filters and discharged to atmosphere via high-velocity exhaust stacks.
Operations inside the radiological controlled areas and cleanrooms involve the handling and chemical processing of radioactive substances. Differential air pressures inside the cleanrooms and radiological controlled areas, fume cupboards and hotcells must therefore manage by a system designed to maintain negative pressures inside the controlled areas relative to atmosphere, in order to minimise the potential escape of airborne radioactive contamination, whilst maintaining positive pressures inside the cleanrooms relative to the controlled area in order to avoid the ingress of airborne contaminants into the cleanroom.
The 5 cleanrooms are located inside radiological controlled areas, where each cleanroom draws supply air from the general area through high-efficiency particulate air (HEPA) filters. Air is then exhausted via biohazard cabinets with integral filtration systems back to the general areas and eventually to atmosphere via the general area extraction system through a HEPA filter bank and an exhaust stack. Some cleanrooms are equipped with biohazard isolators that are exhausted directly to the exhaust stacks of the general plant through the HEPA filter bank.
The existing heating, ventilation and air conditioning (HVAC) system requires upgrading and/or replacement in order to maintain the required air flow, air temperature and relative humidity in all the radiological controlled areas in accordance with modern GMP requirements as well as the air quality requirements of the cleanrooms to Grade B standard.
iThemba LABS has appointed as Principal Agent, the service provider Project Assignments, who will act on behalf of iThemba LABS in managing the contractor to ensure successful execution of the project. BCE (Buhrmann Consulting Engineers) has been appointed as the Electrical Engineering Sub-Consultant.

2. DETAILED SCOPE OF WORK

2.1 Design Verification / Clarification

The contractor shall allow for a period of 3 days for a complete review of the proposed design with the Client and Consultant team. This will allow for any further clarifications and optimisation of the proposed design. It should be noted that this step does not affect the design responsibility, which remains the responsibility of the Client i.e. FIDIC RED Book Contract.

2.2 Removal of Redundant Equipment

As mentioned, the facility has an existing HVAC system which will be upgraded under this contract. This therefore means that the redundant systems shall be removed by the Contractor and placed in a location on site identified by the Client.
The Contractor shall take note that where ducting is to be removed inside ceiling voids, the rates offered in the BOQ shall include the appropriate measures to access the applicable ducting. This includes, but is not limited to, all the existing ducting inside the five cleanrooms and the associated changerooms.
The equipment that is required to be removed on the 6m slab is easily accessible via the existing overhead gantry crane to be used during construction.
The Contractor shall take note that special care shall be taken when any possibly contaminated equipment is to be removed. This includes the removal of anything involving the extraction systems such as, but not limited to, the removal and replacement of the extraction fans. The Client's responsible person shall be involved in the procedure for all this type of work, and anything related to possible contamination.

2.3 New Air Handling Units (AHU)

New AHUs shall be supplied and installed as per the respective datasheets, specifications and relevant drawings supplied.
The AHUs shall have the various filter banks, cooling coils and heating as specified. Chilled water is existing on site and shall simply be connected by the contractor as indicated on the relevant drawings. The ducting network diagrams clearly indicate which ducting needs to be removed, modified and where new ducting shall be installed.

As-built drawings have been supplied of the existing HVAC system supplying the Cleanrooms and associated changerooms. The Existing system consists of a booster fan with a duct network supplying terminal HEPA filters. The entire system shall be removed completely, except the terminal filter housing which shall be reused for the new system. It should be noted that these system's ducting network is above the ceiling and costing shall allow for the removal and installation of new ducting.
The new system shall have the AHU located on the 6m slab and new ducting shall be supplied and installed by the contractor (above the ceiling space) as shown on the respective drawings, and therefore rates supplied shall be inclusive of this installation requirement as well as the fixing method for supports.

2.4 Extraction Systems

The existing extraction systems shall remain in place as the scope of work has been purposefully limited on these systems to avoid handling of possibly contaminated material. However, all the fans shall be replaced with larger fans for increased capacity, within the same footprint.

Fans E8 and E9 do not currently have any redundancy, which will be added under this contract via a platform above the existing fans. This however requires a tie-in to the existing extraction ducting with actuated dampers to avoid any possible backflow in this system.

A new dedicated system shall be installed for the extraction of the Cyclotron area, E10A/B, as shown on the respective drawing. This also requires a tie-in to an existing extraction duct, with the required actuated damper to avoid any possible backflow in the system. It should also be noted that the suction side ducting of this system penetrates the side cladding of the extraction building, which is asbestos material. The contractor shall therefore allow for handling of this asbestos material and replace it with rockwool Isopanel once the ducting installation is completed.

2.5 Instrumentation and Control
The instrumentation as per the supplied P&IDs shall be supplied and installed in order to affect the respective system's desired control system.

2.6 Minor Building Works
As a result of ducting routing, electrical cabling and any other possible requirements, there are minor building works also required in this contract. Openings in masonry walls, concrete or Isopanels, where required shall be included in the scope of works of the Contractor as described in the BOQ.

2.7 Testing, IQ, OQ and PQ
The various tests as required in this specification is the responsibility of the Contractor with support of the design team.

2.8 Electrical Installation
This is described and specified in more detail in the electrical technical specification. The Contractor shall supply and install all the electrical equipment associated with the systems described above as specified in the electrical specification.

2.9 Training
The contractor shall provide documented training of the iThemba LABS staff with the handover of the system to the Client.

3. CONTRACTOR'S RESPONSIBILITY WITH REGARDS TO CIVIL WORK

The scope of civil work under this contract includes the following:

i) General remedial civil works (including damaged and spalled concrete), as required in this specification, to concrete where equipment is being removed and replaced under this contract.

ii) Dispose of all construction debris offsite, as a result of i) above, to an approved location.

iii) Breaking out of concrete and brickwork in walls and slabs for the purpose of modifying the existing structures for forming new piping or ducting penetrations. This may be done by cutting or core drilling as appropriate.

iv) Breaking out or removal of asbestos sheeting for forming new piping or ducting penetrations. Any work involving asbestos shall be completed by an approved sub-contractor including certified disposal of any removed material.

v) Coredrilling openings for ducting, piping or electrical conduits

vi) Openings in Isopanel walls for ducting or air grilles.

3.1. Material Of Construction

As a guide, the following specification for concrete works is applicable:-

3.1.1. Specification For Concrete Work

All in situ concrete work (mass and reinforced) shall comply with SANS 2001-CC1 (latest edition thereof) supplemented by the following Project Specification. Where SANS 2001-CC1 and the Project Specification are in conflict, the Project Specification shall take precedence.

Wherever the term "Engineer" appears in SANS 2001-CC1 or in the following Project Specification this shall be deemed to mean the Principal Agent's representative responsible for this section of the Works.

3.1.2. Project Specification

The following amplifications, additions and amendments to SANS 2001-CC1 shall constitute the Project Specification.

<u>Classification of Finishes</u>

Smooth - Imperfections such as small fins, bulges, irregularities, surface honeycombing and surface discolorations shall be made good and repaired by approved methods. The finish of the concrete shall be accurate to Degree of Accuracy II.

Concrete mix

The use of ready-mixed concrete and the acceptability of test results from a central concrete production facility shall be subject to the review of the Engineer.

Frequency of sampling and testing

The frequency of sampling and testing shall be as directed by the Engineer, but not less than one set of test cubes from every 50m³ cast.

3.2. Quality Management

All building and civil works shall be in accordance with SANS 1200 and SANS 10400 and any other applicable SANS documents. Designs shall be submitted for review prior to commencement of construction. Quality control inspections shall be conducted by the Contractor's Engineer at regular intervals.

3.3. Requirements for General Remedial Civil Works

All concrete work shall comply with SANS 2001-CC1 (latest edition thereof).

3.3.1. Concrete Repairs

Concrete repairs shall be carried out, where detailed elsewhere in this specification, to reinstate sections of degraded concrete or to finish off rough edge exposed by demolition.

3.3.2. Surface Preparation

The surface to which repair mortar is to be applied shall be thoroughly cleaned by high pressure water jetting or by wire brushing and compressed air. The surfaces shall be free of loose material, laitance, dirt, grease, oil and rust.

In addition, the surface preparation shall comply with any additional requirements of the manufacturer of repair mortar to be used.

3.3.3. Application

The repair mortar shall be applied strictly in accordance with the manufacturer's instructions by trained applicators.

3.3.4. Break out Concrete or Brickwork and make good

Separate items will be scheduled for different materials and different areas with different working conditions. The item shall cover all costs associated with breaking out concrete or brickwork in walls and slabs for the purpose of modifying the existing structures or forming new pipe penetrations. The rate shall include removal from site and disposal of the waste material. It shall also cover for making good the broken edges with an approved epoxy mortar (Sika Monotop 620 or equivalent approved) with a steel float finish to the Engineers satisfaction.

The quantity measured shall be the net volume of concrete or brickwork required to be removed based on the actual average thickness of the sections to be broken out and the extent of the sections to be broken out shown on the drawings or directed by the Engineer. No payment will be made for over-break unless with prior approval by the Engineer.

3.4. Concrete Joints

All jointing materials shall be carefully stored and protected to avoid damage, distortion or contamination by other materials prior to use. They shall be applied by trained applicators, strictly in accordance with the manufacturer's instructions and as approved.

3.5. Tolerances

The permitted tolerances in concrete work shall be to a Degree of Accuracy II as specified in Sub-Clause 5.2 of SANS 2001-CC1 (latest edition thereof) for Structural Concrete Works.

3.6. Testing

Sampling and Testing of concrete to comply with Clause 5.1 of SANS 2001-CC1 (latest edition thereof) for Structural Concrete Works.
The cost of sampling and testing shall be to the Contractor's account, including where check tests have failed.
Payment for the cost of taking and crushing concrete cubes shall be deemed to be included in the Contractor's rates for concrete.

4. SYSTEM OPERATION AND DUTIES

4.1. Reference Specifications

The facility is serviced by a heating, ventilation and air conditioning (HVAC) plant, which requires upgrading and/or replacement in order to meet stringent Good Manufacturing Practise (GMP) quality requirements.
The upgraded/new HVAC system must conform to the requirements of the following design standards or guidelines:

- International Society of Pharmaceutical Engineers Good Practice Guide for Heating, Ventilation and Air Conditioning
- ISO 17873: Nuclear Facilities – Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors
- ISO 14644: Cleanrooms and Associated Controlled Environments
- IAEA General Safety Guide No. GSG-7 Occupational Radiation Protection
- World Health Organisation (WHO) Technical report Series TRS-1010 Annex 2 – Guidelines on heating, ventilation and air-conditioning systems for non-sterile pharmaceutical products Part 2
- *iThemba LABS URS – Document No. RPG-SPE-0052

*This tender technical specification takes preference over the above-mentioned URS.

4.2. System Design

The heating, ventilation and air conditioning (HVAC) system consists of 8 air handling units (AHUs) and 14 extraction fans, servicing 8 distinct areas in the facility. Each AHU is fitted with two fans (duty/standby), a cooling coil, and an electric heating element. The 14 extraction fans are divided into pairs (duty/standby) that each service one or two of the 8 distinct areas.
The table below shows the temperature, pressure, and air grade requirements of each of the 8 areas serviced by the HVAC system.

Table 1:Air Handling Units Design Data

AHU	Area	Zone in which Area is Located	Temperature (°C)	Pressure (Pa)	Air Grade
1	Blue Zone General Areas	Blue	20°C ± 2°C	-40	D
2	Cleanroom 1	Blue	20°C ± 2°C	-5	B
	Cleanroom 2	Blue		-5	B
	Cleanroom 3	Red		-45	B
3	Cleanroom 4	Blue	20°C ± 2°C	-5	B
	Cleanroom 5	Blue		-5	B

4	Red Zone Ground Floor	Red	20°C ± 2°C	-80	D
5	Red Zone Basement	Red	20°C ± 2°C	-80	D
6	Cyclotron	Red	20°C ± 2°C	-80	D
7	Elephant Vault	Red	20°C ± 2°C	-80	D
	VBTS Vault	Red		-80	D
8	Hot Cells	Red	20°C ± 2°C	-200	B

Each of the cleanrooms in the table above, has two changerooms (changerooms 1 and 2) leading to it. Changeroom 1, as the first changeroom, interfaces with the general Blue or Red areas and has a Grade C air classification. Changeroom 2 is located between Changeroom 1 and the Cleanroom itself, with Grade B air classification; similar to the Cleanrooms.

The HVAC system is therefore designed to supply three Grades of air, namely, B, C, and D. To achieve the respective cleanliness Grades, stepwise filtration is employed. For Grade D areas, primary and secondary filtration is used, while for Grades B and C, tertiary terminal HEPA filtration is added.

The system is designed to maintain 40ACH in all Grade B areas, 30ACH in all Grade C areas, and 15ACH in all Grade D areas. Within the Grade D areas, the Basement is an exception and is thus kept at 7.5ACH. A key requirement of the HVAC system is the maintenance of a pressure cascade throughout the facility. The system is therefore designed to keep the Blue zone and Red zone (except for the Hot Cells) at –40Pa and –80Pa respectively, each relative to atmospheric pressure. The Cleanrooms, with their respective Changerooms 1 and 2 shall each maintain a pressure differential of +35Pa, +30Pa, and +20Pa respectively; relative to the zone in which they are located. This means that for Cleanrooms 1, 2, 4, and 5 (and Changerooms 1 and 2 for each), the internal pressure is relative to the Blue zone (-40Pa), and for Cleanroom 3, it is relative to the Red zone (-80Pa). As mentioned above, the Hot Cells are maintained at a different pressure than the Red zone in which they are located; the system is designed to maintain the Hot Cells at –200Pa relative to atmospheric pressure.

A key constraint in the design of the HVAC system is the use of the existing supply and extraction ducting as far as practically possible. However, another key requirement is the removal of all flexible ducting in the supply ducting network. As such, some of the supply ducting is resized to ensure adequate flow. The duct sizing is based on a maximum flow speed of 12m/s.

As shown in the table above, the HVAC systems is designed to maintain an ambient temperature of 20°C ± 2°C. This temperature is monitored by temperature-indicating controllers (TIC) in each area, that in turn control the function of the cooling coil and heating element. The pressure required in each is monitored by pressure-differential indicators (PDI) strategically placed in each area. The PDIs do not control anything in the system, they are solely for monitoring the state of the required pressure cascade. The pressure cascade is adjusted and controlled by flow transmitters (FT) in the supply and extraction ducts. The FTs in the supply ducts control the functioning of the supply fans, while those in the extraction ducts control that of the extraction fans.

4.3. EXTRACTION SYSTEMS

The existing extraction system consists of 10 extraction fans and 10 HEPA filter banks. These fans and filter banks service the 8 areas supplied by the 8 AHUs detailed above. The following table shows the existing fans and the areas they service.

Table 2: Existing Extraction System

Fan	Fan Redundancy	Filter Bank Redundancy	Areas Serviced
	Y/N	Y/N	
E4	Y	Y	Red Zone Ground Floor & Basement
E5	Y	Y	Blue Zone General Areas
E6	Y	Y	Elephant Vault & VBTS Vault
E7	Y	Y	Hot Cells
E8	Y	N	Red Zone Fume Hoods
E9	Y	N	Blue Zone Fume Hoods

Note that fans E4 to E7 each have duty and standby fans and filter banks. Fans E8 and E9, on the other hand, have no redundancy whatsoever. The update of the extraction systems entails the addition of standby fans for E8 and E9. No redundant filter banks are added for these fans; thus, they remain with no filtration redundancy. In addition, to the standby fans for E8 and E9, a new extraction line is added for dedicated extraction in the Cyclotron room. This line is serviced by new fans E10 (duty & standby) and a new HEPA filter bank (no standby filter bank).
The HVAC system is designed with a built-in 20% additional capacity. This is required to accommodate future expansion of the facility. Therefore, the last step of the extraction system upgrade is the replacement of all the existing fans, to meet this additional capacity.
The resulting extraction system therefore consists of 14 extraction fans and 11 HEPA filter banks. The table below shows the new extraction configuration.

Table 3: New Extraction System

Fan	Fan Redundancy	Filter Bank Redundancy	Areas Serviced
	Y/N	Y/N	
E4	Y	Y	Red Zone Ground Floor & Basement
E5	Y	Y	Blue Zone General Areas
E6	Y	Y	Elephant Vault & VBTS Vault
E7	Y	Y	Hot Cells
E8	Y	N	Fume Hoods (Red & Blue Zones)
E9	Y	N	Cleanrooms 1 through 5
E10	Y	N	Cyclotron

5. DESIGN AND MANUFACTURE

5.1. Ducting

5.1.1. All ducting inside the cleanroom areas shall be sectioned off with ISO panelling as required. Particularly for the return air which is at low level.

5.1.2. Ducting (external to cleanroom areas): If installed shall be galvanised sheet metal. The sealer and gaskets used on duct joints shall not support microbial growth and each joint shall be externally “waterproofed” using membrane and sealing agent to ensure no leakage or condensation. All bolts, nuts and washers shall be stainless steel. Only sealed pop rivets shall be used. The ducting shall be fully compliant with ISO 14644.

5.1.3. Duct cleanliness – The insides of the ducts shall be kept clean during erection and all open ends shall remain capped at all times. Care shall be taken that dirt, metal shavings etc. do not dirty the duct when spigots require fitting. The duct cleaning and capping process shall be carried out in a dust free environment.

5.1.4. The duct system shall be fitted with adequate OBD’s (Opposed Blade Dampers) with locking quadrants and position indicators to enable easy air balancing of each duct leg.

5.1.5. Inspection hatches shall be provided for at all supply and return main branches.

5.1.6. After installation, all ducting shall be pressure tested in accordance with the requirements as specified in ISO 14644.

5.1.7. Duct insulation in ceiling/roof voids shall be 50mm thick foil faced fibreglass (FRK) i.e. two layers x 25mm.

5.1.8. Special care must be taken to ensure that all ducting is thoroughly insulated and that the vapour barrier is never compromised.

5.1.9. Galvanised steel “Cross over Stairs” shall be provided over ducting at all pedestrian traffic cross over points.

5.1.10. The air flow patterns shall ensure adequate crossflow throughout the rooms, especially the cleanrooms, based on high level supply and low level return.

5.2. Diffusers/Grilles

5.2.1. Diffusers and grilles shall have a smooth white epoxy finish. Grilles and diffusers shall be fitted with balancing devices. All grilles (supply, return and exhaust) shall have concealed fixings. No screw fixings through the grille frames will be accepted. All grilles and diffusers must be able to withstand periodic cleaning and all junctions between grille / diffuser frames and walls / ceilings shall be silicone sealed. Supply air grilles and diffusers shall have

provision for full control adjustment over the discharging airstream, without taking down any part of the grille or diffuser.

5.3. Air Handling Unit - must comprise the following minimum features:

5.3.1. Insulated plenum to house the components, plenum to be water tight

5.3.2. Plenum to have an access door to each compartment

5.3.3. Access doors to have camlock handles and gaskets

5.3.4. Compartment doors must open in such a way that the fan pressure holds the door closed

5.3.5. S/S lined on the interior

5.3.6. Each compartment shall have an integral light fitting operated by a single switch

5.3.7. Fresh air inlet grille and balancing damper

5.3.8. Cooling coil – to be copper coil/copper fin/stainless steel casing served by chilled water at 8°C.

5.3.9. Stainless steel drip tray which protrudes a minimum of 300mm downstream of the leading edge of the cooling coil shall be provided to collect all condensate

5.3.10. The outlet of the drip tray to be trapped correctly to ensure no entry of insects etc. the depth of trap to be sufficient to compensate for the pressure in the plenum

5.3.11. Double inlet backward curved centrifugal fan with variable speed drive, as applicable for the particular application

5.3.12. Primary filters – G4 rating per EN779

5.3.13. Secondary filters – F9 rating per EN779

5.3.14. HEPA filters – H14 rating per EN1822

5.3.15. DOP test ports for HEPA filtration integrity tests

5.3.16. Magnahelic pressure differential gauges over each bank of filter

5.3.17. Supply air duct connection

5.3.18. Integral Electrical control panel per AHU

5.3.19. Electrical isolator switch provided

5.4. Control Panel and Motor

5.4.1. The control panel shall be located at an easily accessible location.

5.4.2. The material of construction of the control panel shall be as per electrical specifications, rated IP55 minimum

5.4.3. The control panel shall display/perform the following:

- System status – On/Off/Run/Trip
- Humidity alarms
- Monitor system humidity
- Temperature alarms for individual rooms
- Monitor and control room temperatures
- Dirty filter alarms
- Differential pressure between rooms – Magnahelic gauges
- Switch the fan and monitor status
- Fan variable speed drives
- Switch off plant on receipt of a fire signal (provided by others)
- Airflow indication, airflow failure

5.4.4. The motor control centre (MCC) manufacturer used must be SABS approved if 10kA or greater.

5.4.5. Electric motor shall be of the high efficiency type and suitable for 380V Volt, 3 phase, and earthed neutral 50Hz supply.

5.4.6. Motors shall have ingress protection rating of IP55.

5.4.7. Motors shall be compatible for the inclusion of variable speed drives

5.4.8. Local lockable isolators shall be provided for all motors.

6. QUALITY, INSPECTION AND TESTING

6.1. The contractor shall provide two Operational and Maintenance Manuals with O & M Manual in electronic (PDF) format.

6.2. The O & M Manuals shall include but not be limited to the following:

- The latest approved Functional Design Specification and / or Detailed Design Specification.
- Operating Instructions (Detailed instructions for the operation of all components of the HVAC system) E.g. Normal start-up and shutdown procedures. Emergency shut down procedures. Operation of all safety devices. Troubleshooting / fault finding for the system. Control System Operation
- Maintenance Instructions including maintenance schedules stipulating details of tasks to be performed and frequency, for all equipment and components of the systems.
- Mechanical Equipment Data Sheets List of critical spares. List of all components installed with make, model, range / duty etc., serial numbers (part of IQ), supplier name and contact details.
- Electrical Equipment Data Sheets List of all components installed with make, model, range / duty etc., serial numbers (part of IQ), supplier name and contact details.
- Commissioning / Qualification Records
- Installation checklists (IQ)
- OQ - Commissioning records and plans (reference drawings with referenced equipment numbers and measuring points) for duct & pipe pressure tests, air flow rates, air change rates, equipment performance (fan speeds, power consumed, etc.), filter integrity tests, control system operational checks, control operational and default values.
- Calibration certificates for all installed measuring equipment as well as portable test / measuring equipment.
- As-Built Drawings (hard copies as well as in Auto Cad / Electronic format)
    - Electrical
    - P & ID
    - Mechanical

7. DELIVERY, INSTALLATION AND COMMISSIONING

7.1. The Contractor shall be responsible for the following aspects of Installation Qualification:

7.1.1. The Supplier shall provide written confirmation (in matrix format) that the system has been installed as designed and specified.

7.1.2. Cleaning of the system during and after installation.

7.1.3. Confirmation that the correct size and motor types have been installed for all components.

7.1.4. Commissioning, and documentation thereof, of all HVAC components.

7.1.5. Completion of all installation qualification documentation as required.

7.1.6. Balancing supply and return air to meet the requirement as specified to ensure air flow, temperature and humidity requirements are met and sustained before commencement of OQ. Documented evidence shall be provided.

7.1.7. The supplier shall be responsible for identifying and testing of all controls, indicators and safety devices.

7.1.8. Tagging and labelling of all main components of the system and ensuring that these are indicated on the P&ID.

7.2. The Contractor shall be responsible for the following aspects of Operational Qualification testing:

7.2.1. Balancing of the HVAC system, to ensure an even flow, temperature, pressure cascades and humidity distribution throughout the rooms.

7.2.2. The procedure for commissioning shall, as a minimum, be as follows:

- After installation qualification, the system shall be run.
- The temperature and humidity shall be mapped using a calibrated hand-held instrument by the contractor.

7.2.3. The following testing shall be completed as a minimum in all areas:

- Duct pressure / leakage test
- Air handling unit pressure / leakage test
- Supply air flows (per diffuser)
- Extract air flows (Per grille)
- Air changes per hour verification (per room)
- Temperature mapping
- Pressure cascade verification

7.2.4. The following testing shall be performed in all Grade B and Grade C areas only:

- Non-viable particle counts (per room where applicable)
- Room Recovery tests
- HEPA filer integrity tests
- Air flow pattern tests (visual representation – approved video or witnessed diagrammatic)

7.3. The Contractor shall be responsible for the following aspects of Performance Qualification testing:

7.3.1. Pressure cascades, temperature and humidity.

7.3.2. The Contractor shall be responsible for recording and documenting room temperature and humidity results for the rooms, and shall be responsible for ensuring that the necessary backup is provided to address any problems that may be observed during this phase of the OQ.

7.3.3. Demonstration and documentation shall include, but not be limited to the following activities for each system:

- Controller input and output records (DI, DO, AI and AO).
- Switch the fan motors and monitor fan motor status.
- Control temperature (heating and cooling).
- Display real time temperature and humidity values
- Generate alarms (no air flow, dirty filter, high & low temperature and humidity, fire signal).
- Emergency push button operation (AHU)
- Alarm history report.
- High level password change report.
- Switch off plant on receipt of a fire signal.
- Automatic re-start the plant after a power failure.
- Power usage.

7.3.4. The Contractor shall be responsible for the training of iThemba LABS Technicians on all operation and maintenance aspects of the installed plant. A record of training must be documented.

8. LIST OF DRAWINGS

The following drawings are applicable to the contract and are issued with this tender document and will form part of the Contract Documents.

Table 4: List of Drawings

Drawing Number and short Description
W1986-41001-00 iThemba Labs HVAC Upgrade Single Fan AHU PFD-A2
W1986-41002-00 iThemba Labs HVAC Upgrade Double Fan AHU PFD-A2
W1986-41002-01 iThemba Labs HVAC Upgrade Double Fan AHU PFD-A1
W1986-45005-04 iThemba Labs HVAC Upgrade Double Fan AHU1, 2 & 4-A0
W1986-45006-04 iThemba Labs HVAC Upgrade Double Fan AHU5 & 6-A0
W1986-45007-04 iThemba Labs HVAC Upgrade Double Fan AHU3A & B-A0
W1986-45008-02 iThemba Labs HVAC Upgrade Double Fan AHU2 - Hot Cells-A0
W1986-45009-00 iThemba Labs HVAC Upgrade Chilled Water Supply-A0
W1986-45010-00 iThemba Labs HVAC Upgrade Chilled Water Return-A0
W1986-55001-03 SHT1 iThemba LABS Proposed 7AHU 6m Level Layout-A0
W1986-55001-03 SHT2 iThemba LABS Proposed 7AHU 6m Level Layout-A0
W1986-55002-01 iThemba Labs Cyclotron Ducting Layout-A0
W1986-55003-01 iThemba Labs Cleanroom 1 Layout-A1
W1986-55004-01 iThemba Labs Cleanroom 2 Layout-A1
W1986-55005-01 iThemba Labs Cleanroom 3 Layout-A1
W1986-55006-01 iThemba Labs N13 Cleanroom 4 Layout-A1
W1986-55007-01 iThemba Labs N15 Cleanroom 5 Layout-A1
W1986-55015-00 iThemba Labs E8 Extraction Layout-A0
W1986-55016-00 iThemba Labs E9 Extraction Layout-A0
W1986-57001-00 iThemba Labs Blue Area Schematics-A0
W1986-57002-00 iThemba Labs Blue Area Extraction Schematic-A0
W1986-57003-00 iThemba Labs Cleanrooms 1, 2 & 3 Supply Schematic-A0
W1986-57004-00 iThemba Labs Cleanrooms 4 & 5 Supply Schematic-A1
W1986-57005-00 iThemba Labs Cyclotron Supply Schematic-A1
W1986-57006-00 iThemba Labs Cyclotron Extraction Schematic-A1
W1986-57007-00 iThemba Labs Red Zone Ground Floor Supply Schematic-A1
W1986-57008-00 iThemba Labs Vault Supply Schematic-A1
W1986-57009-00 iThemba Labs Fume Hoods Extraction Schematic-A0
W1986-57011-00 iThemba Labs Basement Supply Schematic-A0
W1986-57012-00 iThemba Labs Red Zone & Basement Extraction Schematic-A0
W1986-57013-00 iThemba Labs Hot Cells Supply & Extraction Schematic-A1
W1986-59005-03 iThemba Labs Block D Zoning Ground Floor Layout-A1
W1986-59006-03 iThemba LABS Air Classification Ground Floor Layout-A1
W1986-59007-02 iThemba Labs Block D Pressure Cascades Ground Floor Layout-A1
W1986-99001-02 iThemba Labs 6m Level Equipment Layout-A0
W1986-99002-01 iThemba Labs Ground Floor Equipment Layout-A0
W1986-FSK001 iThemba 6m Slab As-Built

9. LIST OF DATASHEETS, SCHEDULES AND LISTS

Table 5: List of Datasheets & Lists

Datasheets & Lists
W1986-47001-00 Equipment list
W1986-47002-00 Damper list
W1986-61001-00 Instrument list
W1986-61002-00 - Filter List
W1986-61003-00 Valve List
W1986-61004-00 Control valve list
W1986-53001 AHU 1 Data Sheet
W1986-53002 AHU 2 Data Sheet
W1986-53003 AHU 3 Data Sheet
W1986-53004 AHU 4 Data Sheet
W1986-53005 AHU 5 Data Sheet
W1986-53006 AHU 6 Data Sheet
W1986-53007 AHU 7 Data Sheet
W1986-53008 AHU 8 Data Sheet
W1986 - 53001-00 SF-01A&B Fan Data Sheet
W1986 - 53002-00 SF-02A&B Fan Data Sheet
W1986 - 53003-00 SF-03A&B Fan Data Sheet
W1986 - 53004-00 SF-04A&B Fan Data Sheet
W1986 - 53005-00 SF-05A&B Fan Data Sheet
W1986 - 53006-00 SF-06A&B Fan Data Sheet
W1986 - 53007-00 SF-07A&B Fan Data Sheet
W1986 - 53008-00 E4 A&B Fan Data Sheet
W1986 - 53009-00 E5 A&B Fan Data Sheet
W1986 - 53010-00 E6 A&B Fan Data Sheet
W1986 - 53011-00 E7 A&B Fan Data Sheet
W1986 - 53012-00 E8 A&B Fan Data Sheet
W1986 - 53013-00 E9 A&B Fan Data Sheet
W1986 - 53014-00 E10 A&B Fan Data Sheet

Annexure C – Electrical Specification

Project Title

iTHEMBA HVAC UPGRADE

Project Number

CT0340

Document Title

ELECTRICAL TENDER SPECIFICATION

Document Number

CT0340-EL-SPE-0001

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TERMS OF REFERENCE

This work has been conducted by Project Assignments and Bührmann Consulting Engineers (Pty) Ltd (BCE) for iThemba Labs.

This tender, specification and accompanying drawings, has been prepared by Project Assignments and Bührmann Consulting Engineers for the exclusive use of iThemba Labs Detailed Engineering and Design, and no other party is an intended beneficiary of this report or any of the information, opinions and conclusions contained herein. The use of this document shall be at the sole risk of the user regardless of any fault or negligence of iThemba, Project Assignments or Bührmann Consulting Engineers. Project Assignments and Bührmann Consulting Engineers accept no responsibility for damages, if any, suffered by any third party as a result of decisions or actions based on this report. Note that this report is a controlled document and any reproductions are uncontrolled and may not be the most recent version.

CONTENTS

TERMS OF REFERENCE ii
CONTENTS iii
NOMENCLATURE v
1. PROJECT SPECIFICATION 6
1.1 SCOPE DEFINITION 6
1.2 REFERENCE DOCUMENTS 7
1.3 ENVIRONMENTAL CONDITIONS 9
1.4 ELECTRICAL SUPPLY ON SITE 9
1.5 CERTIFICATE OF COMPLIANCE 11
1.6 INSPECTION AND HANDING OVER PROCEDURE 11
1.7 MOTOR CONTROL CENTRE (MCC) 12
1.8 VARIABLE SPEED DRIVES (LV) 34
1.9 LV SWITCHBOARDS, SUB DISTRIBUTION BOARDS & DE-TUNED PFC 39
1.10 PROGRAMMABLE LOGIC CONTROLLERS 42
1.11 Fail – Safe Operation 44
1.12 INSTRUMENTATION 45
1.13 CABLE TRAY 49
1.14 CABLES 50
1.15 LABELLING 58
1.16 LIGHTING INSTALLATION 60
1.17 EMERGENCY STOPS 61
1.18 CONDUIT 61
1.19 TRUNKING AND WIRE WAYS 62
1.20 EARTHING AND BONDING 63
1.21 SIGNAGE 67
1.22 FIRE EXTINGUISHERS 67
1.23 AS BUILT DOCUMENTATION AND PROJECT CLOSE OUT PROCEDURE 68
2. PREFERRED EQUIPMENT SUPPLIERS 70
2.1 Preferred Electrical Equipment Suppliers 70
2.2 Preferred Control Suppliers 70
3. BILLS OF QUANTITIES 71

3.1 GENERAL 71
3.2 DESCRIPTION OF ITEMS IN THE BILLS 71
3.3 QUANTITIES REFLECTED IN THE BILLS 71
3.4 PRICING OF THE BILLS OF QUANTITIES 71

NOMENCLATURE

A	Amps
ACB	Air Circuit Breaker
ANSI	American National Standard Institute
GA	General Arrangement
HVAC	Heating Cooling Air Conditioning
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
kW	kilowatts
LV	Low Voltage
m	meters
MCB	Miniature Circuit Breaker
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
PCS	Plant Control System
PFD	Process Flow Diagrams
P&ID	Process & Instrumentation Diagrams
PLC	Programmable Logic Controller
PVC	Polyvinyl Chloride
RSA	Republic of South Africa
SLD	Single Line Diagram
SWA	Steel Wire Armoured
TTA	Type Tested Assemblies
UL	Underwriters Laboratories
UPS	Uninterruptable Power Supply
URS	User Requirement Specification
V	Volts
W	Watts
XLPE	Cross Linked Polyethylene

1. PROJECT SPECIFICATION

1.1 SCOPE DEFINITION

The iThemba HVAC project requires the design, construction, and integration of the electrical, control, and instrumentation systems for a new HVAC setup on an existing platform. This includes an upgrade to the current low-voltage electrical distribution system to support the additional HVAC load. A new distribution tier will be added on the main distribution board to supply power to a motor control center (MCC), which will be constructed by the contractor as part of this project. The MCC will then distribute power to the HVAC equipment, with power and control cables routed on support structures connecting the MCC to HVAC units on the platform. The extract fans will be powered from this MCC as well.

The MCC will include necessary control features to manage HVAC operations. Additionally, an automation system with a control unit will be installed to monitor and manage HVAC functions, including an operator interface and integration with third-party equipment via a standard protocol. The automation system will interface with field instruments. The field instruments must be wired to the control panel by the electrical contractor.

The project scope covers testing, commissioning, and final handover, with all relevant documentation and training provided for operational use.

The **electrical installation** shall consist of the following:

(1) Supply, install and commission additional electrical panel to supply HVAC MCC.

(2) Supply, install and commission Motor Control Centre

(3) Supply, install and commission PLC Automation with Field IO.

(4) Supply, install and commission field instrument cables. (Instruments installed by others)

(5) Supply, develop and commission Automation Software. This includes Client Viewing Software

(6) Integrate the VSD's and HVAC systems into the PLC automation software according to a control philosophy.

(7) Supply and install cable ladder, cable trays & trunking for all of the abovementioned LV and control cabling.

(8) Install control & power cabling from Motor Control Centres to the field equipment.

(Note cabling and wireways to be supplied by the Tenderer under this contract)

(9) Earthing & bonding of the installation (Earthing of structure & lightning protection by others). This includes earth bars in the MCC to link up with the earth mats supplied by others.

(10) Lighting fixtures must be moved to suit the new HVAC & MCC positions.

(11) As built documentation and project closeout procedures as specified.

(12) Issue of certificate of compliance in terms of the OHS-Act per distribution board area for the work as carried out. A certificate will be required only for the work to be performed.

(13) 12 Months free maintenance during the defects liability period

1.2 REFERENCE DOCUMENTS

This specification shall comply with the latest edition, including all amendments and requirements, of the specifications, codes and regulations referenced herein but shall not be limited to just those. The Supplier shall clearly define which standards are applicable to the equipment offered.

Modifications for local government regulations, rules and codes shall be made only if they exceed the codes as specified below and must have the approval of the client.

1.2.1 Codes, Standards and Regulations

The work shall be performed in accordance with the most recent versions of relevant codes and standards from the regulatory agencies and institutes.

The Owner's Engineer should be consulted for clarification wherever discrepancies in the technical information exist between the various documents contained in the bid package, reference codes and standards, drawings, specifications, before proceeding with the work.

The design and construction shall conform with Standards prepared by the following authorities:

Standard	**Name / Description**
SANS 10142 Part-1	The wiring of premises Part 1: Low-voltage installations
SANS 1507	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SANS 1804	Induction Motors
SANS 1973-1	Low-Voltage Switchgear and Controlgear Assemblies Part 1 Type-tested assemblies with stated deviations and a rated short-circuit withstand strength above 10 kA
SANS 10114-1	Artificial Lighting for Interiors

Standard	Name / Description
SANS 60529	Degrees of Protection Provided by Enclosure (IP Code)
SANS / IEC 60598	Luminaires
SANS 60947	Low-Voltage Switchgear and Controlgear Part 1: General rules
SANS 61439	Low-Voltage Switchgear and Controlgear assemblies
SANS 61641	Internal Arcing Faults
NRS048	Quality of Supply
ANSI/ISA-5.1-2009	Instrumentation Symbols and Identification
ISA-20	Specification Forms for Process Measurement and Control instruments, Primary Elements, and Control Valves

1.2.2 Quality Control and Quality Assurance Standards

The materials supplied to site shall be of high quality and suitable for the site's climatic conditions. The Employer/Engineer must approve these materials, which must conform to the relevant quality, manufacturing, testing, and performance standards set out in the SANS or the appropriate IEC specifications if no such standards exist. Materials manufactured in South Africa should, as far as possible, be used and bear the SABS mark where applicable. Imported materials must comply with the appropriate IEC specification. All materials must be appropriate for the installation and use conditions. If the materials or components are not suitable for temporary use under the site's conditions, the contractor shall bear the cost of providing suitable protection until the unfavourable site conditions cease to exist.

1.2.3 Safety Standards

The design shall conform to standards prepared by the following authorities:

- South African laws and legislation
- Republic of South Africa Occupational Health and Safety Act No. 85 of 1993 (OHSA).

1.2.4 Precedence, Deviation and Conflicts

In the event of conflict between parts of the documents referred above, the most stringent standards will take precedence.

Whenever a difference exists between this Specification and the referenced codes and specifications, the order of precedence of documents and specifications is as follows:

(1) Contractual requirements

(2) Design drawings

(3) This document

(4) Other referenced documents

1.3 ENVIRONMENTAL CONDITIONS

All the equipment supplied shall be suitable for continuous operation under the following conditions:

Item	**Value**	**Comments**
Site Location Name	iThemba Labs, Eerste River	
Site Location Co-ordinates	34°01'29.8" S 18°43'01.7"E	
Altitude (ASL)	13m	Above Sea Level
Maximum temperature	+45°C	Western Cape
Minimum temperature	5°C	Westerm Cape
Corrosion	Medium	Western Cape
Contamination	High	Dust
Relative Humidity	60%	Western Cape
Access to Site	Paved road	
Security	Gated 24/7 Security	

1.4 ELECTRICAL SUPPLY ON SITE

Note that all electrical equipment specified for this contract shall be able to operate under with the following system voltages:

1.4.1 Supply Voltages

Utilization	Requirement		Comments
Electrical Supply System Earthing	TN-S		-
Distribution Between Substations (MV)	11kV, 3PH + E; 50Hz		Earthing TN-S
DOL Motor Starters (LV) ≤ 90kW VSD Motor Starters (LV) ≤ 750kW	400V, 3PH + E; 50Hz		
Small Power & Lighting (3PH)	230V/400V, 3PH + N + E; 50Hz		
Total Harmonic Voltage Distortion	5% (≤ 1kV)		
Voltage Unbalance	2%		
Frequency	50Hz Tolerance ±1% (49Hz-51Hz)		
Volt Drop (% of Supply Voltage)	5%	Distribution Feeder Cables	Sum and in Series
	3%	Outlets and Light Circuits from DB	At Full Load
	15%	Motor Source Bus for DOL Starting	LV System
	20%	Motor Terminals for DOL Starting	
Phase Rotation	To Be Confirmed on Site		
Motor Control Contactor Coils	24VDC		
Control Auxiliary Power (field control Instruments)	24VDC		
Control System Supply (UPS)	110V, 1PH +N, 50Hz		
Control Discrete Inputs (PLC)	24VDC		
Control Discrete Outputs (PLC)	24VDC		
Analog Inputs (PLC)	4-20mA		
Analog Ouputs (PLC)	4-20mA		
Digital Communication (Remote Control)	Ethernet IP		
Digital Communication (to Drives)	Profinet/Modbus		
Solenoid Valves	24VDC		
Motor Anti-condensation heaters	230V, 1PH +N, 50Hz		

Utilization	Requirement	Comments
General Purpose Socket Outlets	230 VAC, 16A, 1 Phase+ Neutral+ Ground. All outlets ground leakage protected. SA 3-Pin and Euro Combination (SANS 164-1 & 2)	
LV Circuit Breakers	For 3 Phase + Neutral Circuits – 3 pole For 1 Phase Circuits – 1 pole	
230 V, 1 ph, 50 Hz (Solidly Grounded)	Indoor lighting, receptacles, motors up to and including 0.37 kW and heater supply for motors/ equipment (derived from Vendor-provided auxiliary transformer and distribution panel)	

1.5 CERTIFICATE OF COMPLIANCE

All work covered under this contract that has to be carried out on site, must be executed by a qualified and fully representative person. Only persons registered as an "installation electrician" will be accepted to carry out the installation work. After completion of the contract the Contractor shall submit a Certificate of Compliance in terms of the OHS-Act to the Engineer prior to final payment being processed.

Where alterations are made to distribution boards, the certificate only need to cover the alterations made to the distribution board.

A certificate shall be issued for every distribution board in which work is carried out.

1.6 INSPECTION AND HANDING OVER PROCEDURE

1.6.1 Inspection by contractor

When the installation is completed, the Contractor shall conduct an inspection to satisfy himself that all connections have been properly fastened, that all labels are engraved and properly fixed, that no bolts and screws are missing, and in general that the installation has been completed to the requirements of the specification and that the workmanship complies with the applicable standards and to the satisfaction of the Engineer.

1.6.2 Testing by contractor

Upon completion of the work, the Contractor shall perform all tests as specified or as required by the Engineer to ensure that all equipment and cabling have been connected correctly, and that the installation is ready for handing over and commissioning.

The Contractor shall provide his own test equipment, which shall be of acceptable standards.

1.6.3 Inspection and testing by engineer

After the Contractor has conducted the abovementioned inspection, he shall apply in writing to the Engineer for a handing over inspection. At least 2 days' notice shall be given.

The following forms shall be thoroughly completed by the Contractor. These forms are not included in the contract, but the forms basically consist of the following:

In commissioning and handing over certificate:

(1) Application form.

(2) Visual inspection list.

(3) Earth leakage tests.

(4) Conductor resistance tests.

(5) Insulation resistance.

(6) Functional tests.

Other standard forms:

(7) Notice of Commencement of Installation Work

(8) Application for Inspection

(9) Certificate of Acceptance

(10) Certificate of Compliance by an Accredited Person

(11) As-built quantities and materials used

Should the completed section not pass the inspection, the Contractor shall rectify the fault(s) and apply for re-inspection.

One (1) re-inspection of the work as a whole, shall be conducted free of charge. The Contractor shall incur a penalty of **R2000-00 (Two Thousand Rand)** for all subsequent re-inspections required on the contract and this amount will be deducted from the next payment due to the Contractor.

1.7 MOTOR CONTROL CENTRE (MCC)

1.7.1 Scope

The contractor is responsible to manufacture and install the HVAC MCC according to the single line drawings (SLD) supplied by the engineer.

1.7.2 Codes and Standards

All equipment supplied, including all components and auxiliary equipment, shall comply with the latest version of all applicable standards including:

- IEC 61869 Instrument Transformers
- IEC 60529 Degree of Protection Provided by Enclosures (IP Code)
- IEC 60947 Low-voltage Switchgear and Controlgear
- IEC 61439 Low-voltage Switchgear and Controlgear Assemblies
- SANS 10142 The Wiring of Premises
- All Statutory Acts and Regulation (as applicable)

1.7.3 General

Switchboards shall be free standing floor mounting, of the metal enclosed air break type of fully segregated construction in accordance with IEC 61439. Switchboards shall be Form 3b as specified in IEC61439, unless other specified.

Switchboards shall be designed and constructed in such a manner as to facilitate testing, inspection, component replacement, repairing and normal maintenance. Continuity of use and safety are the first considerations.

Outdoor switchboards shall be weatherproof of a minimum of IP65 and shall be provided with sunshades.

Indoor switchboards shall be a minimum of IP42, except vents, which as a minimum shall be IP41.

Switchboards shall be suitable for continuous operation on a solidly earthed three phase low voltage power system.

Provision shall be made for the complete removal of any serviceable equipment from the switchboard for replacement or repair purposes without interfering with the operation of other equipment.

The electrical equipment installed in the switchboard shall be new equipment, free from damage, rust and complying with the applicable standards and shall be suitable for the duty specified.

The equipment shall be installed strictly in accordance with the manufacturer's instructions, particularly concerning clearances and enclosure sizes.

Equipment shall be securely mounted and braced so that movement cannot occur during operation under normal or fault conditions and so that adjacent equipment is unaffected and personnel operating the equipment are not endangered.

1.7.4 Arc Faults

Measures shall be taken to provide increased security against the occurrence or the effects of internal arcing faults. IEC TR61641 shall be used as a guide.

Where specified, switchboards shall be of the arc containment type. The design shall have been type tested by a recognised testing authority in accordance with the standard test procedures detailed in IEC 61439. A copy of the test certificate shall be provided upon request.

1.7.5 Main Busbar Rating and Temperature Rise

The busbars shall be designed for a maximum temperature of 90°C. The main busbar circuit shall be constructed to withstand, without thermal or mechanical damage, the short circuit stresses generated by the fault level specified for the time specified.

1.7.6 Equipment and Fault Co-ordination

Every current carrying part of the equipment shall be capable of carrying, under the atmospheric conditions existing at site, its specified rated current continuously.

Each item of equipment, including all busbars and connections, shall be capable of withstanding, without mechanical or thermal damage, the rated short time current specified, except that outgoing circuits protected by HRC fuses shall be capable of withstanding the maximum fusing current of the largest fuse which can be inserted in the circuit.

The short time rating of current transformers shall not, without special acceptance, differ from that of the associated equipment.

1.7.7 Air Circuit Breakers

Circuit breakers shall be of the air-break type. They shall be cubicle mounted and arranged for horizontal isolation and withdrawal.

Circuit breakers shall be of the magnetic blowout type. The arc control devices shall be pivoted or so arranged that the contacts can be easily exposed for inspection without having to completely remove the arc control device and shall be designed for convenient handling and removal during maintenance. Where necessary arc control device lifting tackle shall be supplied. Suitable interlocking shall be provided so that the circuit breaker cannot be located in the primary circuits with any arc control device removed.

Operating mechanisms shall be of the "trip-free" type, i.e., the circuit breaker is free to open immediately the trip coil or tripping mechanism is energised.

A mechanically operated indicator shall show whether the circuit breaker is open or closed, and it shall be operative when the circuit breaker is in the service, isolated or test positions.

Each circuit breaker shall be closed by means of a manually charged spring, manual release closing device.

It shall be necessary for the spring to be fully charged before it can be released.

The spring closing mechanism shall be capable of being charged when the circuit breaker is open or closed. The spring arrangement shall not be dependent on one spring and the loss of any one spring shall not prevent the full circuit breaker rating being achieved.

A visual mechanical indicating device shall be provided to indicate the state of the spring and inscribed "SPRING CHARGED" when the mechanism is in the condition to close the circuit breaker and" SPRING FREE" when it is in any other condition.

In the event of a failure to latch in the closed position, it shall not be possible for the circuit breaker to open except at normal speed.

The circuit breaker “CLOSE" push button shall be shrouded to avoid inadvertent operation and shall be coloured green.

Means shall be provided for slow closing of the circuit breaker for maintenance purposes only. The opening mechanism of the circuit breaker contacts shall be initiated by a self-powered solid state trip system and by a manually operated mechanically linked push button. The tripping mechanism shall be of a type which acts directly on the circuit breaker mechanism.

The manual tripping push button shall be shrouded, coloured red and mounted in a conspicuous position on the circuit breaker front panel. The manual tripping device shall be capable of being padlocked in the inoperative position.

Each circuit breaker cubicle shall be fitted with shutters which operate automatically over the primary circuit apertures when the circuit breaker is engaged or disengaged. These covers shall fit in an insect-proof and dust-proof manner. The arrangement shall be such that busbar and circuit spout shutters are operated independently from one another by mechanical means from the metallic portion of the circuit breaker. It shall be possible, when the circuit breaker is isolated, to lock each shutter independently in the closed position with a padlock, and a stop shall be provided to hold the shutter open for testing purposes. The colours and labelling of the shutters shall be in accordance with IEC 62271.

Each circuit breaker shall be provided with locking, interlocking and safety devices to ensure the following:

- that the connection or disconnection of the circuit breaker to and from the busbar is prevented unless the circuit breaker contacts are in the open position. This interlock shall not cause a closed breaker to trip when an attempt is made to isolate it. It shall also be interlocked to prevent the circuit breaker from being closed unless it is fully engaged, fully isolated or in a position for maintenance.
- that the circuit breaker shall be capable of being locked in the open position with padlock to prevent inadvertent operation.
- Means shall be provided for completing the secondary connections when the circuit breaker is isolated in order to permit the circuit breaker to be operated for test purposes
- That the circuit breaker can be closed and opened for test purposes when in the isolated position, preferably without the use of additional attachments
- that access to the circuit breaker by opening the cubicle door is prevented with the circuit breaker closed and that it is not possible to put the circuit breaker into service operation with the door open. Attempting to open the cubicle door with the circuit breaker closed shall not trip the circuit breaker.

Air circuit breakers shall have the following classification characteristics:

- Rated frequency 50 Hz
- Rated voltage 415 VAC
- No. of poles 3
- No. of phases 3
- Mounting Withdrawable
- Open/close mechanism Independent manual
- Trip units (adjustable) Overcurrent, instantaneous and earth fault
- Rated continuous current As per Single Line
- Interrupting rating As per Single Line (50kA)
- Spare auxiliary contacts 2 X Normally Open and 2 x Normally Closed (minimum).

1.7.8 Moulded Case Circuit Breakers

Moulded case circuit breakers shall be fitted with instantaneous overcurrent protection only unless otherwise specified.

Provision shall be made for padlocking each circuit breaker in the "Off" position.

Each circuit breaker shall also incorporate control circuit isolator with two normally open auxiliary switches rated at 10A, 230Vac, 50 Hz. The control circuit isolator shall be interlocked with the circuit breaker such that, under normal operation, it opens before and closes after the main isolator.

Moulded case circuit breakers shall have the following classification characteristics:

- Rated frequency 50 Hz
- Rated voltage 415 VAC
- No. of poles 3
- No. of phases 3
- Trip units Instantaneous
- Rated continuous current As per Single Line
- Interrupting rating As per Single Line (50kA)
- Spare auxiliary contacts As Specified

1.7.9 Motor Starters (Contactors)

Contactors shall be of the double air-break, block type with modular design suitable for vertical mounting. Mounting screws shall be accessible from the front. Contactors shall be capable of 100 000 no-load operating cycles in accordance with IEC 60947.

Each contactor shall be provide with positive " On/ Off" indication, which shall not interfere with the efficient operation of the contactor.

Contactors shall close satisfactorily with the voltage at the operating coil terminals reduced to 85% of the nominal value. The contactors shall also remain closed satisfactorily with the voltage at the operating coil terminals reduced to 70% of the nominal value.

Not less than two spare auxiliary contacts, one normally open, one normally closed, shall be provided with each contactor. All auxiliary contacts shall be wired to a suitable accessible terminal strip. Contacts shall be strong and shall have a positive wiping action when closing.

Auxiliary contacts and auxiliary relay contacts hall be rated for 10A, 230Vac,50 Hz.

Motor starters shall have the following classification characteristics in accordance with IEC 60947:

- Rated frequency 50 Hz
- Rated voltage 415 VAC
- No. of poles 3
- No. of phases 3
- Interrupting medium Air
- Control method Electrical

- Type of release Relay) — Electronic Protection Relay (e.g. Schneider TeSysT Motor
- Rated duty — Uninterrupted
- Utilisation category — AC3
- Co-ordination with protective device — Type2

1.7.10 Motor Protection

Each motor starter shall incorporate a motor protection relay (unless otherwise specified). Thermistor relays shall only be incorporate in those motor starters specified.

Motor starters 110kW and above shall have provision for motor heaters.

1.7.11 Current Transformers (CT)

Current transformers shall comply with the requirements of IEC 61869, shall be of the encapsulated type and shall be so mounted within the switchgear that they are easily accessible.

Current transformer test links shall be provided, configured for shorting and / or isolation. The secondary side of each current transformer shall be earthed at one point only. Each such earth connection shall be made through a removable bolted link placed in an accessible position and of dissimilar design to other types of links to prevent any interchanging.

Current transformers shall have the following characteristics:

- Construction — Window
- Number of primary turns — 1
- System voltage — 525Vac
- Rated frequency — 50 Hz
- Rated primary currents — As specified

Additional information for measurement current transformers:

- Type — M
- Accuracy class — 1
- Rated burden — 0.6 ohms
- Rated output — 15VA (minimum)
- Preferred secondary current — 5 A

Additional information for protection current transformers:

- Classification P
- Accuracy limit factor 10
- Composite error 2,5
- Secondary reference voltage 10
- Preferred secondary current 1A

Polarity markings shall be marked on each current transformer along with other information as required by IEC 61869.

Metering current transformers shall be installed on the white phase.

1.7.12 Control Supply Transformer

Control supply transformers shall be of the air-cooled type, single phase, with an isolated secondary winding.

Where a control supply transformer is supplied in a switchboard or switchboard section, the transformer primary and secondary circuits shall be protected by moulded case circuit breakers.

One side of the control supply transformer secondary winding shall be effectively earthed, and all operating coils and lamps shall be connected to this side.

A metal screen shall be provided between the primary and secondary windings. The metal screen, transformer core and case shall be connected at a common earth terminal.

The control supply transformer shall have a kVA rating that takes into consideration worst case voltage drop conditions (all standing loads on and the largest contactor pull-in current) plus a 25% spare margin.

Tappings shall be provided at the secondary for ±5% and ±10%.

1.7.13 DC Power Supplies

DC power supply modules shall be isolated from the primary power supply in such a manner or as to conform with the requirements of a protected extra low voltage installation.

DC power supply modules, associated circuit breakers and monitoring shall be mounted in a separate auxiliary supplies enclosure.

The DC power supplies shall be dual redundant such that each power supply is rated to supply 100% of the load.

Each DC power supply shall be capable of handling the largest inrush load with all other operating loads on line. Each power supply shall provide a minimum of 20% spare capacity.

The DC power supplies shall have current limiting protection in the event of a short circuit or fault on the outgoing DC circuit. There shall be potential free contacts available at each DC power supply for indicating unit failure or fault detection.

A DC short circuit within modules shall be automatically isolated at the associated module's circuit breaker. Discrimination shall be provided between module circuit breakers and upstream 24Vdc supply circuit breakers.

The DC control circuit breaker within the feeder enclosure shall be suitably rated to protect the DC power supply in the event of a short circuit or fault. The circuit breaker shall also be rated to trip based on a single DC power supply in operation.

Where applicable, the DC control circuits within the auxiliary supplies feeder enclosures and motor starter modules shall be wired in accordance with the standards for protected extra low voltage (PELV), enabling work to be carried out within the enclosure whilst he PELV is still energized.

1.7.14 Indicating Lights

Indicating lights shall be low voltage transformer operated LED cluster type. Colours shall be as specified.

Lamp holders shall be arranged so that lamps may be changed from the front of the panel without the use of special tools.

1.7.15 Panel Meters

All meters shall be mounted such that they are not less than 600 mm or more than2000mm above the floor level.

All meter shall be flush mounting type with DIN96 square bezels and Class1 accuracy.

All instruments and apparatus shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents up to the maximum fault current of the switchgear. All instruments and apparatus shall be back connected.

All indicating instrument scales shall be clearly divided and indelibly marked and the pointer shall be of clean outline. Unless otherwise accepted, the markings of the main area of the dials shall be restricted to the scale marking. Instrument transformer ratios, maker's name, accuracy grades, etc shall not appear on the dials but shall be marked in an accepted position, preferably below the bezel.

Red lines shall be provided in the instrument scales to indicate the full load current of the circuit. Minimum scale reading shall be not less than 10% of the full load reading. Normal range of the meters shall be 0-120% full load value. Motor feeder ammeters shall have a suppressed scale of not less than five times the normal scale.

All instruments shall be calibrated in the attitude in which they will be mounted.

Instrument glasses shall be costed with anti-reflective material.

All ammeters shall be calibrated in amps.

All voltmeters shall be calibrated in volts.

1.7.16 Terminals

Terminals shall be polyamide (nylon), not melamine or other brittle material, of minimums size capable of accepting 4mm² conductors.

1.7.17 Incoming Cable and Incoming Section Equipment

Each switchboard shall have an incoming section with provision for the connection of several incoming cables. The incoming section shall have a circuit breaker or isolator as specified.

The incomer circuit breaker shall be de-rated as necessary by the manufacturer to suit the installation position and ventilation.

Unless otherwise specified the incomer shall be located in the centre of the switch board with the load evenly distributed on each side.

1.7.18 Busbars

Busbars shall be formed from hard drawn, high conductivity, solid round-edged rectangular copper bar.

Busbars and the conductors directly connected to them shall be air-insulated unless the use of insulation is a necessary design feature of the equipment. Where busbars and connections are insulated, such insulation shall be capable of withstanding without damage the maximum temperature occurring during the passage of fault current. Connections shall be secured with high-tensile steel bolts, tensioned to a design figure related to the application in accordance with manufacturer's instructions.

The current carrying surfaces of busbar joints shall be thoroughly cleaned to remove all traces of dirt and grease and shall be coated with a layer of corrosion-inhibiting jelly immediately prior to jointing.

Bus supports shall be formed of high dielectric strength, low moisture absorbing, high impact resistant material with ample creepage distance between bus bars. The supports shall be designed to minimise the surface dust collection.

Dust and vermin proofing of the busbar chamber shall not be dependent on a seal between the cubicle walls and the floor, but shall be by a complete metal enclosure. If ventilation is required in the bus chamber, then the openings shall be covered with bronze insect and vermin proof screens.

1.7.19 Enclosures

Each switchboard shall be suitably constructed to accommodate the equipment specified. Switchboards shall be single front or back-to-back with front cable access.

Cable entry shall be from top or bottom as specified.

Switchboards shall be of overall height not greater than 2300mm. No relays, instruments, contactors, switches or handles shall be positioned more than 2000mm or less than300mm above floor level. No equipment or terminal lock shall be mounted less than 200mm above the floor.

The panels and cubicles shall be complete with all equipment, necessary internal wiring, control fuses, test links, terminal boards, accessories, cable gland plates, brackets, plates and fittings.

Each switchboard shall be a completely self-supporting, fully welded rigid structure with a channel base. Switchboards shall be constructed from folded zinc annealed mild sheet steel, minimum thickness 2mm, free from rust, dents and any surface defects. The construction shall be such that the switchboard is a dust and vermin proof enclosure with the IP rating specified. All sheet metal shall be suitably braced. Bracing, when necessary, shall be arranged well clear of components and this shall apply equally to initial and possible future additions. There shall be no undue movement of panels or cubicles during normal operation including withdrawing and replacing circuit breakers and relays.

Heavy equipment shall be supported by separate independent framework and shall not rely on the enclosure sheeting. All nuts, bolts and studs shall be cadmium plated mild steel.

Switchboards shall be readily extensible at each end, and busbars shall be pre-drilled at both ends for this purpose. Each end of each switchboard shall be provided with end covers to give the installation a neatly finished appearance.

Each switchboard shall be constructed such that it may be broken down into sections not exceeding 4 metres in length for packaging and transport. Discontinuities at the junctions shall be avoided. Switchboards shall be designed to facilitate re-assembly on site, and all nuts, bolts and other fittings required for re-assembly shall be provide.

1.7.20 Doors, Escutcheons and Cable Zone Cover

All compartment other than busbar chambers and cable zones shall have hinged doors. Hinged doors shall be mounted on lift off hinges. The lift off hinges shall have unequal length pins to enable the door to be refitted with ease. Doors shall have a minimum opening of 100 degrees from the closed position for equipment access and any door exceeding a height of 200mm which contains fitted instrumentation shall be equipped with door stays to hold the door in the open position.

1.7.21 Removable Access Panels

Compartments which are not equipped with hinged doors shall have removable panels. The panels shall be provided with 'D' shaped grip handles and two locating pins at the bottom of each panel and shall be fastened using captive chrome head fasteners. The captive thread section of the fasteners shall be securely fixed to the switchboard frame. Only bus compartment access panels shall require a tool for opening.

1.7.22 Base

Unless otherwise specified the switch board shall have a hot dip galvanised channel iron base securely fixed to the board. All welds shall be ground smooth prior to galvanising. The plinth shall have external lugs for bolting to the floor and holes for inserting lifting bars.

1.7.23 Paint Treatment

The surface of the switch board metalwork shall be degreased and cleaned with solvent prior to painting.

The switchboard shall be coated with an electrostatically applied polyester powder coating in accordance with the paint manufacturer's recommendations. The coating shall be uniformly applied with no uneven build up or accumulation evident.

Bare metal surfaces exposed after welding or drilling, or damage to paintwork, shall be smoothed and treated with the full number of coats of matching paint that had previously been applied.

Unless otherwise specified, the switch board external colour shall be electric orange (B26) while switch board interiors and mounting plates shall be gloss white.

Details of the proposed method of protective coating shall be provided.

1.7.24 Cable Zone

Cable zones shall be adequately sized, of minimum internal width of 300mm, and shall be designed for ease of installation and maintenance of cables.

1.7.25 Switchboard Compartments

Switchboard compartments shall have standardised width and depth and an interchangeable standardised set of heights. Compartments shall be designed and sized for ease of access for maintenance.

1.7.26 Motor Starter Module

Each motor starter module shall typically contain:

- Motor circuit breaker
- Control circuit breaker
- Motor contactor
- Motor protection relay (or what is specified)
- Control relay
- Current transformers, switches, indicating lamps, ammeter, and terminals as specified.

Each motor starter module shall be fitted with a hinged, interlocked door. Each motor starter module door shall be fitted with camlock type latches that operate with square drive keys. Each motor starter module doors hall be interlocked such that all supplies to the module (other than those energised by interlocking circuits must be isolated prior to the door being opened but means of defeating the interlocking shall be available for opening the door when the motor starter is "ON" for testing purposes.

Fixed type motor starters shall have all motor starter components directly mounted in the motor starter module in such a way that components and wiring are readily accessible from the front for maintenance purposes. Field cabling shall generally terminate within the module.

Demountable type motor starters shall have all motor starter components mounted on a readily withdrawable mounting panel, and the control wiring connecting the panel to the switchboard and field shall do so at a terminal strip within a cabling zone, external to the motor starter module.

Withdrawable type motor starter and feeder modules shall be connected to the supply bus by means of suitable connection protuberances to busbars and outgoing connectors. These connectors shall provide a positive contact with both sides of the supply bus. Each module shall be earthed to the vertical earth bus when inserted. The earth stub shall be the first connector to make positive contact during module insertion, and the last to break contact during withdrawal. Control wiring connecting the module and field shall terminate at a plug and socket combination. Mechanical interlocks shall be provided to prevent insertion or withdrawal of a circuit with a closed circuit breaker or isolator.

1.7.27 Distribution Board

Compartments enclosing circuit breakers and distribution boards shall be fitted with a hinged metal escutcheon mounted behind the compartment door, and the operating handles of the devices shall protrude through holes in the escutcheon. The escutcheons shall be latched with 1/4 turn locks. The compartment door shall be equipped with non-lockable 'T' type handles.

The circuit breakers shall be padlockable in the "Off' position.

1.7.28 Variable Speed Drives

Where specified, variable voltage, variable frequency controllers shall be installed in the switchboards in strict accordance with the manufacturer’s instructions.

Cooling fans shall be provided as necessary to maintain the manufacturer's required air flow through the compartment.

All inlet vents shall be filtered and filters shall be accessible for cleaning or replacement. Outlet vents shall be bronzes Screened and louvred to direct air upwards.

Heat deflectors shall be installed between variable frequency controllers mounted vertically above each other.

Control keypads shall be door-mounted for operation without the need to open the cubicle door.

However, it is preferred that variable speed drives be wall mounted or floor standing to facilitate better cooling.

1.7.29 PLC Cubicles

Programmable logic controller input / output racks shall be located in a compartment separate from motor starter equipment, but integral with the switchboard. One or more tiers shall be dedicated to PLC and control as required.

All wiring within the PLC tier and between the PLC and other tiers shall be provided. PLC input / output wiring shall be direct from the PLC input / output card faceplate to the terminal strip adjacent to each drive motor starter in the cable access tier.

The PLC input / output racks shall be mounted on a mounting plate in the PLC cubicle. PLC cubicles shall be fitted with hinged doors and lockable handles. The doors shall be fitted with document holders on the inside of the door suitable for holding drawings and schedules.

PLC cubicles shall be isolated by metallic barriers or partitions from all switchgear.

One PLC cubicle shall be provided for each switchboard section, to avoid the need to break control wiring after manufacture and testing.

PLC equipment shall be installed strictly in accordance with the manufacturer's instructions.

Particular attention shall be paid to cooling and clearances around power supplies and processor units. Cooling fans and vents shall be installed where required.

Power conditioning transformers shall be mounted in a separate vented compartment in the same tier as the PLC input / output racks. The power conditioning transformers shall be of the ferro resonant type, rated 25% above the maximum required load.

Moulded case circuit breakers shall be provided for the PLC input / output rack power supplies, and the PLC input / output card reference voltages. The PLC input / output rack power supply shall be derived from the associated PLC power conditioner. The PLC input / output card reference voltage supply shall be derived from the switchboard control transformer.

Cable ducts shall be sized for future installation of PLC input / output modules into all spare PLC slots and wiring of all spares.

An earth leakage protected double general socket (SA 3-PIN) shall be installed in the PLC processor section. Door operated LED light shall be installed in all PLC and marshalling sections.

1.7.30 Sealing

Switchboard cubicles shall be designed so that an internal fault with the maximum possible rate of energy release shall not open, or force out of position any of the front doors or panels. Hot gases and other products of the fault shall be directed away from any operator standing near to the cubicles.

Module cable entry points shall be bushed to prevent cable damage.

1.7.31 Shrouding

All live parts (including terminals, busbars, and control devices and meters mounted on the doors) which are behind hinged non-interlocked doors or escutcheons and which carry voltage higher than extra low voltage (ELV), shall be shrouded to IP20 with clear rigid plastic covers to protect against accidental contact when the enclosure doors or escutcheons are open. Particular attention shall be paid to shrouding inside enclosures that contain predominantly ELV equipment with some circuits at voltages above ELV. Warning labels shall be installed on all such shrouding.

1.7.32 Gland Plates

Unless otherwise specified, removable single piece, 6 mm thick aluminium gland plates of adequate dimension shall be provided to accept glands for all incoming and outgoing cables. No single gland plate shall be longer than 1000mm. 25% allowance for future cabling shall be made when sizing gland plates.

1.7.33 Spare Space

Unless otherwise specified, future starter space equivalent to 30% of the used panels shall be provided in the switchboard and fitted with blank panels.

1.7.34 Conductors and Wiring

All control wiring shall be stranded copper with a cross sectional area not less than 0.75mm² with V75, 0.6/1kV moisture resistant PVC or XLPE insulation. The exception is PLC wiring which maybe 0.5mm², 110V grade. Shielding shall be grounded at one end only. Power wiring shall be of cross-section not less than 2.5mm².

Protection current transformer wiring shall be stranded copper with a cross section of not less than 4mm².

All wiring shall be provided with adequate mechanical protection to ensure freedom from insulation abrasion, cutting, pinching or other damage.

1.7.35 Switchboard Internal Wiring

Where cabling bridges to a hinged panel, the arrangement shall be such that opening of the hinged panel will cause the wiring loom to twist longitudinally and not bend or rub on a panel edge or face, and the wiring shall be firmly anchored on both sides. At no point shall any undue stress be placed upon the wires. Wiring passing out of the panels and cubicles shall be run in non-rustable flexible tubes or galvanised steel tubes. Hinged panels carrying wiring shall be provided with a flexible earth bonding strap of appropriate size.

Wires shall not be jointed or teed between terminal points.

All conductors shall be terminated with accepted crimping lugs, separate lugs being used for each conductor. The size of lug shall be suited to the size of conductor and only correct crimping tools shall be used.

The colours for wiring shall be as follows:

- 415Vac power wiring Red, White, Blue

▪ Neutral	Black
▪ Earthing	Green, Green with Yellow Stripes, Bare Copper
▪ 110Vac Control (Live)	Grey
▪ 110Vac Control (Neutral)	Black
▪ 24Vdc Power (Live / Positive)	Purple
▪ 24Vdc Power (Zero / Negative)	Black
▪ 110Vac Signal (Signal)	Grey
▪ 110Vac Signal (Reference / Zero)	Black
▪ 24Vdc Signal (Signal – Digital Input)	Yellow
▪ 24Vdc Signal (Reference / Zero)	Black
▪ 24Vdc Signal (Signal – Digital Ouput)	Orange
▪ 24Vdc Signal (Reference / Zero)	Black
▪ 4-20mA Signals (Input and Output)	White
▪ 4-20mA Signals (Reference / Zero)	Black
▪ Intrinsically Safe	Blue

1.7.36 Wiring Duct and Strapping

Where wiring is not run on cable tray in cable zones, wiring shall be run in slotted insulated wiring ducts fitted with a snap-on lid. The slots shall be of the "open" type so that it is possible to install or remove a wire without threading it through a slot.

Where it is not practicable to run the wiring in ducts, wires shall be run in looms using spiral strap.

Wiring looms shall be supported adequately by a suitable approved means. Looms shall be sufficiently small such that they remain flexible. Multiple small wiring looms shall be used in preference to larger looms.

1.7.37 Arrangement of Wiring Duct and Loom

Ducts shall be arranged to allow wiring passing through the slots to be taken as directly to the terminals as possible. Access to terminals studs shall not be impeded by the ducts, except in the case where ducts are used to shroud terminals which are then accessible only by removal of the duct lids.

Ducts shall not interfere with the mounting of equipment on any surface and vice versa. Duct fixings shall not have sharp projections inside the duct which could damage cable insulation.

All groups and bunches of wires shall be run on sections of the cubicle that are free from projections such as small studs, etc., that may damage the conductor insulation. Where wires pass through holes in panels, suitable bushes or plastic grommets shall be used.

1.7.38 Control Wiring Terminations

The control and earth cores of all control cables shall terminate at a point adjacent to each motor starter module, within the cable access tier.

Looping terminals shall be provided at the top of each cable access tier for looping the control supply active and neutral conductors.

Control and instrument cable cores connected to tunnel-type terminals shall be terminated using a pre-insulated pin lug and label carrier of the correct size for the conductor. The lug shall be crimped using a ratchet crimping tool prior to insertion into the terminal. Crimping shall not be effected using the terminal screw alone.

Crimping lugs or pins shall be applied using an approved tool with a ratchet action. Separate lugs or pins shall be used for each conductor. The size of the lug or pin shall be suited to the size of the conductor to be terminated.

Lugs shall be of the type most suited to the device terminal e.g. fork tongue for stud terminals and wire pin type for tunnel type terminals. Only one wire shall be crimped in each terminal lug or pin.

All conductor strands shall be effectively crimped in the terminal lug. If strands are broken or separated during conductor preparation, the termination shall be re-made. Conductor insulation shall end well inside the lug insulation.

Not more than two wires shall be connected to any terminal. Not more than one wire shall be connected on one side of any tunnel type terminal. Where multiple connections are required on tunnel terminals multiple terminals linked with proprietary terminal link bars shall be used.

Looped wiring such as control neutrals shall have a lead and tail wire connected to a common bus to allow the loop to be broken without interference to equipment.

Terminal screws shall not directly contact the conductors.

Terminals shall be generously spaced to provide easy access to the terminals of any circuit, and to prevent accidental contact with live circuits in the same compartment. Terminals shall be numbered consecutively from top to bottom and left to right, or as specified.

20% spare terminal capacity shall be provided to cater for the termination of spare cable cores with a minimum of five terminals whichever is the greater.

1.7.39 Power Circuit Connections

Provisions hall be made for the active cores of power cables to be directly terminated at the motor overload relay or the moulded case circuit breaker terminals as appropriate, except in the case of fully withdrawable units. Adequate bushed access shall be provided for cables to enter modules from the cable access tier.

All power cables within the switchboard shall be connected with a suitably sized lug unless the equipment circuit breaker or contactor has tunnel type terminals. All conductors above 25mm² shall use hexagonal die crimps. The crimp die used shall be of the type and size recommended by the lug manufacturer. The recommended tonnage pressure shall be applied to the lug.

Power circuit connections shall be made with high-tensile, electroplated steel or phosphor bronze bolts with a large flat washer and spring locking washer under the bolt head.

It shall be possible to check the tightness of all connections by removing covers, if necessary, when the switchboard is completely assembled.

Provision shall be made in the termination area to allow circuits to be readily checked with clip-on type ammeters.

1.7.40 Numbering of Wires

All wiring shall be clearly and permanently labelled at each terminal. A tubular plastic or heat shrink type ferrule shall be fitted to each terminating end of every wire. Ferrules shall have black letters on a background of white insulating material. Adhesive or snap on wire labels shall not be used.

The same ferrule number shall be used on wires forming connections directly in series or parallel in the same panel.

Ferrules shall be arranged to read from left to right and from top to bottom.

Wire numbers internal to a motor starter and on the motor starter side of the cable access tier terminal strip shall be derived from the motor starter schematic diagram. Wire numbers on the field wiring (outgoing) side of the cable access tier terminal strip shall be the corresponding internal motor starter wire number pre-fixed with the motor starter's drive tag number. Wiring from each motor starter to the PLC cubicle shall also comprise the motor starter wire number pre-fixed with the motor starter's drive tag number.

An allowance shall be made on the length of wire at each terminal to permit cutting and remaking of the wire termination at least once without interference with the main run of the wire.

Each end of every circuit breaker trip circuit wire shall be fitted with a red ferrule engraved "TRIP" in addition to the numbered ferrule.

1.7.41 Earthing

Each switchboard shall be fitted with a copper earth bar sized in accordance with SANS 10142, but not less than 160mm² cross section, running the whole length of the switchboard to, which shall be effectively connected all metal parts not intended to be alive. Each tier shall have its own vertical earth bar which shall be bolted to the main earth bar.

All hinged panels and doors shall be provided with flexible copper earth connections from the fixed panel frame work.

Gland plates and terminal mounting rails shall be effectively earthed.

1.7.42 Labelling

The switchboard and each module shall be labelled with equipment number and title as specified.

In addition, every device, including terminals, terminals trips, fuses, switches, test blocks, indication lamps, relays and other equipment, shall be identified by a label fixed near the device and oriented so that it is readable from the appropriate access door. The label shall give both the device title or function and a unique alphanumeric identification code. Within a single drive module, the power circuit breaker, contactor and thermal overload need not be labelled.

All device labels, other than proprietary legend and escutcheon plates on devices, are to be engraved from white/black/white laminated engraving material. External labelling is to be fixed by stainless steel threaded screws, rivets are not permitted. Labels longer than 30mm shall have clearance fixing holes and shall have some freedom of movement to allow differential expansion of label and mounting. Where labels are mounted on standoffs, they shall be suitably backed to prevent breakage.

Label letter height shall be as follows:

- Switchboard equipment number 25mm
- Switchboard title 25mm
- Module labels 6mm
- Equipment labels 3mm

Warning labels shall be provided as necessary in accordance with IEC 61439.

Warning and safety labels other than the above shall be white letters on a red background.

1.7.43 Switchboard Inspection and Testing

During the course of manufacture, all work will be subject to progressive inspection and testing by the Engineer or his representative.

Not less than 14 days' notice of all tests shall be given to the Engineer in order that he may be present if he so desires. Duplicate copies of the Supplier's records of all tests and type test certificates shall be furnished to the Engineer.

1.7.44 Routine Tests

Each item of equipment shall be subjected to and satisfactorily withstand the routine tests specified in the applicable standard.

Control circuits, including cubicle wiring and all connected apparatus, shall withstand accepted high voltage tests appropriate to the equipment. Where solid state or electronic devices are included in the cubicle they shall be removed or isolated while insulation testing is being carried out on wiring a and other equipment.

Continuity checks shall be carried out on all panel wiring.

Each circuit breaker shall be operated not less than ten times without requiring adjustment. Circuit breaker opening and closing times shall be checked for comparison with the speed of operation of the equipment which successfully withstood the short circuit capacity tests.

Main copper circuits shall be tested for millivolt drop.

Circuit breakers and motor starters shall be tested to prove closing and tripping mechanisms, protection functions and interlocks and, where necessary, conjunctive testing shall be performed with other items of equipment to which the switchboards are to be connected.

The Seller shall carry out function tests to prove that every relay, contactor, interlock, push button, selector switch, indicating light and control device will function as designed.

Circuit breaker as and other withdrawable item shall be checked for interchangeability.

All current transformers shall be tested in accordance with IEC 61869.

Secondary injection tests shall be carried out on all protection relays. Motor thermal overload relays shall be tested by having a current equal to twice the full load current of the connected load injected into each overload element in the relay with the overload relay set at 100% and 125% of full load current. In each case the tripping time of the overload relay shall be recorded and compared with the relay manufacturer's current / time characteristic.

All protective circuits shall be tested for correct operation by primary injection tests.

Instrumentation devices shall be tested and calibrated, or the manufacturer's calibration certificates shall be submitted to the Engineer.

1.7.45 PLC Tests

Power shall be applied to the PLC and the voltage tested. All inputs shall be tested from the initiating device by monitoring the input indicator LED on each card. The

Engineer will connect the PLC and programming equipment in the workshop, load the PLC programme and test all PLC functions in conjunction with the Supplier's test engineer prior to shipment. The Supplier shall allow for this testing phase in the manufacturing schedule.

1.7.46 Type Tests

Where type tested equipment is not offered, this shall be clearly stated, and documentary evidence provided to show that the equipment is designed and built to fulfil type testing requirements.

1.7.47 Delivery and Shipping

If accessories are removed or the equipment is split, suitable blank shipping plates shall be installed. Items which are free to move, vibrate or chafe during shipping shall be adequately secured or blocked. Warning notices shall be provided to ensure removal on site prior to operation.

1.7.48 General

The motor control centre (MCC) shall be manufactured in accordance with SANS/IEC 61439-2:2009 (Low-voltage Switchgear & Control Gear Assemblies).

The MCC shall be manufactured with internal separation equal to **Form 3b**.

The MCC shall be manufactured according to the schematic distribution board drawings.

The MCC construction, physical and electrical requirements are indicated on the above drawings.

The MCC supplier shall be responsible for the physical design of the MCC in accordance with the requirements of the specification and the schematic layout diagrams forming part of the documentation.

On completion a Certificate of Compliance shall be issued for the MCC installation.

1.8 VARIABLE SPEED DRIVES (LV)

1.8.1 General

The Contractor shall employ ABB variable speed drives (VSD).

Where indicated on the schematic drawings and specified, VSD's shall be supplied and installed in the applicable MCC's.

The Contractor shall ensure that all the available safeties within the motor are hard-wired into the VSD control circuits

The Contractor shall be responsible to ensure that the variable speed drive system, the motor and the PLC are fully compatible as a system.

The VSD's shall be suitable for centrifugal pumps with a squared torque characteristic.

The Contractor shall guarantee the availability of spares for 10 years after Contract acceptance.

1.8.2 Detailed Requirements of VSD's

The VSD's shall operate on the Modified Sinusoidal Pulse-Width Modulation (PWM), suitable for driving the motors coupled to the pumps as specified elsewhere.

The system parameters shall be as follows:

System voltage	400 V
Motor voltage	400V, programmable to suit motor selected
System fault level	15kA
Drive Type	6-pulse, ULH for VSDS >= 90kW
Motor speed (Max)	As determined by the motor supplier and control philosophy
Motor speed (Min)	5Hz
Colour	N/A

The output to the pumps shall incorporate chokes and / or dV/dT filters to suit the motors offered by the mechanical supplier.

Harmonic disturbances on the supply shall be limited by inclusion of input chokes and / or DC chokes to reduce the harmonic content to the following:

- Any individual harmonic voltage may not exceed 1%.

- The total harmonic voltage may not exceed 3%.
- The current harmonics may not exceed 5% of the current rating of the equipment.

An interface via Modbus, Fieldbus or Industrial Ethernet shall be provided for each VSD and this shall be connected to the PLC for full diagnostics and alarming.

All VSD's shall be rated to accept 15% overload of the motor shaft power required at any speed over the full speed range of the motor. Furthermore, all VSD's shall be capable of continuous rating at the specified load and power supply conditions (24 hours per day, 365 days per year).

The stability tolerance on speed control shall be better than 1% of the set point.

Electrolytic capacitors used in the dc application of electronic equipment (e.g. filter circuits) shall be of the long-life grade complying with IEC Publication 384-4.

All semiconductor devices, power transformers, chokes and other components forming necessary parts of the drive equipment shall be suitable for the particular application with respect to their rated voltages, rated currents, temperature rise and service life.

Solid-state electronic components shall be used.

Digital control based on the latest microprocessor technology shall be used. However, standard products and components shall be used and purpose made systems shall not be acceptable.

The VSD's shall be equipped with Ethernet/IP interface protocol with facilities to report all fault conditions on a first in first out basis as well as control functions and the parameters during normal running condition. A suitable data storage buffer shall be provided of sufficient capacity to ensure a real time record of the above information and of any other variables the Contractor consider necessary for fault diagnostics.

Protection devices in the VSD shall be hardwired to ensure that an electrical fault within the controller trips the transformer feeder circuit breaker.

Electrical interlocks shall be provided to trip the VSD in the event the access doors to the power section and the DC sections of the drive are opened.

1.8.3 Installation

The VSD's shall be installed inside the cubicles of the MCC.

The VSD's shall be so arranged in their enclosure that ambient air circulated through the unit for cooling only pass over the VSD's heat sink. Air vents with suitable barriers and ventilation fans as per the manufacturer's design shall therefore be provided in the enclosures.

A remote display and control unit, mounted on the door of the respective cubicle of the MCC shall be provided with every VSD. This display shall allow control of the VSD as well as a means of monitoring the motor rotational speed.

The Tenderer's attention is also drawn to the ambient conditions as detailed under the heading for site conditions. Due to the potential heat build-up in the switchboard, each VSD cubicle must be equipped with louvers and a form of mechanical division in the back of the cubicle separating the VSD's intake air from the discharge air to prevent short-circuiting of the cooling air flow.

1.8.4 Protection

VSD drives shall be provided with the following integral protection features. **A separate motor protection relay shall be provided if these features are not part of the VSD protection features.** The Contractor shall explain how each requirement is met in his drive and shall supply detailed supporting literature for each item.

Thermal Overload with current time characteristics matched to the thermal response curve of the drive motor.

VSD and Motor Short Circuits and Earth Faults to protect the drive and the motor fully protected against internal and external short circuits and earth faults on the supply connections, transformers, the DC link, or on the motor. This protection shall preferably be instantaneous in operation and arranged to trip the supply. It shall not operate incorrectly if the drive is able to feed current to a supply side fault unless the condition is sustained for long enough to damage the drive components.

Negative Phase Sequence Voltages to protected the motor and drive against negative sequence currents resulting from the presence of negative sequence voltages on the supply lines, or produced by unbalanced operation of inverters, etc. The protection shall detect the condition and stops the drive before it or the motor can be damaged. The drive shall be able to operate continuously at the rated output if the negative sequence voltage on the supply does not exceed 2,5%.

Loss of Supply Voltage should the positive sequence voltage to the drive fall below 85% for longer than 1 second. The drive shall be disconnected without any damage to the rectifiers, thyristors, or any other components in the drive liable to be adversely affected by a low supply voltage condition.

An under voltage trip which is pre-settable to a minimum of 15% voltage drop shall be provided. If the voltage drops more than the pre-set voltage above, the drive shall trip automatically. In the event of the supply voltage returning to a value, which is greater than the pre-set voltage in less than 2 seconds, which is also pre-settable, the drive shall automatically start up. A facility to enable the flying start shall be provided on the drive.

The variable speed drive system shall be able to tolerate a sudden total loss of power without any damage to the drive.

High Supply Voltage in case the supply voltage rises above 110% for more than the safe withstand time for all components in the drive, it shall be disconnected automatically.

Electronic equipment shall be provided with all protection equipment necessary to ensure that over-voltage, over-current, or other transient conditions will not result in component failure. Such protection shall be arranged to disconnect the drive, where necessary for its safety.

Phase failure protection in case of failure of one or more supply phases shall cause the drive to be disconnected sufficient rapidly to prevent damage.

Incorrect phase rotation protection shall preventing start-up of the drive.

The drive shall also be protected against the following faults:

(1) Over voltage in the dc link

(2) Under voltage in the dc link

(3) Over current in the inverter

(4) Motor stalling

(5) Motor winding temperature

(6) Transient surges

(7) dv/dt and di/dt

(8) Over speed

(9) Open motor circuit of HRC fuses

Audible and visible indication shall be provided for all trip and alarm functions.

1.8.5 Indications and Transducers

Any protection function or condition that originated and cause any drive shutdown shall be indicated clearly on approved operation indicators. All protection functions shall be complete with the necessary current and voltage transducers required for this purpose.

The following are examples of preferred indications to be displayed on the panel door. Contractors shall provide information of fault indications offered applicable to the equipment.

(1) Over speed trip.

(2) Instantaneous over current trip.

(3) Inverse time over current trip.

(4) Converter over temperature trip.

(5) Earth fault trip.

(6) Converter ventilation fan failure trip.

(7) Power supply low voltage trip.

(8) Back-up electronic trip.

(9) Supply phase-loss and incorrect phase rotation protection trip.

(10) Stator winding over temperature alarm/trip.

(11) Earth fault alarm/trip.

(12) External fault.

(13) Long starting time.

A potential free contact shall be wired to terminals at the back of the panel to indicate a system fault for remote indication.

1.8.6 Control indication and Instrumentation

The following minimum controls and instrumentation shall be provided on the front panel drive compartment:

(1) Start / Stop push buttons for local operations.

(2) Emergency stop push button.

(3) Test / Off / Normal: This switch shall operate with a key removable only in the normal position. In the test position the complete starting and tripping sequence shall be operational for testing without applying power to the motor.

(4) Protection trip reset push buttons.

(5) Indication test push button to test lamps.

(6) Speed control.

(7) Trip signal lamp (Red)

(8) Run / Ready signal lamp (Green)

(9) VSD Healthy signal lamp (White)

(10) Stop / Emergency Stop push button (Red)

(11) Start push button (Green)

(12) Trip Reset push button (Blue)

(13) Lamp Test push button (White)

(14) Alarm Mute push button (Yellow)

(15) LCD Display of instrumentation functions.

(16) Ammeter on one phase with instantaneous reading and over scale facility.

(17) Speed indication.

(18) Non-resettable running hour meter.

1.9 LV SWITCHBOARDS, SUB DISTRIBUTION BOARDS & DE-TUNED PFC

1.9.1 General

The following LV Switchboards shall form part of the installation:

(1) 01-MCC-100 (HVAC MCC)

The LV Switchboards & Sub Distribution Boards shall be manufactured according to the schematic distriution board drawings.

The LV Switchboards & Sub Distribution Boards construction, physical and electrical requirements are indicated on the above drawings.

The LV Switchboards & Sub Distribution Boards supplier shall be responsible for the physical design of the LV Switchboards & Sub Distribution Boards in accordance with the requirements of the specification and the schematic layout diagrams forming part of the documentation.

On completion a Certificate of Compliance shall be issued for the LV Switchboards & Sub Distribution Boards installation.

1.9.2 Colour and finish

The final finish of the normal power sections of the distribution boards shall be Electrical Orange.

The final finish of the essential power sections of distribution boards shall be Signal Red.

The final finish of the UPS sections of distribution boards shall be Blue.

1.9.3 Grouping of equipment

All equipment on distribution boards shall be mounted behind hinged panels. Hinged lockable doors shall enclose the panels.

The grouping of equipment shall be arranged in order that future extensions and additions may be done in a logical fashion.

1.9.4 Outgoing circuits

All outgoing circuits of the local section of distribution boards with a rating equal or less than 40A shall be wired to terminals. Terminals shall be provided for the live as well as the neutral conductors of the circuits. The circuits shall be grouped with the live and neutral terminals of a circuit adjacent on the terminal strip.

Terminals shall be DIN-rail mounted and shall be of the Sprecher & Shuh or approved equivalent manufacture.

1.9.5 Hardware

Where required door hinges shall be of the Procast, Perano or Barker Nelson manufacture.

If lockable doors are indicated on the schematic drawings, the front panels shall be lockable with catches using the Client's standard key. Alternatives will not be accepted unless authorised by the Engineer in writing.

1.9.6 Equipment ratings

All equipment utilised in distribution boards shall be rated at 400/231 volt AC. Circuit breakers shall have a minimum rupturing capacity of 5kA unless otherwise indicated on the drawings.

1.9.7 Approval procedures

The Electrical Contractor is advised to order the distribution boards from a reputable manufacturer, as inferior boards will not be accepted. The Electrical Contractor shall submit the details of the board builder that he intends to use, for approval by the Engineer, with his tender.

The Engineer will not approve the workshop drawings of the boards unless all information as requested is submitted as a complete package. General arrangement drawings or incomplete drawings will not be considered to be a complete package and shall be returned to the contractor forthwith.

It shall further be noted that late approval of workshop drawings or distribution boards, due to non-compliance with the specifications, schematic layouts and diagrams, or approval procedures as specified in this document, will not relieve the Electrical Contractor from any of his obligations to complete the contract according to programme. No claims for delays, for extension of time or extra costs in this regard, will be entertained.

The following procedure for the approval of distribution boards and workshop drawings is to be strictly followed:

(1) Electrical Contractor appoints board manufacturer.

(2) Board manufacturer submits workshop drawings for approval, to the Electrical Contractor.

(3) Electrical contractor checks workshop drawings for compliance with all requirements of the specifications, schematic layouts and diagrams, and submits 3 copies, signed off as checked, to the engineer for approval.

(4) The Engineer returns 2 copies as approved or for re-submission, to the Electrical Contractor.

(5) Manufacture of equipment commences after approval of the drawings by the Engineer. Workshop drawings shall include the scaled and dimensioned general arrangement, sections, busbar dimensions, equipment clearances, cubicle layouts, busbar stubs, instrumentation of details, equipment, comprehensive wiring diagrams, terminal and cable numbers, etc. The wiring diagrams shall be complete with wire and terminal numbers as well as the status of each contact, normally open or normally closed. The wiring diagrams shall include the description of all symbols used in the diagrams.

(6) Electrical Contractor checks and inspects boards at the manufacturer during all stages.

(7) Electrical Contractor presents the Engineer with written confirmation that the boards are in full compliance with the specifications, schematic layouts and diagrams, that they have been checked, inspected, and fully tested. This confirmation, signed and dated by both the Electrical Contractor and board manufacturer is to accompany a written request, by the Electrical Contractor, for the Engineer to witness the re-inspection and re-testing of the distribution boards. The Electrical contractor shall also confirm that each of the distribution boards will fit into the space or area allocated.

(8) During the inspections, a fault list, if necessary, will be drawn up and handed to the Electrical Contractor.

(9) After satisfactory rectification of the fault list, and subsequent re-inspection, the Electrical Contractor may instruct the board manufacturer to dispatch the boards to site. No repairs or rectification of fault list items will be permitted to be carried out on site.

(10) Under no circumstances will the Engineer enter into any discussions regarding conformance to specifications with the board manufacturer. All communication will only be directed to the Electrical Contractor from either the Engineer or the board manufacturer.

(11) The Electrical Contractor shall ensure that a full copy of the specifications as well as a copy of the drawings, which were approved and signed by the Engineer, is at hand, during all inspections.

(12) All tests, i.e. pressure tests, trip tests, injection tests, and functional tests shall be carried out as specified in the technical specification, at the premises of the board manufacturer. All tests as specified shall be performed by the board manufacturer for the Electrical Contractor, and shall be repeated for witnessing by the Engineer. The Electrical Contractor

shall ensure that all tests as specified are carried out, and shall satisfy him that all equipment irrespective of the source, or origin, or supplier, will perform satisfactorily in site tests and future continuous use.

1.10 PROGRAMMABLE LOGIC CONTROLLERS

The contractor shall implement the following control logic, alarms and data logging by means of a PLC.

Note that all PLC, SCADA and Historian programming shall be done in accordance with the following documentation provided:

(1) Process Flow Diagrams

(2) Process and Instrumentation Diagram

(3) PLC Input & Output Lists

For conventional instrumentation, signal levels to and from the PLC shall be as follows:

Discrete Inputs:	24 VDC
Discrete Outputs:	24 VDC isolated voltage free relay contact
Analogue Inputs:	24 VDC, 4-20 mA, loop powered, or field powered transmitters shall be used as approved by purchaser
Analogue Outputs	24 VDC, 4-20 mA, loop powered and individually isolated shall be used as approved by the purchaser

Individual fuses shall be provided for all inputs and outputs. Groups of 8 is accepted.

The system arrangement shall permit significant future expansion if required. Nominally 20% spare installed I/O shall be provided at all control centers.

1.10.1 Interface to Plant Control Systems (PCS)

In general, interface requirements shall depend on the complexity of the system, the mode of control and the level of communication required.

This could range from a zero requirement, for simple independent systems, to a major requirement for complex systems that have a high level of integration with other process components. The actual interface method will either be direct, via hardwired I/O, or a communication network (as detailed below).

Direct Interface

All control signals to be connected to the PCS shall be hardwired I/O, terminated at a dedicated termination point in the local control panel.

Discrete inputs to the PCS shall be from voltage-free contacts of a local PLC or from interface relays.

All input contacts shall be wired and programmed to be 'fail safe' whereby the contact is closed for the 'healthy' condition.

External control functions from the PCS shall be arranged through interface relays. Interface relays shall have 24VDC coils with a maximum coil rating of 1.2 W.

All instrumentation and control signals which will be interfaced to the PCS shall be electrically isolated from any grounding system other than those of the facility control system power supplies.

There will be minimum interface requirements for system "RUN" and "FAULT" signals to be sent to the PCS with provision for a remote start and stop capability from the PCS.

All emergency shutdown signals shall be hardwired and self-contained.

Communication Network Interface

Where the package does not have its own PLC, the inputs and outputs required may be wired to the PCS.

PLCs shall be directly connected to the PCS control network either via a IP Ethernet network. If this option is not available, industry standard serial communication protocols, such as Modbus, shall be used. Compatible communication interfacing module/s shall be installed on the packaged PLC panels to establish communication with the PCS control system.

1.10.2 PLC Specification

The PLC shall be approved and equal to type **Siemens S7-1500.**

I/O modules shall be approved and equal to type **Siemens ET 200MP.**

It is a requirement that data should be logged of all the input and output parameters indicated on the I/O List. Data shall be available in Microsoft Excel (.xls) or **.csv format**.

Provision shall be made to store the data on a removable **USB** data storage device or on an external personal computer by means of a LAN cable connection (**RJ45**). The RJ45 LAN point shall be installed in the MCC.

The Contractor is to allow for the inputs / outputs as per the schematic diagrams with an additional **30% spare** for future extensions.

1.10.3 PLC Development Software

The PLC shall be programmed by means of **TIA Portal (Totally Integrated Automation Portal)** development software.

1.10.4 Client Software

The supply, installation, programming, commissioning and training of Client software shall form part of this contract.

The latest version of **WinCC (Windows Control Center)** be installed on the HMI.

1.10.5 Client Hardware

A HMI (Human Machine Interface) installed on the face of the MCC (Motor Control Centre) shall be used to display the status of the controls and alarms mentioned below. The HMI display shall be approved and equal to type **SIMATIC TP1200 Comfort HMI** (colour).

1.10.6 SCADA Software

The supply, installation, programming, commissioning and training of SCADA software shall form part of this contract.

The SCADA software shall be licenced for **unlimited** displays.

The integration of the control system with the client's existing monitoring software does not form part of this project, however an interface for this integration must be provided under this project's scope. The interface shall be OPC UA or Modbus TCP.

1.11 Fail – Safe Operation

All interlocks, trips and emergency stop functions, either used within the package or provided to interlock other process plant, shall be fail-safe.

All signal inputs from field devices shall be fail-safe regardless of the type of function. The high input shall represent the healthy condition.

All package PLCs using communications shall include communications fail detection that uses a cyclic high/low 'heartbeat' pulse and a fail timer so that if a change of state is not detected by the receiving device within a predetermined time, then a latched communications fail alarm shall occur. Where signals from the PLC are used for plant interlocking then a trip of the machine shall automatically occur. Both devices (for example the plant PLC and the package PLC shall include the heartbeat pulse and fail detection and act in a fail-safe manner when interlocks and controls are required. The action shall be to trip the driven machinery or return valves to a safe position as required by review.

Medium voltage and low voltage motor protection relays shall also include a 'heartbeat' communications detection so that at both the main plant PLC and the protection relay, a communications failure can be detected. The drive shall stop on communications failure. Schematic diagrams and device programs for motors shall be reviewed for fail-safe operation under all conditions.

Variable speed drives shall have the same fail-safe operation philosophy – including communications and internal programming.

1.11.1 Interlocks

Interlocks are intended to preserve integrity and prevent personnel injury and damage to equipment. They are divided into three groups: safety, equipment, and process interlocks.

1.11.2 Safety Interlocks

Safety interlocks shall be designed for personnel safety and shall be hardwired into final element power supply circuits. They shall include emergency stops, conveyor safety pulls cords, and others, and shall be integrated with Startup and operation. The stop condition shall be monitored by a control system supplied by others.

1.11.3 Equipment Interlocks

Equipment interlocks shall be provided to protect equipment. They shall be wired to an interfacing junction box supplied by The Contractor for integration into a control system.

They include lubrication, pressure, level and flow detectors, belt excursion detectors, etc.

1.11.4 Process Interlocks

Process interlocks shall be provided to ensure smooth process operation. They shall be wired to an interfacing junction box supplied by the Contractor for integration into a control system. The devices comprising a process group shall be interlocked in such a way that any accidental stop of any of the devices during operation will result in the stopping of all upstream devices to prevent congestion at the defective device.

1.12 INSTRUMENTATION

1.12.1 General

Transmitters shall be 'SMART' versions with digital HART communication where available. Microprocessor-based sensor and transmitter systems incorporating self-diagnostic features will be used for all process measurement and control applications. The exceptions will be head-mounted temperature transmitters used for non-critical applications.

Analogue transmitters will provide signals at 4-20 mA DC, fully isolated where possible. Electronic housings will be selected for compatibility with the corrosive environment.

The action of controllers, alarm switches, final control devices, etc., shall be such that the system is fail-safe. That is, upon failure of air supply and/or power, the final control device shall move in the direction which presents the least hazard. Fail positions of valves shall be shown on P&IDs and noted on instrument data sheets. Valves shall be configured to fail closed as a default, unless this conflicts with safety or operating requirements.

All instruments and valves shall be specified to be provided as one fully assembled unit.

Electronic transmitters' output signals shall not be affected by very high frequency (VHF) or ultra-high frequency (UHF) radio communication equipment of 1 watt power rating in use at 1 meter from the transmitters. Engineer shall request the supplier to advise on acceptable storage and operating ambient temperature extremes for the equipment supplied.

Electronic transmitters shall be protected from transient induced by welding, heavy electrical equipment, lightning or switchgear.

Instruments shall be physically tagged by the supplier before shipment for identification with a stainless steel (SST) tag and permanently affixed to the instrument using a stainless-steel wire.

Instrument ranges shall be selected such that the normal operating point is between 35% and 75% of the instrument total range

Transmitters shall be equipped with a local digital display. The LCD displays shall be suitable for the ambient temperature and other site conditions.

Transmitters shall be used in place of on/off switches, whenever practical. Transmitters shall be configured to fail low as a default, unless it conflicts with safety or operating requirements. Fail status shall be noted on data sheets. Switches (on/off) will be added where required for pump protection or safety and as a back-up to the transmitters such as in tanks, etc.

Transmitters shall have an accessible local indicator displayed in engineering units as standard.

Proximity sensors shall be used in preference to mechanical type limit switches wherever possible (e.g. valve limits).

Where only contact outputs are available from primary actuated devices (field pull wire switches) contacts shall be double pole double-throw (DPDT) isolated contacts, rated for 5A minimum at 120 VAC and +/-24 VDC, unless otherwise specified. Field contacts (e.g. panel alarms) shall be single pole

double-throw (SPDT) isolated contacts, rated for 5A minimum at 120 VAC and +/- 24 VDC, unless otherwise specified.

Mechanical contacts shall be capable of reliably switching 5A at 120 VAC and +/-24 VDC. Contacts shall be suitably coated or hermetically sealed to prevent high contact resistance.

Each field-mounted pneumatic controller, transmitter and valve transducer or positioner shall be furnished with an air isolation valve, adjustable air filter/regulator combination with output gauge. Each instrument shall be provided with its own supply pressure shut-off valve, upstream of the filter/regulator.

Instruments shall be mounted to provide easy access for operation and maintenance. Instruments requiring calibration shall be installed such that they can be easily removed and reinstalled. High maintenance instrumentation which is subject to frequent plugging shall include flush/drain points for cleaning purposes.

In-line instruments shall be flanged to match the piping code and lined as required for the service. Screwed process connections shall only be used where they are consistent with the piping specification. In-line instruments such as valves or magnetic flow tubes in a pipeline subject to pressure testing shall be supplied with a pressure test certificate to the piping code.

Materials in direct contact with the process shall be selected on the basis of the piping material specification, process fluid and process conditions. 316 stainless steel shall be the minimum requirement for process contact. Plating is unacceptable. Non-standard material finishes and pressure applications shall be supplied with material certificates.

Instrument junction boxes shall NEMA 4 as required by the process area. All junction boxes shall be of UV resistant fiberglass or epoxy painted carbon steel construction with a sloped sunshade. Cable entries will be from the bottom of junction boxes, where possible. All instrument junction boxes shall have a hinged, lockable door with rail-mounted terminals.

Local indicators (e.g. pressure, temperature) shall be selected on the basis of readability, rugged construction, safety, vibration resistance, shall have shatter-proof glass and shall be liquid-filled.

Transmitters shall be mounted on building steel or on separate stands or supports, as applicable, with due consideration given to remoteness from heat or vibration sources, as well as water and material spillage. Field instruments shall be located so that they are accessible from grade or adjacent platforms but shall not obstruct walkways or passageways. Standard instrument mounting shall be DN 50 (2 inch) pipe mount.

Enclosures of all instruments shall be protected from direct sun exposure using a sunshade.

During the design review, recommendations shall be made with regard to installing wireless instrumentation. Wireless shall be considered in remote areas where instruments are grouped in quantities and used only for monitoring purposes. The use of wireless instruments shall be considered only if economically viable.

Power supply for field instruments shall be 24 VDC. For analogue instruments 24 VDC loop power shall be used.

Analogue instruments instead of switches are preferred, where possible, to improve reliability and condition monitoring of the instrument and mechanical equipment.

The normal instrument air supply pressure on the plant air headers will be 650 kPag. The minimum air pressure on the unit air header will be between 460 kPag and 680 kPag maximum.

Process screwed connections shall be as per ASME B16.11

Process flanged connections shall conform to ASME B16.5 All field-mounted pneumatic controllers, transmitters and valve transducers or positioners shall be furnished with an adjustable air filter/regulator combination.

All field controllers shall be furnished with external set-point adjustment. The use of “blind” controllers is not permitted.

Switch trip point setting shall be adjustable.

Materials required to interconnect or install instrument or electrical devices located on the package unit shall be supplied as part of the package (e.g. thermo-wells for thermocouples).

Interconnections between items supplied in the package unit (electrical, pneumatic, etc.) shall be supplied and installed by the Vendor prior to shipping. All devices shall be pre-wired to a rated junction box. The junction box shall be pre-wired, pre-piped, etc., except where shipping constraints necessitate dismantling of the unit, in which case interconnecting cables, pipe, tubing, etc., shall be clearly tagged for re-connection at the job site.

In areas where instrumentation cannot be installed and/or connected for practical reasons, with approval of the Owner, the Vendor shall supply all necessary installation details and required interconnections to properly terminate instrumentation on site to Vendor junction boxes.

Isolation valves shall be provided so that valves and instruments can be removed for maintenance without draining tanks or reservoirs and without de-pressurizing entire systems. Isolation valves shall be full bore to allow “rodding out” of the connection points. The first isolation valve for instrument connections shall be a full process-rated piping valve (not an instrument valve). Separate process

connections are required for each instrument, including pressure gauges. Process connections for instruments on vessels shall be dedicated to the instrument (instrument bridles are not permitted) and not shared with process piping. An isolation valve (block and bleed) shall also be installed at the instrument to isolate the instrument from the process for maintenance. Instruments shall be physically tagged by the supplier before shipment for identification with a stainless steel (SST) tag and permanently affixed to the instrument using a stainless-steel wire.

Calibration certificates for all transmitters and switches supplied shall be submitted by the supplier for client review.

1.1.1 Instrumentation Isolation

All field instrumentation, outside of the PCS, shall be individually fused.

Individual fuse links shall be provided for each field switch and for each solenoid. 10% spare fuse links shall be provided.

Lamp test facilities shall be provided on all control panels. Lamp circuits shall be separately fused from control and trip/alarm circuits.

Individual control loops should feature electronic current limiting. Where not provided, input and output circuits shall feature individual fuses. In no case shall fewer than one be provided.

1.13 CABLE TRAY

All cables shall be installed on:

- Galvanized steel cable ladders or equivalent
- Cables shall be installed on ladders and trays in a single layer and held in position with cable ties.
- Power and control/instrumentation cables shall be segregated by installation in separate conduits or, where run on a common cable ladder or tray, a metal segregation barrier shall be provided between power and control/instrumentation cables.

Cable tray shall be:

- Standard ladder type tray (cable ladders) used in plants should be heavy-duty type.
- All trays to be hot-dipped galvanized steel.
- Standard sizes for cable ladder used are 100mm, 150mm, 200mm, 300mm, 400mm, 600mm, 800mm and 1000 mm wide.
- Ladder type tray shall have 300 mm rung spacing, and shall have rail heights at 100mm
- Cable tray shall be perforated type, with side rail height 50 mm, 75 mm and 100 mm.

- All installations in the cable tray shall have maximum three meters (3 m) between support points.

In general, the cable tray support system must comply with the following requirements:

- All cable trays must be laid **horizontal** where possible. Vertical tray mounted on its side shall only be installed in areas where spacing for horizontal trays is not adequate.
- Cable tray shall be supported rigidly, so as to prevent excessive vibration or deflection.
- Cable tray support spacing shall not exceed 3 m.
- Wall, floor and ceiling openings and penetrations shall be sealed with approved waterproof fire barriers.
- All vertical runs shall be properly clamped – maximum spacing 1.5 m.

Heavy-duty galvanized steel cable tray systems must be continuously bonded by grounding cables routed in the tray and bonded to the tray every 6 m. The grounding cables shall be grounded to structural steel support at max. 20m intervals.

Where a number of cable trays are installed in tiers, each cable tray shall be connected by a bonding conductor to the next one, every 15 m. The lowest cable tray shall be grounded to structural steel support at maximum 15 m intervals.

Cable tray system shall consist of straight runs required fittings (tees, elbows, reducers, etc.). Construction, fabrication, and Installation of all cable trays shall be per SANS standard.

1.14 CABLES

1.14.1 General

The tender price shall include for the supply, delivery, installation, testing and commissioning of all cables referred to in the cable schedule, drawings and specifications including all terminations, ends and connections.

All cables shall:

- Have copper multi-strand conductors unless otherwise specified.
- Low voltage power cables shall be insulated with non- flame propagating polyvinyl chloride (PVC)
- Be circular multicore type with.
- Be protected against overload and short circuit
- Be adequately protected against mechanical damage over the entire route length

- All cables shall be terminated by means of suitably sized metal weatherproof-type cable glands, shrouds and lugs to suit the hazardous area classification. Shrouds shall cover the gland completely.
- Single core cables shall be terminated via a non-ferrous gland plate (minimum thickness of 3mm) and non-ferrous glands. Aluminium is preferred.
- Have cable numbers in accordance with the cable numbering system at each end of each cable
- Colors shall not be changed between source and device
- All conductors (including spare conductors) must be terminated on terminal blocks at all points and properly identified.
- Allow 25% spare cores in multi-conductor control cables. For equipment fixed in design and of standard connection, spare cores are not required.
- Multi-conductor cable cores are to have each individual core tagged at both ends with a unique alphanumeric code (prefer numbered cores to color coded).
- Low voltage control systems should use minimum 2,5mm² stranded wire in cables (as per system requirements).
- All wires shall have stranded copper conductor per applicable SANS standards with PVC insulation. Solid conductor cables are not acceptable. Flexible cords are not acceptable.
- Calculated wire sizes for loads shall allow for:
    - Voltage drop at full load to any receptacle not to exceed: 3%
    - Voltage drop at full load to any lighting fixture not to exceed: 3%
    - Voltage drop to control or signal circuit elements not to exceed: 2%

1.14.2 Low Voltage Cables

All low voltage cables shall have stranded copper conductors, shall be new and shall be of the PVC/PVC/SWA/PVC type, 600/1000 V grade and shall comply with SANS 1507. No aluminium conductors will be allowed. Single core cables shall have stranded copper conductors with PVC insulation and PVC sheath, and shall comply with SANS 1507.

Copper earth conductors shall be installed with each cable and shall be strapped to the cable at 2000-mm intervals. The bunching of earth conductors is not acceptable.

Cables to motors on **variable speed drives** shall be shielded 3-core cables with 3 symmetrical ground conductors – designed for VSD duty.

The following test shall be performed after cables are installed

(1) Insulation Testing (1000V megger SANS 1507)

(2) Correct phase rotation

XLPE Cables shall be subjected to a very low frequency test and not a DC Pressure Test.

All test results shall be submitted to the Engineer in writing before the final commissioning of the equipment and cables take place.

It shall be the **responsibility of the CONTRACTOR to verify the correct lengths of each cable on site before placing an order**. The CONTRACTOR will be paid for installed cables only. No reimbursements will be made for the remaining cables on drums under any circumstances.

Cables shall generally be installed in cable trenches or on cable ladders and trays. Where cables are run on surface, against walls, on floors or against machines or structures, these cables shall be installed in galvanised conduit sections to afford mechanical protection. Fixing of cables directly to floors, walls or equipment by means of saddles will not be permitted. Only raised type, alloy saddle bases with plated or galvanised saddles will be permitted for the installation of conduit sections.

1.14.3 Instrumentation Cables

General instrumentation cables shall, in addition to general requirements:

- Have flame-retardant PVC insulation, 300 V insulated, UV resistant grey PVC sheathing
- Have plain annealed multi-strand copper conductors
- Have individual pairs, twisted
- Have core identification as follows:
  - Have pair colors black and white
  - Have 3-core colors: red, white, and black
  - Have pair/triple number digit on each core
- Have screens of aluminum polyester with drain wire
- Have an aluminum copolymer water barrier bonded to the outer sheath where direct buried
- Intrinsically safe installations shall comply with the following requirements:
  - In addition to the requirements of general instrumentation cables, intrinsically safe cables shall have individual and overall screens and a light blue sheath
  - Withstand a test voltage of 500 V rms between any cores and between any core and any screen
  - Have an insulation resistance between screens of not less than 1 m ohms/km at 500 Vdc and after the test voltage has been applied for 1 minute
- Control wiring selection shall be as per the table below (Table I).

- Shields shall be continuous through all terminals and panels and only be terminated at the control system end to avoid ground loops.
- Panel control wire conductor insulation shall be type THHN (thermoplastic high heat – resistant nylon coated).
- All control cables shall be installed with 25% spare conductors.

Table I: Signal Types and Wire Types

Signal Type	**Wire type**	**Shielding and Isolation**	**Comments**
Analog signals	Twisted single-pair, minimum 1mm², stranded copper	Individual shield Tinned copper drain wire 300 V insulated UV resistant Flame retardant	
	Twisted multi-pair, minimum 1mm², stranded copper	Individual and overall shield Tinned copper drain wire 300 V insulated UV resistant Flame retardant	Individual and overall shields shall be Aluminium/Mylar tape.
24 VDC Discrete signals	minimum 1mm², single- pair, stranded copper	- Without shield and drain wire 300 V insulation UV-resistant flame-retardant	
	Twisted multi-pair, minimum 1mm², stranded copper	Individual and overall shield Tinned copper drain wire 300 V insulated UV resistant Flame retardant	Individual and overall shields shall be Aluminium/Mylar tape.
RTD	Twisted Single/multi-triad, minimum 1mm², stranded copper	Individual and overall shield Tinned copper drain wire 300 V insulated UV resistant Flame retardant	
Thermocouple extension	Twisted single pair, (Type K or R), minimum 1mm²	Individual shield Tinned copper drain wire 300 V insulated UV resistant Flame retardant Solid conductor	
Communication	4 pair Category 6 per ANSI/TIA/EIA 568-C	Overall shield for PCN connections Business LAN may use shielded cable in areas with high levels of E.M.I.	

Signal Type	Wire type	Shielding and Isolation	Comments
	Fiber optic (single mode)	None	Aerial cable for distribution lines or lines without grounding shall be ADSS (all dielectric self-supported) for high tension lines or lines with grounding shall be OPGW (optical ground wire).

- Control cables containing more than two conductors will be purchased with all conductors having the same color (black) with identification from 1 to the last conductor number in the cable.

1.14.4 Cable routes and installation

All joints and taps shall be made with solderless crimp-type compression connection, securely fastened so as to remain tight under vibration or normal strain and insulated properly.

All wires installed shall be without splicing. Interconnections shall be made at terminal blocks in junction boxes where indicated.

Cables shall generally be installed on cable ladders or welded mesh cable trays and shall follow the cable routes as indicated. If a route for a particular cable is not indicated, the Contractor shall choose a route as close as possible to the indicated route, and shall obtain approval from the Engineer for this route beforehand. The Contractor shall take cognisance of the heights of the structures and changes in levels and planes in the cable routes and shall allow for all riser cable ladders.

Cable runs shall be planned to avoid the crossing of cables, which will only be acceptable, if it is impossible not to cross over.

Cables installed in cable trenches shall be neatly laid preferably without crossovers. Earth conductors shall be strapped to the associated cables with suitably sized cable ties at 2m intervals.

Specific care shall be taken in the installation of single core cables (particularly the neutral conductor) to not have the cables separated by ferrous elements. Cables shall be laid in trefoil formation with the neutral conductor in close proximity to the trefoil. Suitable trefoil clamps shall be used to prevent damage due to electromagnetic forces on conductors due to short circuits and fault conditions.

1.14.5 Cable Bending Radii

Cable bending radii shall not be less than the following:

PVC Insulated Cables (≤ 1000V)

- Multi & Single Core (16mm² - 50mm²): 8 x d
- Multi & Single Core (≥70mm²): 10 x d

1.14.6 Cable Segregation

Cables for different electrical services shall be grouped as follows:

- High Voltage Cabling
- Low Voltage Cabling
- Instrumentation and Communication

  Generally each group shall be allocated to a separate cable ladder.

The minimum distance between High Voltage cabling and Telecommunications cable in parallel runs shall be 300mm.

The minimum distance between Low Voltage cabling and Instrumentation cable in parallel runs shall be 300mm.

1.14.7 Cable Spacing

The spacing between individual cables shall be as follows except if indicated otherwise on drawings:

Cables on Cable Ladder

- LV Cables ≤ 4mm²: Maximum of two layers and touching
- LV Cables ≥ 6mm²: Maximum of single layer and touching
- LV Cables Trefoil: Single layer, trefoil groups one cable diameter apart
- HV Cables: Single layer, cables (including trefoil groups) spaced one cable diameter apart
- Instrumentation, control, small power and lighting: Multi-layered up to 75% of the depth of the cable ladder.

Cables Underground

- LV Cables: Trefoil arrangement spaced 150mm apart
- LV Cables: Multicore cables spaced 150mm apart

1.14.8 Cable Securing (Cable Ties)

Cables shall be tied to ladder using UV stabilized nylon cable ties (Black)unless otherwise specified.

Cables on cable ladder shall be neatly laid in parallel runs with no crossing over of cables except at take-off points.

Cables shall be tied to the cable ladder on the following intervals:

- Vertical Runs: All cables to be tied every second rung of cable ladder (600mm intervals)
- Horizontal Runs: All cables to be tied every third rung of cable ladder (900mm intervals)

The maximum number of cables tied together shall be four.

Cable ties shall be correctly sized as follows:

- PVC or XLPE Armoured Multicore ≤ 25mm² a minimum of 8mm wide cable ties
- PVC or XLPE Armoured Multicore 35mm² to 95mm² a minimum of 12mm wide cable ties
- PVC or XLPE Armoured Multicore ≥ 95mm² a minimum of 14mm wide cable ties

1.14.9 Cables Installed in Sleeves

All sleeves for MV and LV cable shall be rated for heavy duty application and be manufactured from uPVC. Sleeves shall conform to SANS 791 (Class 6).

Sleeves shall be sized as follows unless specified otherwise on drawings:

- LV Cables: 110mm diameter (uPVC, Class 6)
- Data Services: 110mm diameter (uPVC, Class 6)

Sleeves shall be installed at the following depths:

- Sleeves for LV Cables: 800mm to top of sleeves
- Sleeves for Data Services: 800mm to top of sleeves

The allocation of cables per sleeve shall not exceed:

- LV Cables: One cable per sleeve
- Equipment & Site Lighting: Four cables per sleeve

1.14.10 Cables Installed Underground

Underground cables shall be laid directly in the ground and be bedded in sand.

The Contractor shall be responsible to ascertain the final ground levels prior to excavating.

The Contractor shall be responsible to obtain the necessary permits and wayleaves prior to excavating.

Furthermore, the Contractor shall be responsible to establish the location of other services (i.e. Telecommunication cables, pipes and ducts) which may cross the proposed trench. The Contractor shall be responsible to repair any damages to the aforementioned services at his own expense.

Trenches shall have parallel sides and shall be free of any protruding objects.

Trenches shall be cordoned off with protective fences and the trench shall be maintained to prevent wall collapse and entry of water.

The minimum radius for change in direction shall not be less than 1m or the minimum bending radius of any cable laid along the trench, whichever one is greater.

Cables shall be laid in clean sand with a minimum bed of 75mm and a minimum cover of 75mm. Prior to placing the sand the Contractor shall ensure that the trench is clear of any sharp objects.

Cables shall be laid in straight runs along the trench and spaced 150mm apart.

Immediately after the laying of cables the cable route shall be marked up on an **as-built** drawing. Dimensions to landmarks shall be indicated to ensure ease of cable finding for maintenance purposes.

Trenches shall be backfilled in 150mm layers. Each layer shall be compacted by means of a mechanical tamper.

The contractor shall be responsible for the procurement and transport of suitable sand bedding. Furthermore, the Contractor shall be responsible for the transport of backfill material to the trench and the disposal of surplus backfill material.

Warning tape shall be installed 150 mm above the cables. The warning tape shall be a continuous strip of 150mm wide orange PVC marker tape with the words: '**Attention Cable Danger**'.

Cable Depth

Cables shall be installed at the following depths below finished ground level:

- LV Cables: 800mm to top of cable

1.14.11 Earth cables and wiring

All earth wires shall be of the stranded copper type, (insulated except where otherwise indicated) and shall follow the same route as the cables. The cross sectional area of all earth wires shall be as indicated on the drawings.

Earth wires shall be installed with all cables, and shall be strapped to each cable at 2-m intervals. Each continuity conductor shall be strapped to its corresponding cable. Collective bunching and strapping of earth continuity conductors is not acceptable.

Earth continuity conductors to outlets shall be of the green / yellow PVC insulated type with stranded copper conductors.

1.15 LABELLING

All electrical components (relays, switches, fuses, breakers, etc.) and door-mounted devices shall be tag identified at the component location with a suitable designation and likewise identified on any/all drawings supplied by the supplier. All meters, relays, etc., shall be provided with panel- mounted engraved Traffolyte nameplates (black with white background).

The labels shall be Traffolyte labels engraved with black letters and numbers on white background. Warning and danger labels shall have white lettering on red background.

The labels shall have bevelled edges.

Labels and tags shall be fitted to equipment prior to transporting to site to enable ease of identification during construction.

Local control station labels shall have identical wording to the labels installed on the associated motor starters. Each light switch and power outlet shall be labelled to identify the origin of the final sub-circuit supplying it. The label shall correspond with the identification of the respective final sub-circuit fuse or circuit breaker.

Nameplates should not be fixed on removable covers. Labels shall be fixed to the panel sheet metalwork. They shall not be fixed to equipment items or duct covers and shall not be obscured by wiring. Labels within panels shall have 5 mm minimum lettering.

The following electrical equipment shall be labelled with lettering heights:

- Main Equipment (e.g., Switchboard, Control Panel): 20 mm
- Danger Labels: 20 mm
- Secondary Equipment (Field Push Button Station, Field Instrument Identification, Junction Box Identification): 10mm
- Marshalling / RIO Panels: 10 mm
- Pushbutton, indicating lamps, selector switch: 6 mm
- Pushbutton, indicating lamps, selector switch: 6 mm

- Equipment mounted inside panels (e.g., relays, fuses): 3 mm
- Field Instruments: 3 mm

Equipment numbers and labels located in the field shall be engraved stainless steel, secured to the equipment with stainless steel screws, nuts and washers or stainless-steel wire ties for instruments.

Nameplates for outdoor equipment shall be stainless steel, 316L type. Nameplates for indoor equipment and the interior of outdoor equipment shall be lamacoid type.

Nameplates shall be attached with stainless steel screws. Attaching nameplates with a chemical compound is not acceptable.

Equipment identification labels or nameplates shall be minimum 200 mm x 50 mm with bevelled edges. Letters shall be block type measuring 6 mm x 6 mm with 10 mm line spacing.

Main equipment tag number nameplates shall be minimum 1.6 mm thick with 20 mm high characters

Motor tags shall be mounted on the local control station. All other equipment shall have the tags mounted on their front covers, where they are easily read.

Terminal blocks shall be identified with block-mounted labels.

Each phase of alternating current switchgear and connections shall be coloured in an approved manner to distinguish phase or polarity. Colours shall be permanent and free from fading.

1.15.1 Wire and Cable Tagging

Wire and cable tagging will be as follows:

- Cables shall be tagged with the cable number shown on the cable schedule, at both ends.
- Cable tags shall be imprintable, stainless steel (304 or 316) type
- Resistant plastic of type resistant to salt water, acid and caustic, of field-printable type or pre- printed carrier type, with the following preferred dimensions: 20 mm x 100 mm x 1.2 mm (WxLxD)
- The tag should be able to accommodate 2 lines of 20-character text with 5 mm letter sizing and be compatible with cable ties. Some examples of suitable cable tags include ABB (Thomas and Betts) SSID series, Siegrist-Orel itag CLXi series, and Critchley K-type series.
- Wires shall be identified with the wire tag shown on the drawings at both ends, with machine- printed labels on heat shrink-type sleeve-type wire markers

1.16 LIGHTING INSTALLATION

1.16.1 General

All light fittings shall be new and unused and shall be supplied complete with all LED Modules, Optics and LED Drivers (Electronic Control Gear and Power Supplies).

All fittings shall bear the SANS / IEC 60598 safety mark. A certificate of approval shall be submitted if requested by the Engineer.

Light fittings shall be rated for operation from mains power, nominal 230VAC, 50Hz and shall have a power factor ≥ 0,95.

Light fittings shall be equipped with surge protection.

Preference will be given to Philips, Osram and Tridonic, Vossloh-Schwabe, type LED modules and drivers.

The following minimum lifetime guarantees are required in terms of this contract:

(1)	LED modules and drivers	100 000 hours
(2)	LED Lamps	40 000 hours

LED light fittings shall generally have a colour temperature of 4000 K [cool white] unless otherwise indicated on the lighting schedule and a minimum colour-rendering index (Ra) of 80. The LEDs shall have a small colour tolerance of at least - MacAdam 3.

All LED Modules, Optics and LED Drivers, fixtures and components shall be replaceable.

1.16.2 LED Modules and Control Gear

LED modules shall generally have a colour temperature of 4000 K [cool white], a minimum colour-rendering index (Ra) of 80 and a long lifetime of 72 000 hours.

1.16.3 Installation of luminaires

Lighting Installation in the Switch Rooms & Utility Areas

Luminaires installed in the switch rooms and utility areas be installed at 4m AFFL on suspended P2000 Unistrut trunking. The P2000 Unistrut shall be suspended from the switch room / utility area concrete soffit or roof structure purlins with threaded rod or Gripple cables.

Wiring of the lighting circuits shall be single phase and comprise two 1,5 mm^2 PVC insulated conductors and a 1,5 mm^2 insulated earth conductor.

The insulated conductors shall be coloured in the relevant phase colours.

1.17 EMERGENCY STOPS

Emergency stop buttons shall be supplied as follows:

- Surface mounted
- Environmental protection to be **IP65**
- **Red Mushroom Type Push Button** (Latching and twist to release)
- Labelled Disc with the inscription **"Emergency Stop"**
- **Metal** enclosures (die cast aluminium).
- **1NO + 1NC Auxiliary Contacts** for feedback to a PLC (SCADA system)
- Emergency Stop Buttons shall be equal or approved to the type Gewiss 74PS Range
- Local emergency stops shall be installed in white back boxes
- Global emergency stops shall be installed in yellow back boxes

Emergency stop buttons shall be wired into a **safety relay** located in the Motor Control Centre.

1.18 CONDUIT

The Contractor shall carefully plan the surface mounted conduit runs with all the services for which they will be required prior to the installation thereof. Crossovers shall be kept to a minimum and where they occur, all the conduits running in one direction shall be kept on a base level with all the conduits crossing over in the other direction being offset over the base layer of conduit. The practice of crossing over at an ad hoc basis with a resultant weaving of conduit appearance shall not be tolerated.

The use of **PVC conduit**, fittings and accessories **is not permissible**, except where specifically called for. Even though the distribution boards may be shown as surface mounted, all conduits shall be built or cast in. Surface mounted conduits shall not be permitted except where specifically called for.

All conduits (chased or surface mounted), regardless of the system employed, shall be of the galvanised steel BOSAL type and bear the SABS mark of approval.

Galvanised screwed steel conduits, minimum diameter 20 mm. Open conduit system shall be allowed only for armored cables. For non-armored cables, it will require elbows (closed conduit system).

Where flexible elbows are required for galvanised conduit steel Sprague tubing covered with PVC shall be used, similar to type Kopex.

All surface conduits (where specifically called for) against painted surfaces shall be painted to match the surfaces on which it is installed. The galvanising shall be lightly sanded to remove all surface

oxidation, oil or dirt. The conduits shall be primed by means of an etching calcium plumbate primer. Zinc chromate primers shall not be used, as they are not suited to galvanised finishes. The conduits shall then be finished in 2 coats of gloss enamel in a matching colour. The gloss enamel coat shall be applied BEFORE the conduits are cut or installed. Inferior paintwork shall be rejected.

All surface mounted conduits where called for shall be installed using raised type alloy bases with galvanised or plated saddles. The alloy bases shall be fixed to the mounting surface by means of M5 brass machine screws. The saddles shall be fixed to the alloy bases by means of M5 pan head plated machine screws. **Self-tappers will not be permitted**.

Conduit saddles shall be fixed to roof timber or structures by means of screws. Nails will not be permitted.

Chasing by means of hammer and chisel will not be accepted. All chasing work shall be carried out by means of power driven machinery using abrasive cutting discs.

All steel conduits shall be securely bonded to earth at the distribution board tray.

Bushes shall be fitted to the cut ends of all steel conduits.

All chasing in walls will be plumb and straight and done in a neat manner. No slow bends will be accepted.

Surface conduits, where called for, shall be installed parallel and plumb with the gridlines of the building or structures to which it is fixed.

1.19 TRUNKING AND WIRE WAYS

The wiring channels shall be suspended in the positions as indicated on the drawings. Care shall be exercised to ensure that the fixing of wire ways shall no lead to sharp protrusions in the wire ways leading to possible damage to wiring. Wire ways for power or lighting shall be terminated directly onto the respective distribution boards.

Punching for power and light unswitched socket outlets shall be provided at 500-mm intervals. Safety barriers shall be provided for all socket outlets. The standard size of the ducting shall be 123 x 75 mm unless otherwise specified on the drawings.

The covers for the ducting shall be manufactured from steel and shall either be a snap-in type lid or shall be provided with a non-removable catch type system. Drop-on covers shall not be permitted.

Wiring channels shall generally face upwards for ease of wiring.

The channels down the columns or walls shall be fixed thereto with purpose made galvanised brackets. Shot fired fixing of the brackets to concrete columns or walls may be employed.

This contract includes the drilling of all holes and making good of resultant damage, for the fixing of cable trays, wire ways and supports.

Where applicable, cables to luminaires or to sockets shall pass through conduits of suitable size. The conduit shall be fitted with brass bushes at both ends. The conduits shall be fixed with raised hospital type saddles. The cable need not pass through conduit around cable bends.

The openings in walls and slabs through which cable trays and wire ways pass shall be sealed after commissioning of the installation with an approved non-hardening compound. The above compound shall prevent a fire from propagating through the openings.

In the case where conduit is required to run to equipment and where a wall or structure is not available, the conduit shall be supported by means of a 75 x 75-mm hot dipped galvanised square section tube. The square section shall be bolted to the cable tray and to the relevant equipment or steelwork. Both ends of the tube shall be sealed by means of welded end plates.

All wire ways shall have purpose made end caps and metal covers.

All wire ways and cable trays shall be colour coded to identify its intended use with permanent painted bands as specified elsewhere.

1.20 EARTHING AND BONDING

1.20.1 General

All earthing and bonding shall be done in accordance with SANS 10292, SANS 10142-1 and the Occupational Health and Safety Act as amended.

The Supply Authority Earth Conductor shall be connected the Main DB earth bar as well as the additional earth spike as indicated on the drawings. All outgoing circuits shall be earthed to the electrical earthing system and replicate the electrical distribution network with a dedicated earth conductor for every cable feed to sub distribution boards or equipment.

Metallic parts shall be bonded to the electrical earthing installation as per the requirements of SANS 10142-1.

The earthing installation shall comply with the requirements of:

- Occupational Health and Safety act, Act 85 of 1993 as amended (including regulations),

- Mine Health & Safety Act , Act 29 of 1996 as amended (including regulations),
- Explosives Act, Act 15 of 2003 as amended (including regulations),
- SANS 10142-1 as amended: The wiring of premises. Part 1: Low-voltage installations,
- SANS 10292: Earthing of low-voltage (LV) distribution systems,
- SANS 10313: Protection against lightning – Physical damage to structures and life hazard,
- SANS / IEC 62305-1: Protection against lightning. Part 1: General principles,
- SANS / IEC 62305-2: Protection against lightning. Part 2: Risk management,
- SANS / IEC 62305-3: Protection against lightning. Part 3: Physical damage to structures and life hazard.

1.20.2 Earth Electrodes

Earth electrodes shall be a minimum of 16mm diameter copper sheathed steel rods ranging in length from 1,8m; 3,6m; 6m & 12m

Generally, earth electrodes shall be spaced a minimum length of an earth electrode apart.

If the ground is too hard to drive the earth electrode into the ground 40-80mm diameter holes will be drilled (ranging from 6m – 15m depths). The holes will be filled with conductive concrete made up from mixing Bentonite with the backfill material as per the recommendation of the Bentonite supplier. The Contractor shall ensure that the connection between the earth electrode and the earth cable is exposed as to allow for future maintenance.

If the ground has a very high earth resistivity the same methodology of employing conductive concrete made up from mixing Bentonite with the backfill material as per the recommendation of the Bentonite supplier shall be employed.

1.20.3 Earth Conductors

Buried earth conductors shall be BCEW (Bare Copper Earth Wires) and be installed at a minimum depth of 800mm below the natural ground level.

Earth conductors to movable equipment or hinged equipment shall be braided flexible copper.

In general, all other earth conductors installed above ground shall be green PVC covered stranded copper conductor unless otherwise specified.

1.20.4 Earth Connections

All buried and exposed taps, splices and connections in bar and cables shall be made by brazing or exothermic welding unless otherwise specified. The pre-welding treatment of the conductors shall be in accordance with the manufacturer's instructions. All buried connections will be inspected by the Engineer prior to burial.

Exposed bolted connections in earthing conductors shall be protected from corrosion by covering with approved sleeving or tape (Denso Tape).

Conductor clamps shall be made of a strong cast bronze body to provide a high pressure contact between the earth conductor and earth electrode. The clamp shall be provided with a non-ferrous set screw.

All lugs crimped to earth conductors of 16mm² or larger shall be crimped by means of hexagonal type crimpers. Dimple crimping of these shall not be accepted.

1.20.5 Earthing of Equipment

All equipment shall be earthed by means of earth continuity conductors run either singly or together with power supply cables.

The following conductors and cables parts shall be connected to the earth bar at the point of supply and the earth stud of all equipment to which the respective conductors and cables are connected to:

- Earth Conductors
- Metallic Armouring of High & Low Voltage Power Cables
- Control and Instrumentation Cables

Cable ladder shall be earthed at each end.

Metallic trefoil cable clamps and armoured cable glands shall be solidly earthed.

1.20.6 Earth Bonding

Metallic parts shall be bonded to the electrical earthing installation as per the requirements of SANS 10142-1.

Equipotential bonding shall be realised by means of connecting all metallic parts of the installation that is not intended to be live. This includes the earthing and bonding of basins, taps, waste pipes, gutters, down pipes, stair railings, gates, fences, cables, wire ways etc. and shall be in accordance with the regulations and codes of practice.

Cable bridges, pipe rack frames, steelwork of buildings and structures shall be solidly connected to earth.

1.20.7 Substation Earth Bar

A 600mm long 40 * 6,3 mm earth bar, mounted on stand-off insulators shall be supplied and installed in the MCC in the position as indicated on the drawings. The **earth bar** shall be pre-drilled with 15 holes (9mm Ø) and M8 * 40 high tensile galvanised bolts with two flat washers, one spring washers and one nut per bolt. All bolts, nuts and washers shall be galvanised. The earth bar shall be complete with a single disconnection link to isolate the earth electrode for testing purposes.

A lightning protection installation in compliance with SANS 10313 and SANS / IEC 62305 parts 1, 2 and 3 shall be supplied and installed. The installation shall comply with the layout and detail drawings.

1.20.8 Lightning Protection of Structures

The external lightning protection installation shall comprise the following:

- A 70mm² bare copper earth wire ring conductor around the floor slab of structure as indicated on the drawings, 1 m outside the circumference and 500 mm below the finished ground level. This conductor shall be installed centre in a 100mm thick conductive concrete backfill at the bottom of the trench into which the ring conductor is installed.
- Conductive concrete made up from mixing Bentonite with the backfill material as per the recommendation of the Bentonite supplier.
- 16mm diameter round solid copper earth spikes, 1,8m long at each of the positions as indicated on the drawings. Should it not be possible to drive the earth spikes into the ground, a suitable borehole (minimum 80mm diameter) shall be drilled and the rod installed in a conductive concrete backfill in the hole.
- 70mm² black insulated copper conductors with lugs fitted to the studs on the structural steel columns of the buildings. The other end shall be connected to the earth spike and the ring earth electrode in a dedicated earth electrode connection box with lid to facilitate access to the system for maintenance purposes.
- Roof bonding conductor (35mm² black insulated copper conductors) bonded to the roof sheeting and lugged to the top of the structural steel columns.

The Contractor is referred to the drawings for more detail on the above system.

On completion of the installation, the Contractor shall survey the earth resistance of the complete system and submit a report to the Engineer.

The Contactor shall complete and submit a Lighting Protection System Installation Safety Report using the pro-forma as bound in as Annex A of SANS 10313:2010.

1.20.9 Instrumentation Bonding and Earthing

The instrumentation ground shall be connected to an isolated ground bar, which shall be bonded to the main ground bar at a single point.

All instruments, relays and meter enclosures in a control panel shall be effectively bonded to the panel frame.

The panel frame shall be provided with grounding lugs for connection to the Owner's ground system.

Where a control transformer is used, one side of the secondary winding shall be grounded.

Bonding cables must be provided where electrical or instrumentation components are not mounted on metal frames welded to the equipment or skid base.

All motor frames and process area electrical equipment shall be visibly grounded.

All process equipment subject to hazardous static voltage charges shall be permanently grounded such that all potential static voltage charges will be discharged to ground.

The screen of an instrumentation cable shall only be earth at one point.

1.21 SIGNAGE

Where specified, signs for substation buildings and transformer compounds shall comprise the following:

1.21.1 Substation Buildings:

- Resuscitation signs inside each door
- Substation identification e.g., "PASTE PLANT SUBSTATION outside each door
- "DANGER HV" sign outside each door as appropriate
- "AUTHORISED PERSONNEL ONLY” signs outside each door.

1.21.2 Transformer Bays:

- "DANGER HV" signs, one on each fence and each entrance.

1.22 FIRE EXTINGUISHERS

The Contractor shall supply and install the following portable fire extinguishers (complete with bracket and sign) next to each exit door:

1.22.1 Substation Buildings

- 3 x 10kg portable fire extinguisher

1.22.2 Control Rooms

- 3 x 10kg portable fire extinguisher

1.23 AS BUILT DOCUMENTATION AND PROJECT CLOSE OUT PROCEDURE

As built drawings of the installation of the installation shall be compiled according to the following procedure:

One set of the Engineers drawings will be supplied to the Contractor. The Contractor shall then:

(1) Update the drawings so that they coincide with the actual installation on site.

(2) Return the marked up drawings to the Engineer, in order that the Engineer may update CAD drawings.

(3) The Engineer will then issue the As Built Drawings to the Client.

The following documentation shall be provided in triplicate on completion of the project in a binder file entitled as "ELECTRICAL INSTALLATION – VALIDATION DOCUMENTATION"

(1) Complete set of "As Built" drawings,

(2) **Technical** information brochures on **all** equipment used. Generalised sales brochures will not be acceptable and the information must be specific to the equipment installed,

(3) Operating procedures,

(4) Adjustment settings and calculations of settings of equipment with adjustable operators,

(5) Results listings of all commissioning tests performed including data of measurement techniques used, serial numbers of instruments and copies of calibration certificates of all instruments used. The listings must be in such a format that the tests can be repeated at any time in future and the results compared with the initial commissioning data.

(6) Maintenance procedures and schedules, and

(7) List of recommended spare parts.

The final claim for payment will not be processed unless the above information has been submitted to the satisfaction of the Engineer and Client.

1.23.1 MAINTENANCE AND REPAIR DURING THE 12 MONTH DEFECTS LIABILITY PERIOD

The equipment and installation supplied under this contract shall be guaranteed and maintained for a period of twelve months from date of acceptance by the Engineer in all respects and commissioned for continuous service. The tender price shall include for the above.

1.23.2 REPAIR DURING THE 12 MONTH DEFECTS LIABILITY PERIOD

The defects liability period will be for a period of twelve months, calculated from the date of issue of the Certificate of Completion by the Engineer. Retention funds will be reduced to 2,5% upon commencement of the defects liability period. The balance of the retention money will be paid out after lapse of the defects liability, provided the installation has, in the opinion of the Engineer, been in satisfactory working order during this period.

The Contractor shall be responsible for the replacement of all faulty equipment, including blown or faulty lamps during the defects liability period.

Faulty equipment shall be attended to immediately, irrespective of the scheduled date of the next maintenance visit, and shall be replaced or repaired within 3 working days of being instructed by the Engineer.

All repairs shall commence within 24 hours of written or verbal advice by the Engineer. Advice by facsimile or e-mail shall be considered to be in writing. Should the Contractor fail to commence repairs to the faulty installation within 24 hours from the time of notification, the repair work may be carried out by others and the costs thereof deducted from the funds held in retention.

All repairs shall be carried out to the satisfaction of the Engineer. All labour, material and infrastructure costs incurred for the repair of faulty equipment shall be borne by the Contractor. No claims in this regard will be considered.

1.23.3 MAINTENANCE DURING THE 12 MONTHS DEFECTS LIABILITY PERIOD

The Contractor shall allow for 1 monthly scheduled maintenance visit during the 12 months defects liability period to attend to preventative maintenance of the installation. Details of each visit, undersigned by the Client's authorised representative shall be submitted to the Engineer as proof of the required visits in order that retention funds may be released at the expiry of the 12 month period.

All labour, material and infrastructure costs incurred for the repair of faulty equipment shall be borne by the Contractor. No claims in this regard will be considered.

2. PREFERRED EQUIPMENT SUPPLIERS

2.1 Preferred Electrical Equipment Suppliers

Equipment Type	Preferred Supplier 1	Preferred Supplier 2	Preferred Supplier 3
MCC Incoming Meter	Schneider PowerLogic PM8000	n/a	n/a
LV Switchgear	ABB	n/a	n/a
Electronic Overload Relays	ABB	n/a	n/a
LV Variable Speed Drives	ABB (Ethernet IP) ULH ≥ 90kW	Siemens	Weg
Light Fittings	BEKA	Lascon	Magnitech
Stop / Start / E-Stop Field Stations	Eaton (Cutler Hammer) – Steel	n/a	n/a

2.2 Preferred Control Suppliers

Equipment Type	Preferred Supplier 1	Preferred Supplier 2	Preferred Supplier 3
Programming Software	TIA	n/a	n/a
SCADA Software	WinCC Unified	n/a	n/a
Distributed Controllers	ET 200 Series	n/a	n/a
PLC	S7-1500 Series	n/a	n/a
HMI	Unified Comfort Panels	n/a	n/a
Instrumentation Cabling	Mylar Screened with APL Armouring and Black UV resistant Outer Jacket.	n/a	n/a

3. BILLS OF QUANTITIES

3.1 GENERAL

The Conditions of Tender, General Conditions of Contract, the Special Conditions of Contract, the Specifications (including the Project Specification) and the Drawings are to be read in conjunction with the Bills of Quantities.

The general requirements and descriptions of the Works and materials given in the Specifications are not repeated in the Bills of Quantities and Tenderers shall refer to the other parts of the Documents for this information.

The cost of complying with all conditions, obligations and liabilities specified in the Conditions of Tender, General Conditions of Contract, Special Conditions of Contract, Specifications and Bills of Quantities, including all overhead charges and profit, and the cost of carrying out the work as shown on the Drawings, shall be deemed to be included in the rates and sums quoted in the Bills of Quantities.

3.2 DESCRIPTION OF ITEMS IN THE BILLS

The Bill comprises items covering the Contractor's profit and costs of general liabilities and of the construction of temporary and permanent Works.

3.3 QUANTITIES REFLECTED IN THE BILLS

The quantities of work and material set forth in the Bills of Quantities are estimates only, and shall not be considered as limiting or extending the amount of work to be done and material to be supplied by the Contractor, nor shall these quantities be regarded as constituting authority to the Contractor to order material or to execute work. The Contractor shall obtain the Engineer's detailed instructions for all work before ordering any materials or executing work or making arrangements for it. The Works as finally completed in accordance with the Contract shall be measured and paid for as specified in the Bills of Quantities and in accordance with the General Conditions of Contract, the Special Conditions of Contract, the Specifications and the Drawings. Unless otherwise stated, items are measured net in accordance with the Drawings, and no allowance has been made for waste.

3.4 PRICING OF THE BILLS OF QUANTITIES

The prices and rates to be inserted in the Bills of Quantities are to be the full inclusive prices to the Employer for the work described under the several items. Such rates and prices shall cover all costs and expenses that may be required in and for the construction of the work described, and shall cover the cost of all general risks, liabilities, and obligations set forth or implied in the documents on which

the Tender is based (excluding Value added Tax (VAT)). VAT shall be added at the end of the summary of the Bills of Quantities as indicated.

The Tenderer is at liberty to insert a rate of his own choosing for each item in the Bills and his attention is drawn to the fact that the Contractor has the right, under various circumstances, to payment for additional Works carried out and that the Engineer is obliged to base his assessment of the rates to be paid for such additional work on the rates inserted in the Bills by the Contractor.

If the Contractor omits to price any items in the Bills of Quantities, then these items will be considered to have a nil rate or price.

All items for which terminology such as "inclusive" or "not applicable" have been added by the Tenderer will be regarded as having a nil rate, and shall be valid irrespective of any change in quantities during the execution of the Contract.

The Tenderer shall fill in rates for all items where the words "rate only" appear in the "Amount" column. The intention is that although no work is foreseen under such an item, and no quantities are accordingly given in the "Quantity" column, the quoted rate shall apply in the event of work under this item being actually required.

The Tenderer shall price each item in the Bills of Quantities in black ink.

All rates and amounts quoted in the Bills of Quantities shall be in South African Rand.

The bill for preliminary and general items shall be priced for the three phases in total. Payment against these items, however, shall only be certified according to the pro-rata value of the three individual phases of the work as executed.

----- End of Report ----

Annexure D – Datasheets & Lists

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 01	
DESCRIPTION	Blue Zone AHU	
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: W1986-53001**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	<60
Air Flowrate	[m^3/h]	43250
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45005-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	297
Cooling Medium Flowrate	[m^3/h]	43
Pipe Size(diameter)	[mm]	80
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	160
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		1 x G4 as per EN779
Primary Filters		1 x F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop
Design Temperature	[°C]	50

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Normal Operating Temperature		[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	43250
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	43250
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[Pa g]	1762
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
5.2. Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
5.3. Construction			
Materials of Construction	Casing		Aluminium
	Shaft		Stainless Steel
	Impeller		Stainless Steel
	Baseplate		Mild Steel with Epoxy coating or Stainless Steel
5.4. Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	32.9
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			
6. Dampers			
Type			2 x Positive Shut-off
Actuation			Pneumatic
Operation Mode			Open/Closed
Leakage Rating			

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 02	
DESCRIPTION	Cleanrooms 1, 2, 3 AHU	
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: W1986-53002**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	<60
Air Flowrate	[m^3/h]	27425
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45005-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	161
Cooling Medium Flowrate	[m^3/h]	23
Pipe Size(diameter)	[mm]	65
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	120
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Type Required		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Design Temperature	[°C]	50
Normal Operating Temperature	[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)	[m^3/h]	27425
Inlet Pressure (at operating temperature)	[kPa g]	
Discharge Capacity (at operating conditions)	[m^3/h]	27425
Discharge Pressure at 20°C	[kPa g]	
Discharge Pressure (at operating Temperature)	[Pa g]	2438
Efficiency	[%]	
Rotational speed of fan/blower at Duty Point		
Seal Type		
5.2. Physical Data		
Inlet Nozzle size and rating		
Outlet nozzle size and rating		
Mass		
Impeller Type		
Impeller Diameter	[mm]	
Max. Sound Pressure Level at 1m	[dBA]	
5.3. Construction		
Materials of Construction	Casing	Aluminium
	Shaft	Stainless Steel
	Impeller	Stainless Steel
	Baseplate	Mild Steel with Epoxy coating or Stainless Steel
5.4. Electric Drive Specification		
Motor Electrical Supply	[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating	[kW]	28.75
Motor Enclosure Rating		
Rotational Speed	[rpm]	
Rated Power	[kW]	
Absorbed Power at Duty Point	[kW]	
Frequency Inverter on motor		
Coupling Type		
6. Dampers		
Type		2 x Positive Shut-off
Actuation		Pneumatic
Operation Mode		Open/Closed
Leakage Rating		

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 03	
DESCRIPTION	Cleanrooms 4, 5 AHU	
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: W1986-53003**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	<60
Air Flowrate	[m^3/h]	8229
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45005-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	50
Cooling Medium Flowrate	[m^3/h]	7
Pipe Size(diameter)	[mm]	40
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	36
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Type Required		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Design Temperature	[°C]	50
Normal Operating Temperature	[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)	[m^3/h]	8229
Inlet Pressure (at operating temperature)	[kPa g]	
Discharge Capacity (at operating conditions)	[m^3/h]	8229
Discharge Pressure at 20°C	[kPa g]	
Discharge Pressure (at operating Temperature)	[kPa g]	1775
Efficiency	[%]	
Rotational speed of fan/blower at Duty Point		
Seal Type		
5.2. Physical Data		
Inlet Nozzle size and rating		
Outlet nozzle size and rating		
Mass		
Impeller Type		
Impeller Diameter	[mm]	
Max. Sound Pressure Level at 1m	[dBA]	
5.3. Construction		
Materials of Construction	Casing	Aluminium
	Shaft	Stainless Steel
	Impeller	Stainless Steel
	Baseplate	Mild Steel with Epoxy coating or Stainless Steel
5.4. Electric Drive Specification		
Motor Electrical Supply	[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating	[kW]	6.84
Motor Enclosure Rating		
Rotational Speed	[rpm]	
Rated Power	[kW]	
Absorbed Power at Duty Point	[kW]	
Frequency Inverter on motor		
Coupling Type		
6. Dampers		
Type		2 x Positive Shut-off
Actuation		Pneumatic
Operation Mode		Open/Closed
Leakage Rating		

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
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THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 04	
DESCRIPTION	Red Zone Ground AHU	
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: W1986-53004**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	< 60
Air Flowrate	[m^3/h]	11081
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45007-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	64
Cooling Medium Flowrate	[m^3/h]	9
Pipe Size(diameter)	[mm]	
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	48
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Type Required		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	11081
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	11081
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[kPa g]	799
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
5.2. Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
5.3. Construction			
Materials of Construction	Casing		Aluminium
	Shaft		Stainless Steel
	Impeller		Stainless Steel
	Baseplate		Mild Steel with Epoxy coating or Stainless Steel
5.4. Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	3.83
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			
6. Dampers			
Type			2 x Positive Shut-off
Actuation			Pneumatic
Operation Mode			Open/Closed
Leakage Rating			

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 05		
DESCRIPTION	Red Zone Basement AHU		
PROJECT TITLE	iThemba LABS HVAC Upgrade		**DATA SHEET No.: W1986-53005**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	< 60
Air Flowrate	[m^3/h]	22248
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45007-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	142
Cooling Medium Flowrate	[m^3/h]	20
Pipe Size(diameter)	[mm]	65
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	97
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Type Required		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Design Temperature	[°C]	50
Normal Operating Temperature	[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)	[m^3/h]	22248
Inlet Pressure (at operating temperature)	[kPa g]	
Discharge Capacity (at operating conditions)	[m^3/h]	22248
Discharge Pressure at 20°C	[kPa g]	
Discharge Pressure (at operating Temperature)	[kPa g]	3054
Efficiency	[%]	
Rotational speed of fan/blower at Duty Point		
Seal Type		
5.2. Physical Data		
Inlet Nozzle size and rating		
Outlet nozzle size and rating		
Mass		
Impeller Type		
Impeller Diameter	[mm]	
Max. Sound Pressure Level at 1m	[dBA]	
5.3. Construction		
Materials of Construction	Casing	Aluminium
	Shaft	Stainless Steel
	Impeller	Aluminium
	Baseplate	Galvanized Steel
5.4. Electric Drive Specification		
Motor Electrical Supply	[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating	[kW]	31.23
Motor Enclosure Rating		
Rotational Speed	[rpm]	
Rated Power	[kW]	
Absorbed Power at Duty Point	[kW]	
Frequency Inverter on motor		
Coupling Type		
6. Dampers		
Type		2 x Positive Shut-off
Actuation		Pneumatic
Operation Mode		Open/Closed
Leakage Rating		

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 06	
DESCRIPTION	Cyclotron AHU	
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: W1986-53006**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	< 60
Air Flowrate	[m^3/h]	1696
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45006-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	31
Cooling Medium Flowrate	[m^3/h]	4
Pipe Size(diameter)	[mm]	32
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	4
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Type Required		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Design Temperature	[°C]	50
Normal Operating Temperature	[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)	[m^3/h]	1696
Inlet Pressure (at operating temperature)	[kPa g]	
Discharge Capacity (at operating conditions)	[m^3/h]	1696
Discharge Pressure at 20°C	[kPa g]	
Discharge Pressure (at operating Temperature)	[kPa g]	382
Efficiency	[%]	
Rotational speed of fan/blower at Duty Point		
Seal Type		
5.2. Physical Data		
Inlet Nozzle size and rating		
Outlet nozzle size and rating		
Mass		
Impeller Type		
Impeller Diameter	[mm]	
Max. Sound Pressure Level at 1m	[dBA]	
5.3. Construction		
Materials of Construction	Casing	Aluminium
	Shaft	Stainless Steel
	Impeller	Stainless Steel
	Baseplate	Mild Steel with Epoxy coating or Stainless Steel
5.4. Electric Drive Specification		
Motor Electrical Supply	[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating	[kW]	0.27
Motor Enclosure Rating		
Rotational Speed	[rpm]	
Rated Power	[kW]	
Absorbed Power at Duty Point	[kW]	
Frequency Inverter on motor		
Coupling Type		
6. Dampers		
Type		2 x Positive Shut-off
Actuation		Pneumatic
Operation Mode		Open/Closed
Leakage Rating		

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 07		
DESCRIPTION	Elephant & VBS Vaults AHU		
PROJECT TITLE	iThemba LABS HVAC Upgrade		**DATA SHEET No.: W1986-53007**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	< 60
Air Flowrate	[m^3/h]	2331
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45006-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	13
Cooling Medium Flowrate	[m^3/h]	2
Pipe Size(diameter)	[mm]	20
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Copper coil/Copper fin/Stainless steel casing
3.Heating Element		
Heating Capacity	[kW]	10
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Electrical Heating Element
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5.Fans		
Fan / Blower Type Required		
Fan / Blower Make and Model		
Fluid		Air
Density at Start-up Conditions	[kg/m^3]	1.293
Density at Operating Conditions	[kg/m^3]	1.293
5.1. Operating Conditions		
Closed or Open Loop System		Open Loop

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

Design Temperature	[°C]	50
Normal Operating Temperature	[°C]	25
Inlet Capacity (at 0°C and 101.3kPa)	[m^3/h]	2331
Inlet Pressure (at operating temperature)	[kPa g]	
Discharge Capacity (at operating conditions)	[m^3/h]	2331
Discharge Pressure at 20°C	[kPa g]	
Discharge Pressure (at operating Temperature)	[kPa g]	944
Efficiency	[%]	
Rotational speed of fan/blower at Duty Point		
Seal Type		
5.2. Physical Data		
Inlet Nozzle size and rating		
Outlet nozzle size and rating		
Mass		
Impeller Type		
Impeller Diameter	[mm]	
Max. Sound Pressure Level at 1m	[dBA]	
5.3. Construction		
Materials of Construction	Casing	Aluminium
	Shaft	Stainless Steel
	Impeller	Stainless Steel
	Baseplate	Mild Steel with Epoxy coating or Stainless Steel
5.4. Electric Drive Specification		
Motor Electrical Supply	[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating	[kW]	1.01
Motor Enclosure Rating		
Rotational Speed	[rpm]	
Rated Power	[kW]	
Absorbed Power at Duty Point	[kW]	
Frequency Inverter on motor		
Coupling Type		
6. Dampers		
Type		2 x Positive Shut-off
Actuation		Pneumatic
Operation Mode		Open/Closed
Leakage Rating		

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	AHU 08	
DESCRIPTION	Hot Cells AHU	
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: W1986-53008**

Shaded areas to be completed by Vendor

Equipment Details		
AHU Make		
AHU Model Number		
Supply Air Fan Make		
Supply Air Fan Model Number		
Serving		
1.Overall AHU		
Air Inlet Temperature (T1)	[°C]	5 - 35
Air Outlet Temperature (T2)	[°C]	15
Outlet Humidity	%	< 60
Air Flowrate	[m^3/h]	1200
AHU Casing MOC		Double skin panels with 0.5mm chromadek and 0.4mm stainless-steel internal lining.
AHU Instrumentation		Refer to P&ID W1986-45008-05
Lights		1 x 15W LED in each compartment
Drip Tray		Stainless Steel
Access Hatches		4 x with camlock handles and gaskets
Anti-Vibration Mountings		Neoprene Pads
2.Cooling Coil		
Cooling Medium		Chilled Water
Coil Inet Temperature (T1)	[°C]	8
Coil Outlet Temperature (T2)	[°C]	14
Cooling Capacity	[kW]	7
Cooling Medium Flowrate	[m^3/h]	1
Pipe Size(diameter)	[mm]	15
Line End Connections		Flanged SABS 1123 1000/3
Line Inlet Pressure	[kPa g]	
Line Outlet Pressure	[kPa g]	
Differential Pressure (P1-P2)	[kPa g]	
Cooling Coil MOC		Electrical Heating Element
3.Heating Element		
Heating Capacity	[kW]	5
Off-coil Temperature	[°C]	15
Mains Supply	[V]	400V 3ph 50Hz
Heating Element MOC		Copper coil/Copper fin/Stainless steel casing
4.Filters		
Secondary Filters		G4 as per EN779
Primary Filters		F9 as per EN779
Primary Filter Size (actual size)	mm x mm	
Total Intake Area	m^2	
Actual Velocity	m/s	
Design Supply Air Flow	m^3/s	
5. Dampers		
Type		2 x Positive Shut-off
Actuation		Pneumatic
Operation Mode		Open/Closed
Leakage Rating		

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
AHU SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

0	27 Nov. 24	Issue for Tender	BM				
REV.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**APPR.**	**APPR.**	**APPR.**
REVISIONS			**APPROVAL**			**CLIENT APPROVALS**	

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E4 A&B		
DESCRIPTION	**Red Zone Extraction**		
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: 08**	

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			Open
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	36662
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	36662
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[Pa g]	4962
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	78.09
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Issue for Tender	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E5 A&B		
DESCRIPTION	**Blue Zone Extract**		
PROJECT TITLE	iThemba LABS HVAC Upgrade		**DATA SHEET No.: 09**

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			Open
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	48055
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	48055
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[Pa g]	5248
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	108
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Tender Pricing First Issue	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E6 A&B		
DESCRIPTION	**Vaults Extraction**		
PROJECT TITLE	iThemba LABS HVAC Upgrade		**DATA SHEET No.: 10**

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			Open
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	2590
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	2590
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[kPa g]	1529
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	1.7
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Issue for Tender	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E7 A&B		
DESCRIPTION	**Hot Cells Extraction**		
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: 11**	

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			Open
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	1100
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	1100
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[kPa g]	2798
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	1.59
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Issue for Tender	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E8 A&B		
DESCRIPTION	**Fume hoods Extraction**		
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: 12**	

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			Open
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	8800
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	8800
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[kPa g]	2179
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	8.65
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Tender Pricing First Issue	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E9 A&B		
DESCRIPTION	**Cleanrooms 1 – 5 Extraction**		
PROJECT TITLE	iThemba LABS HVAC Upgrade	**DATA SHEET No.: 13**	

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	22144
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	22144
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[Pa g]	1195
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	11.43
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Issue for Tender	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

THEMBA LABS HVAC UPGRADE
CONTRACT: W1986
FAN / BLOWER SELECTION DATA SHEET

PROJECT ASSIGNMENTS
Process & Project Engineers

EQUIPMENT No.	E10 A&B		
DESCRIPTION	**Cyclotron Extraction**		
PROJECT TITLE	iThemba LABS HVAC Upgrade		**DATA SHEET No.: 14**

Shaded areas to be completed by Vendor

Equipment Details			
Fan / Blower Type Required			Fan
Fan / Blower Make and Model			
Product Specification			
Fluid			Air
Density at Start-up Conditions		[kg/m^3	1.293
Density at Operating Conditions		[kg/m^3]	1.293
Operating Conditions			
Closed or Open Loop System			Open
Design Temperature		[°C]	50
Normal Operating Temperature		[°C]	25
Start–up Temperature		[°C]	
Inlet Capacity (at 0°C and 101.3kPa)		[m^3/h]	1884
Inlet Pressure (at operating temperature)		[kPa g]	
Discharge Capacity (at operating conditions)		[m^3/h]	1884
Discharge Pressure at 20°C		[kPa g]	
Discharge Pressure (at operating Temperature)		[kPa g]	951
Efficiency		[%]	
Rotational speed of fan/blower at Duty Point			
Seal Type			
Physical Data			
Inlet Nozzle size and rating			
Outlet nozzle size and rating			
Mass			
Impeller Type			
Impeller Diameter		[mm]	
Max. Sound Pressure Level at 1m		[dBA]	
Construction			
Materials of Construction	Casing		Stainless Steel 304 or 316
	Shaft		Stainless Steel 316 or Coated Carbon Steel
	Impeller		Stainless Steel or FRP
	Baseplate		Stainless Steel or Coated Carbon Steel
Electric Drive Specification			
Motor Electrical Supply		[V/ph/Hz]	400V 3ph 50Hz
Fan Motor Rating		[kW]	0.85
Motor Enclosure Rating			
Rotational Speed		[rpm]	
Rated Power		[kW]	
Absorbed Power at Duty Point		[kW]	
Frequency Inverter on motor			
Coupling Type			

REV.	DATE	DESCRIPTION	BY	CHK.	APPR.	APPR.	APPR.
0	27 Nov. 24	Tender Pricing First Issue	BM				

REVISIONS | APPROVAL | CLIENT APPROVALS

BID NO: NRF/ILABS IOP1/47/2024-25

Equipment Number	Description	Duty = 1 Standby = 0	Drive (kW)	Attributes	Design temp (ºC)	Design pressure (Pag)	Revision last modified	Suggested make and model	P&ID Number	Est. cost (elec + mech)
01-SF-01	Supply Air Fan	1	32.9	Plug type; 12.01 m³/s, 1762 Pa static pressure, direct-driven; speed adjustable via VSD	20	1762	6		45005	
01-SF-02	Supply Air Fan	0	32.9	Plug type; 12.01 m³/s, 1762 Pa static pressure, direct-driven; speed adjustable via VSD	20	1762	6		45005	
02-SF-03	Supply Air Fan	1	28.75	Plug type; 7.62 m³/s, 2438 Pa static pressure, direct-driven; speed adjustable via VSD	20	2438	6		45005	
02-SF-04	Supply Air Fan	0	28.75	Plug type; 7.62 m³/s, 2438 Pa static pressure, direct-driven; speed adjustable via VSD	20	2438	6		45005	
03-SF-05	Supply Air Fan	1	6.84	Plug type; 2.29 m³/s, 1775 Pa static pressure, direct-driven; speed adjustable via VSD	20	1775	6		45005	
03-SF-06	Supply Air Fan	0	6.84	Plug type; 2.29 m³/s, 1775 Pa static pressure, direct-driven; speed adjustable via VSD	20	1775	6		45005	
04-SF-07	Supply Air Fan	1	3.83	Plug type; 3.08 m³/s, 799 Pa static pressure, direct-driven; speed adjustable via VSD	20	799	6		45006	
04-SF-08	Supply Air Fan	0	3.83	Plug type; 3.08 m³/s, 799 Pa static pressure, direct-driven; speed adjustable via VSD	20	799	6		45006	
05-SF-09	Supply Air Fan	1	31.23	Plug type; 6.18 m³/s, 3054 Pa static pressure, direct-driven; speed adjustable via VSD	20	3054	6		45006	
05-SF-10	Supply Air Fan	0	31.23	Plug type; 6.18 m³/s, 3054 Pa static pressure, direct-driven; speed adjustable via VSD	20	3054	6		45006	
06-SF-11	Supply Air Fan	1	0.27	Plug type; 0.47 m³/s, 382 Pa static pressure, direct-driven; speed adjustable via VSD	20	382	6		45007	
06-SF-12	Supply Air Fan	0	0.27	Plug type; 0.47 m³/s, 382 Pa static pressure, direct-driven; speed adjustable via VSD	20	382	6		45007	
07-SF-13	Supply Air Fan	1	1.01	Plug type; 0.65 m³/s, 944 Pa static pressure, direct-driven; speed adjustable via VSD	20	944	6		45007	
07-SF-14	Supply Air Fan	0	1.01	Plug type; 0.65 m³/s, 944 Pa static pressure, direct-driven; speed adjustable via VSD	20	944	6		45007	
01-E5A	Extraction Fan A	1	108	Backward-curved centrifugal type; 13.35 m³/s, direct-driven; speed adjustable via VSD.	20	5248	6	Donkin Fans BCC or similar	45005	
01-E5B	Extraction Fan B	0	108	Backward-curved centrifugal type; 13.35 m³/s, direct-driven; speed adjustable via VSD.	20	5248	6	Donkin Fans BCC or similar	45005	
02-E9A	Extraction Fan A	1	11.43	Backward-curved centrifugal type; 6.15 m³/s, direct-driven; speed adjustable via VSD.	20	1195	6	Donkin Fans BCC or similar	45005	
02-E9B	Extraction Fan B	0	11.43	Backward-curved centrifugal type; 6.15 m³/s, direct-driven; speed adjustable via VSD.	20	1195	6	Donkin Fans BCC or similar	45005	
04-E4A	Extraction Fan A	1	78.09	Backward-curved centrifugal type; 10.18 m³/s, direct-driven; speed adjustable via VSD.	20	4962	6	Donkin Fans BCC or similar	45006	
04-E4B	Extraction Fan B	0	78.09	Backward-curved centrifugal type; 10.18 m³/s, direct-driven; speed adjustable via VSD.	20	4962	6	Donkin Fans BCC or similar	45006	
06-E10A	Extraction Fan A	1	0.85	Backward-curved centrifugal type; 0.52 m³/s, direct-driven; speed adjustable via VSD.	20	951	6	Donkin Fans BCC or similar	45007	
06-E10B	Extraction Fan B	0	0.85	Backward-curved centrifugal type; 0.52 m³/s, direct-driven; speed adjustable via VSD.	20	951	6	Donkin Fans BCC or similar	45007	
07-E6A	Extraction Fan A	1	1.7	Backward-curved centrifugal type; 0.72 m³/s, direct-driven; speed adjustable via VSD.	20	1529	6	Donkin Fans BCC or similar	45007	
07-E6B	Extraction Fan B	0	1.7	Backward-curved centrifugal type; 0.72 m³/s, direct-driven; speed adjustable via VSD.	20	1529	6	Donkin Fans BCC or similar	45007	
08-E7A	Extraction Fan A	1	1.59	Backward-curved centrifugal type; 0.31 m³/s, direct-driven; speed adjustable via VSD.	20	2798	6	Donkin Fans BCC or similar	45008	
08-E7B	Extraction Fan B	0	1.59	Backward-curved centrifugal type; 0.31 m³/s, direct-driven; speed adjustable via VSD.	20	2798	6	Donkin Fans BCC or similar	45008	
E8A	Extraction Fan A	1	8.65	Backward-curved centrifugal type; 2.44 m³/s, direct-driven; speed adjustable via VSD.	20	2179	6	Donkin Fans BCC or similar	45012	
E8B	Extraction Fan B	0	8.65	Backward-curved centrifugal type; 2.44 m³/s, direct-driven; speed adjustable via VSD.	20	2179	6	Donkin Fans BCC or similar	45012	
01-CC-01	Cooling Coil	1	297	Copper coil/Copper fin/Stainless steel casing	8		6		45005	
02-CC-02	Cooling Coil	1	161	Copper coil/Copper fin/Stainless steel casing	8		6		45005	
03-CC-03	Cooling Coil	1	50	Copper coil/Copper fin/Stainless steel casing	8		6		45005	
04-CC-04	Cooling Coil	1	64	Copper coil/Copper fin/Stainless steel casing	8		6		45006	

Equipment Number	Description	Duty = 1 Standby = 0	Drive (kW)	Attributes	Design temp (ºC)	Design pressure (Pag)	Revision last modified	Suggested make and model	P&ID Number	Est. cost (elec + mech)
05-CC-05	Cooling Coil	1	142	Copper coil/Copper fin/Stainless steel casing	8		6		45006	
06-CC-06	Cooling Coil	1	31	Copper coil/Copper fin/Stainless steel casing	8		6		45007	
07-CC-07	Cooling Coil	1	13	Copper coil/Copper fin/Stainless steel casing	8		6		45007	
08-CC-08	Cooling Coil	1	7	Copper coil/Copper fin/Stainless steel casing	8		6		45008	
01-HE-01	Electric Heating Element	1	160	-	80	-	6		45005	
02-HE-02	Electric Heating Element	1	120	-	80	-	6		45005	
03-HE-03	Electric Heating Element	1	36	-	80	-	6		45005	
04-HE-04	Electric Heating Element	1	48	-	80	-	6		45006	
05-HE-05	Electric Heating Element	1	97	-	80	-	6		45006	
06-HE-06	Electric Heating Element	1	4	-	80	-	6		45007	
07-HE-07	Electric Heating Element	1	10	-	80	-	6		45007	
08-HE-08	Electric Heating Element	1	5	-	80	-	6		45008	

Notes: 1. In the duty/standby column a "1" Indicates loads where equipment is on duty, and a "0" on standby (not normally running).

Holds: 1. Vendors to confirm actual motor sizes once procurement complete

Revision	Issue date	Originator	Description
0	11/27/2024	BM	Issue for tender

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
		kPag	ºC					R
01-PSD-01	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-02	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-03	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-04	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-05	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-06	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-07	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-08	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-09	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-10	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-11	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-12	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-13	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
01-PSD-14	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-15	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-16	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
03-PSD-17	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
03-PSD-18	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-19	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-20	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-21	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-22	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-23	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
02-PSD-24	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45005	note 1	
04-PSD-25	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
04-PSD-26	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-27	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-28	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-29	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-30	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-31	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-32	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-33	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-34	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-35	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-36	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-37	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
04-PSD-38	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
05-PSD-39	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
05-PSD-40	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45007	note 1	
06-PSD-41	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-42	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-43	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-44	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-45	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-46	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-47	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
06-PSD-48	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-49	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-50	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
07-PSD-51	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-52	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-53	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-54	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-55	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-56	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-57	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-58	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-59	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
07-PSD-60	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45006	note 1	
08-PSD-61	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-62	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-63	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-64	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-65	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-66	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-67	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-68	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-69	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-70	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-71	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
08-PSD-72	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45008	note 1	
PSD-73	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45012	note 1	
PSD-74	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45012	note 1	
PSD-75	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45012	note 1	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
PSD-76	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45012	note 1	
PSD-77	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45012	note 1	
PSD-78	Positive Shut-off Damper	600	80	Isolation	Pneumatic	45012	note 1	
01-BD-01	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-02	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-03	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-04	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-05	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-06	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-07	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-08	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-09	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-10	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-11	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-12	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-13	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-14	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-15	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-16	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-17	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-18	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-19	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-20	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-21	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
01-BD-22	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-23	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-24	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-25	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-26	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-27	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-28	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-29	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-30	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-31	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-32	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-33	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-34	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-35	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-36	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-37	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-38	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-39	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-40	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-41	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-42	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-43	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-44	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
01-BD-45	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-46	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
02-BD-47	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-48	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-49	Balancing Damper (with Positioner)	500	80	Volume Control	Electric	45005	note 2	
02-BD-50	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-51	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-52	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-53	Balancing Damper (with Positioner)	500	80	Volume Control	Electric	45005	note 2	
02-BD-54	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-55	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-56	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
02-BD-57	Balancing Damper (with Positioner)	500	80	Volume Control	Electric	45005	note 2	
03-BD-58	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
03-BD-59	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
03-BD-60	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
03-BD-61	Balancing Damper (with Positioner)	500	80	Volume Control	Electric	45005	note 2	
03-BD-62	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
03-BD-63	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
03-BD-64	Balancing Damper	500	80	Volume Control	Manual	45005	note 2	
03-BD-65	Balancing Damper (with Positioner)	500	80	Volume Control	Electric	45005	note 2	
04-BD-66	Balancing Damper	500	80	Volume Control	Manual	45007	note 2	
04-BD-67	Balancing Damper	500	80	Volume Control	Manual	45007	note 2	
05-BD-68	Balancing Damper	500	80	Volume Control	Manual	45007	note 2	
05-BD-69	Balancing Damper	500	80	Volume Control	Manual	45007	note 2	
06-BD-70	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	
06-BD-71	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
06-BD-72	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	
07-BD-73	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	
07-BD-74	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	
07-BD-75	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	
07-BD-76	Balancing Damper	500	80	Volume Control	Manual	45006	note 2	
08-BD-77	Balancing Damper	500	80	Volume Control	Manual	45008	note 2	
BD-78	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-79	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-80	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-81	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-82	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-83	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-84	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-85	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-86	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-87	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-88	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-89	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-90	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-91	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-92	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-93	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-94	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-95	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	
BD-96	Balancing Damper	500	80	Volume Control	Manual	45012	note 2	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
01-OBD-01	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-02	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-03	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-04	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-05	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-06	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-07	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-08	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-09	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-10	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-11	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-12	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-13	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-14	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-15	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-16	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-17	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-18	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-19	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-20	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-21	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-22	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-23	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-24	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
01-OBD-25	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-26	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-27	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-28	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-29	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-30	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-31	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-32	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-33	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-34	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-35	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-36	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-37	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-38	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-39	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-40	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-41	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-42	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-43	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-44	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-45	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-46	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-47	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-48	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-49	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
01-OBD-50	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-51	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-52	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-53	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-54	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-55	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-56	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-57	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-58	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-59	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-60	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-61	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-62	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-63	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-64	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-65	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-66	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-67	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-68	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-69	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-70	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-71	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-72	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-73	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-74	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
01-OBD-75	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-76	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-77	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-78	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-79	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-80	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-81	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-82	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-83	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-84	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-85	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
01-OBD-86	Opposed Blade Damper	200	80	Volume Control	Manual	45005	note 3	
04-OBD-87	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-88	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-89	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-90	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-91	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-92	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-93	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-94	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-95	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
04-OBD-96	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-97	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-98	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-99	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
05-OBD-100	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-101	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-102	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-103	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-104	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-105	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-106	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-107	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-108	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-109	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-110	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-111	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-112	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-113	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-114	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-115	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-116	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-117	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-118	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-119	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-120	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-121	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-122	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-123	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-124	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
05-OBD-125	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-126	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-127	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-128	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-129	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-130	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-131	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-132	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-133	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-134	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-135	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-136	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
05-OBD-137	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-138	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-139	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-140	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-141	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-142	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-143	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-144	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-145	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-146	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-147	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-148	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
05-OBD-149	Opposed Blade Damper	200	80	Volume Control	Manual	45007	note 3	
06-OBD-150	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
06-OBD-151	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
06-OBD-152	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
06-OBD-153	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
06-OBD-154	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
06-OBD-155	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-156	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-157	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-158	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-159	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-160	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-161	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	

Equipment Number	Description	Pressure Rating	Temperature Rating	Type	Actuator Type	P&ID	Material	Cost (Supply & Install)
07-OBD-162	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-163	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-164	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-165	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-166	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	
07-OBD-167	Opposed Blade Damper	200	80	Volume Control	Manual	45006	note 3	

Notes:
1. Frame and Blades - Stainless steel (304L or 316L). Seals - Silicone or EPDM. Bearings - Stainless steel or oil-impregnated bronze
2. Frame - Aluminum or galvanized steel. Blades - Aluminum or Galvanized steel. Shaft - Plated Steel. Seals - Rubber or synthetic material
3. Frame - Aluminum or galvanized steel. Blades - Extruded aluminum or Galvanized steel. Seals - Santoprene or silicone

Holds:
1. Vendors may propose alternative materials

Revision	Issue date	Description
0	11/27/2024	Issue for Tender

Instrument No		QTY	Description	Attributes	Mounting info	Design pressure (kPag)	Design temperature (ºC)	New / Existing	Process action	Supply & Installation cost
01-PDI-01		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU1 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 01-PF-01	
01-PDI-02		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU1 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 01-SDF-01	
01-PDI-03		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 01-HEPA-01 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-01	
01-PDI-04		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 01-HEPA-02 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-02	
01-PDI-05		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 01-HEPA-03 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-03	
01-PDI-06		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 01-HEPA-04 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-04	
02-PDI-07		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU2 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 02-PF-02	
02-PDI-08		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU2 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 02-SDF-02	
02-PDI-09		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-05	
02-PDI-10		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-06	
02-PDI-11		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-07	
02-PDI-12		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-08	
02-PDI-13		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-09	
02-PDI-14		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-10	
02-PDI-15		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-11	
02-PDI-16		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-12	
02-PDI-17		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-13	
03-PDI-18		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU3 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 03-PF-03	
03-PDI-19		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU3 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 03-SDF-03	
03-PDI-20		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-14	
03-PDI-21		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-15	
03-PDI-22		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-16	
03-PDI-23		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-17	
03-PDI-24		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-18	
03-PDI-25		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on Control Panel	100	60	New	Provides a visual indication (analog) of differential pressure across the Terminal Filter HEPA-19	
02-PDI-26		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 02-HEPA-20 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-20	
04-PDI-27		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU4 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 04-PF-04	
04-PDI-28		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU4 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 04-SDF-04	
04-PDI-29		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 04-HEPA-21 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-21	
04-PDI-30		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 04-HEPA-22 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-22	
04-PDI-31		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 04-HEPA-23 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-23	
04-PDI-32		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 04-HEPA-24 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-24	
05-PDI-33		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU5 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 05-PF-05	
05-PDI-34		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU5 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 05-SDF-05	
06-PDI-35		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU6 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 06-PF-06	
06-PDI-36		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU6 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 06-SDF-06	
06-PDI-37		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 06-HEPA-25 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-25	
07-PDI-38		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU7 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 07-PF-07	
07-PDI-39		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU7 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 07-SDF-07	
07-PDI-40		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 07-HEPA-26 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-26	
07-PDI-41		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 07-HEPA-27 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-27	
07-PDI-42		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 07-HEPA-28 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-28	
08-PDI-43		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–350Pa range, accuracy ±2% of full scale	Mounted on AHU8 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the primary filter 08-PF-08	
08-PDI-44		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on AHU8 Outter Side Panel (Visually accessible)	100	60	New	Provides a visual indication (analog) of differential pressure across the Secondary filter 08-SDF-08	
08-PDI-45		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-29 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-29	

Instrument No		QTY	Description	Attributes	Mounting info	Design pressure (kPag)	Design temperature (ºC)	New / Existing	Process action	Supply & Installation cost
08-PDI-46		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-01 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-01	
08-PDI-47		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-30 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-30	
08-PDI-48		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-02 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-02	
08-PDI-49		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-31 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-31	
08-PDI-50		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-03 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-03	
08-PDI-51		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-32 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-32	
08-PDI-52		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-04 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-04	
08-PDI-53		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-33 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-33	
08-PDI-54		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-05 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-05	
08-PDI-55		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-34 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-34	
08-PDI-56		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-06 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-06	
08-PDI-57		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-35 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-35	
08-PDI-58		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-07 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-07	
08-PDI-59		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-36 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-36	
08-PDI-60		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-08 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-08	
08-PDI-61		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-37 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-37	
08-PDI-62		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-09 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-09	
08-PDI-63		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-38 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-38	
08-PDI-64		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-10 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-10	
08-PDI-65		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-39 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-39	
08-PDI-66		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-11 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-11	
08-PDI-67		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-40 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-40	
08-PDI-68		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-12 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-12	
08-PDI-69		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-41 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-41	
08-PDI-70		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-13 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-13	
08-PDI-71		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-42 Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Filter HEPA-42	
08-PDI-72		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-ACF-14 - Filter Box	100	60	New	Provides a visual indication (analog) of differential pressure across Carbon Filter ACF-14	
08-PDI-73		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-43 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-43	
08-PDI-74		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-44 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-44	
08-PDI-75		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-45 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-45	
08-PDI-76		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on 08-HEPA-46 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-46	
PDI-76		1	Pressure Differential Indicator	Diaphragm type (Magnehelic); 0–600Pa range, accuracy ±2% of full scale	Mounted on HEPA-47 Filter Bank	100	60	New	Provides a visual indication (analog) of differential pressure across Filter Bank HEPA-47	
01-TI-01		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 80NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 1	
01-TI-02		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 80NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 1	
01-TI-03		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU1 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 1	
02-TI-04		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 65NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 2	
02-TI-05		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 65NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 2	
02-TI-06		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU2 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 2	
03-TI-07		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 40NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 3	
03-TI-08		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 40NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 3	
03-TI-09		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU3 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 3	
04-TI-10		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 40NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 4	
04-TI-11		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 40NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 4	
04-TI-12		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU4 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 4	

Instrument No		QTY	Description	Attributes	Mounting info	Design pressure (kPag)	Design temperature (ºC)	New / Existing	Process action	Supply & Installation cost
05-TI-13		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 65NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 5	
05-TI-14		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 65NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 5	
05-TI-15		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU5 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 5	
06-TI-16		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 32NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 6	
06-TI-17		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 32NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 6	
06-TI-18		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU6 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 6	
07-TI-19		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 20NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 7	
07-TI-20		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 20NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 7	
07-TI-21		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU7 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 7	
08-TI-22		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 15NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the inlet of cooling Coil of AHU 8	
08-TI-23		1	Temperature Indicator	Immersion type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in 15NB Chilled Water Line	500	60	New	Provides a visual indication (digital) of the temperature of the chilled water at the outlet of cooling Coil of AHU 8	
08-TI-24		1	AHU Outlet Temperature Indicator	Duct type; 0–50°C range, accuracy ±0.5°C; digital display	Mounted in AHU8 Outlet Duct	-	60	New	Provides a visual indication (digital) of the temperature of the air at the outlet of AHU 8	
01-HI-01		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU1 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 1	
01-HI-02		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Blue Zone	-	50	New	Provides a visual indication (digital) of the humidity of the air in the Blue Zone	
02-HI-03		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU2 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 2	
02-HI-04		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Cleanroom 1	-	50	New	Provides a visual indication (digital) of the humidity of the air in Cleanroom 1	
02-HI-05		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Cleanroom 2	-	50	New	Provides a visual indication (digital) of the humidity of the air in Cleanroom 2	
02-HI-06		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Cleanroom 3	-	50	New	Provides a visual indication (digital) of the humidity of the air in Cleanroom 3	
03-HI-07		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU3 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 3	
03-HI-08		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Cleanroom 4	-	50	New	Provides a visual indication (digital) of the humidity of the air in Cleanroom 4	
03-HI-09		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Cleanroom 5	-	50	New	Provides a visual indication (digital) of the humidity of the air in Cleanroom 5	
04-HI-10		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU4 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 4	
04-HI-11		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Red Zone Ground Floor	-	50	New	Provides a visual indication (digital) of the humidity of the air in the Red Zone Ground Floor	
05-HI-12		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU5 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 5	
05-HI-13		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Basement	-	50	New	Provides a visual indication (digital) of the humidity of the air in the Basement	
06-HI-14		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU6 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 6	
06-HI-15		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Cyclotron room	-	50	New	Provides a visual indication (digital) of the humidity of the air in the Cyclotron room	
07-HI-16		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU7 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 7	
07-HI-17		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in Elephant Vault	-	50	New	Provides a visual indication (digital) of the humidity of the air in the Elephant Vault	
07-HI-18		1	Humidity Indicator	Digital type; 0–100% RH range, accuracy ±2%	Wall-Mounted in VBTS Vault	-	50	New	Provides a visual indication (digital) of the humidity of the air in the VBTS Vault	
08-HI-19		1	Humidity Indicator	Duct type; 0–100% RH range, accuracy ±2%; digital display	Mounted on AHU8 Side Panel	-	50	New	Provides a visual indication (digital) of the humidity of the air at the outlet of AHU 8	
01-FT-01		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct Main Header	100	85	New	Outputs an analog signal (4-20mA) to control fans SF-01/03 via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
01-FT-02		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Extraction Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E5A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
02-FT-03		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Transmitts analog signal (4-20mA) to PLC. PLC controls Fans SF-03/04 by sum of FT-03/04/05, to maintain constant volume flow. Triggers high/low alarm from PLC	
02-FT-04		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Transmitts analog signal (4-20mA) to PLC. PLC controls Fans SF-03/04 by sum of FT-03/04/05, to maintain constant volume flow. Triggers high/low alarm from PLC	
02-FT-05		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Transmitts analog signal (4-20mA) to PLC. PLC controls Fans SF-03/04 by sum of FT-03/04/05, to maintain constant volume flow. Triggers high/low alarm from PLC	
02-FT-06		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Extraction Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E9A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
03-FT-07		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Transmitts analog signal (4-20mA) to PLC. PLC controls Fans SF-05/06 by sum of FT-07/08, to maintain constant volume flow. Triggers high/low alarm from PLC	
03-FT-08		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Transmitts analog signal (4-20mA) to PLC. PLC controls Fans SF-05/06 by sum of FT-07/08, to maintain constant volume flow. Triggers high/low alarm from PLC	
04-FT-09		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans SF-07/08 via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
04-FT-10		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Extraction Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E4A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
05-FT-11		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans SF-09/10 via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
06-FT-12		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans SF-11/12 via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	

Instrument No		QTY	Description	Attributes	Mounting info	Design pressure (kPag)	Design temperature (ºC)	New / Existing	Process action	Supply & Installation cost
06-FT-13		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Extraction Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E10A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
07-FT-14		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans SF-13/14 via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
07-FT-15		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Extraction Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E6A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
08-FT-16		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Supply Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E7A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
FT-17		1	Flow Transmitter	Duct type; 0–15 m/s range, accuracy ±3%; digital display	Mounted on Extraction Duct	100	85	New	Outputs an analog signal (4-20mA) to control fans E8A/B via a PLC, to maintain constant volume flow. Triggers high/low alarm from PLC	
01-PDT-01		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Blue Zone	100	85	New	Records differential pressure between the blue zone and white zone; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
01-PDT-02		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Blue Zone	100	85	New	Records differential pressure between the blue zone and red zone; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-03		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 1	100	85	New	Records differential pressure between changerooms 1 and 2 (of Cleanroom 1); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-04		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 1	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 1; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-05		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 1	100	85	New	Records differential pressure between the blue zone and changeroom 1 (of Cleanroom 1); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-06		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 2	100	85	New	Records differential pressure between the blue zone and changeroom 1 (of Cleanroom 2); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-07		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 2	100	85	New	Records differential pressure between changerooms 1 and 2 (of Cleanroom 2); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-08		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 2	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 2; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-09		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 3	100	85	New	Records differential pressure between the red zone and changeroom 1 (of Cleanroom 3); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-10		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 3	100	85	New	Records differential pressure between changerooms 1 and 2 (of Cleanroom 3); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-11		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 3	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 3; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-12		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 4	100	85	New	Records differential pressure between the blue zone and changeroom 1 (of Cleanroom 4); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-13		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 4	100	85	New	Records differential pressure between changerooms 1 and 2 (of Cleanroom 4); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-14		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 4	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 4; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-15		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 5	100	85	New	Records differential pressure between the blue zone and changeroom 1 (of Cleanroom 5); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-16		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted Outside Cleanroom 5	100	85	New	Records differential pressure between changerooms 1 and 2 (of Cleanroom 5); & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-17		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 5	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
04-PDT-18		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Red Zone Ground Floor	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
05-PDT-19		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Basement	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
06-PDT-20		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cyclotron Room	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
07-PDT-21		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Elephant Vault	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
07-PDT-22		1	Pressure Differential Transmitter	Capacitive type; 0–150 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in VBTS Vault	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-23		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 1	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-24		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 2	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-25		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 3	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-26		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 4	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-27		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 5	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-28		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 6	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-29		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 7	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-30		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 8	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-31		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 9	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-32		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 10	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-33		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 11	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-34		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 12	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-35		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 13	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
08-PDT-36		1	Pressure Differential Transmitter	Capacitive type; 0–300 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Mounted on Hot Cell 14	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-37		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 1	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
02-PDT-38		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 2	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	

Instrument No		QTY	Description	Attributes	Mounting info	Design pressure (kPag)	Design temperature (ºC)	New / Existing	Process action	Supply & Installation cost
02-PDT-39		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 3	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-40		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 4	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
03-PDT-41		1	Pressure Differential Transmitter	Capacitive type; 0–550 Pa range, accuracy ±0.5% of full scale; 4–20 mA output.	Wall-Mounted in Cleanroom 5	100	85	New	Records differential pressure between changeroom 2 and Cleanroom 5; & outputs an analog signal (4-20mA) to PLC for monitoring. Trigger alarm (high/low) when range is exceeded.	
01-TT-01		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Blue Zone	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
01-TT-02		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Blue Zone	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
01-TT-03		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Blue Zone	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
02-TT-04		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Cleanroom 1	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
02-TT-05		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Cleanroom 2	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
02-TT-06		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Cleanroom 3	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
03-TT-07		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Cleanroom 4	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
03-TT-08		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Cleanroom 5	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
04-TT-09		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Red Zone Ground Floor	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
05-TT-10A/C		3	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Basement	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
06-TT-11		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Cyclotron Room	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
07-TT-12		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in Elephant Vault	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
07-TT-13		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Wall-Mounted in VBTS Vault	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-14		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 1	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-15		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 2	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-16		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 3	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-17		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 4	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-18		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 5	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-19		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 6	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-20		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 7	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-21		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 8	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-22		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 9	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-23		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 10	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-24		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 11	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-25		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 12	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-26		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 13	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
08-TT-27		1	Temperature Transmitter	RTD type; 0–50°C range, accuracy ±0.5°C; 4–20 mA output, digital display	Mounted on Hot Cell 14	-	60	New	Records temperature and outputs an analog signal (4-20mA) to PLC for monitoring and control. PLC controls heating and cooling coils.	
SV-01		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-02		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-03		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-04		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-05		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-06		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-07		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-08		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-09		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-10		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-11		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-12		1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	

Instrument No	QTY	Description	Attributes	Mounting info	Design pressure (kPag)	Design temperature (ºC)	New / Existing	Process action	Supply & Installation cost
SV-13	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-14	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-15	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-16	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-17	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-18	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-19	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-20	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-21	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-22	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-23	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-24	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-25	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-26	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-27	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-28	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-29	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-30	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-31	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-32	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-33	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-34	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-35	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-36	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-37	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-38	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-39	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	
SV-40	1	Solenoid Valve	24V DC , 2-way valve	Mounted on compressed air line	1000	50	New	-	

Notes

1. Balancing dampers (BD-49, 53, 57, 61, 65) are supplied with positioners (to be controlled with 24V DC).

Rev	Date	Description	Author
0	27-Nov-24	Issue for Tender	BM

Filter Number	Description	Qty	Type	Make	Filter Size	Pressure Clean (Pa)	Pressure Dirty (Pa)	New/Existing	Cost (Supply & Install)
01-OF-01	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
02-OF-02	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
03-OF-03	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
04-OF-04	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
05-OF-05	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
06-OF-06	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
07-OF-07	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
08-OF-08	Outer Filter (Plenum)	1	G4	Panel	287 mm x 592 mm	60	250	New	
01-PF-01	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
02-PF-02	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
03-PF-03	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
04-PF-04	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
05-PF-05	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
06-PF-06	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
07-PF-07	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
08-PF-08	Primary Filter	1	G4	Panel	250 mm x 400 mm	60	250	New	
01-SDF-01	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
02-SDF-02	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
03-SDF-03	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
04-SDF-04	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	

Filter Number	Description	Qty	Type	Make	Filter Size	Pressure Clean (Pa)	Pressure Dirty (Pa)	New/Existing	Cost (Supply & Install)
05-SDF-05	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
06-SDF-06	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
07-SDF-07	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
08-SDF-08	Secondary Filter	1	F9	Panel	250 mm x 400 mm	100	450	New	
01-HEPA-01	HEPA Filter	1	H14	Bag	-	150	500	Existing	
01-HEPA-02	HEPA Filter	1	H14	Bag	-	150	500	Existing	
01-HEPA-03	HEPA Filter	1	H14	Bag	-	150	500	Existing	
01-HEPA-04	HEPA Filter	1	H14	Bag	-	150	500	Existing	
02-HEPA-05A/B	HEPA Filter	2	H14	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-06	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-07	HEPA Filter	1	H13	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-08	HEPA Filter	1	H13	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-09	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-10A/H	HEPA Filter	8	H14	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-11	HEPA Filter	1	H13	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-12	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-13A/D	HEPA Filter	4	H14	Panel	610 mm x 610 mm	150	500	New	
03-HEPA-14	HEPA Filter	1	H13	Panel	610 mm x 610 mm	150	500	New	
03-HEPA-15	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
03-HEPA-16A/B	HEPA Filter	2	H14	Panel	610 mm x 610 mm	150	500	New	
03-HEPA-17	HEPA Filter	1	H13	Panel	610 mm x 610 mm	150	500	New	

Filter Number	Description	Qty	Type	Make	Filter Size	Pressure Clean (Pa)	Pressure Dirty (Pa)	New/Existing	Cost (Supply & Install)
03-HEPA-18	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
03-HEPA-19A/C	HEPA Filter	3	H14	Panel	610 mm x 610 mm	150	500	New	
02-HEPA-20	HEPA Filter	1	H14	Bag	-	150	500	Existing	
04-HEPA-21	HEPA Filter	1	H14	Bag	-	150	500	Existing	
04-HEPA-22	HEPA Filter	1	H14	Bag	-	150	500	Existing	
04-HEPA-23	HEPA Filter	1	H14	Bag	-	150	500	Existing	
04-HEPA-24	HEPA Filter	1	H14	Bag	-	150	500	Existing	
06-HEPA-25	HEPA Filter	1	H14	Bag	-	150	500	Existing	
07-HEPA-26	HEPA Filter	1	H14	Bag	-	150	500	Existing	
07-HEPA-27	HEPA Filter	1	H14	Bag	-	150	500	Existing	
07-HEPA-28	HEPA Filter	1	H14	Bag	-	150	500	Existing	
08-HEPA-29	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-30	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-31	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-32	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-33	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-34	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-35	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-36	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-37	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-38	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-39	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	

Filter Number	Description	Qty	Type	Make	Filter Size	Pressure Clean (Pa)	Pressure Dirty (Pa)	New/Existing	Cost (Supply & Install)
08-HEPA-40	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-41	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-42	HEPA Filter	1	H14	Panel	610 mm x 610 mm	150	500	New	
08-HEPA-43	HEPA Filter	1	H14	Bag	-	150	500	Existing	
08-HEPA-44	HEPA Filter	1	H14	Bag	-	150	500	Existing	
08-HEPA-45	HEPA Filter	1	H14	Bag	-	150	500	Existing	
08-HEPA-46	HEPA Filter	1	H14	Bag	-	150	500	Existing	
HEPA-47	HEPA Filter	1	H14	Bag	-	150	500	Existing	
08-ACF-01	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-02	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-03	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-04	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-05	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-06	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-07	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-08	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-09	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-10	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-11	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-12	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	
08-ACF-13	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	

Filter Number	Description	Qty	Type	Make	Filter Size	Pressure Clean (Pa)	Pressure Dirty (Pa)	New/Existing	Cost (Supply & Install)
08-ACF-14	Activated Charcoal Filter	1	-	Panel	610 mm x 610 mm	150	400	New	

Rev	Date	Description	Author
0	27-Nov-24	Issue for Tender	BM

Valve No	Description	Product	Valve Type	Line Size (NB)	Valve Size (NB)	Materials of Construction	Pressure Rating	Design temperature	Connection	Unit Cost (Supply & Install)
				(mm)	(mm)			(°C)		
Temperature Regulation										
01-BV-01	Cooling coil isolation valve	Chilled Water	Butterfly	80	80	note 1	PN6	15	flange	
01-BV-02	Cooling coil isolation valve	Chilled Water	Butterfly	80	80	note 1	PN6	15	flange	
02-BV-03	Cooling coil isolation valve	Chilled Water	Butterfly	65	65	note 1	PN6	15	flange	
02-BV-04	Cooling coil isolation valve	Chilled Water	Butterfly	65	65	note 1	PN6	15	flange	
03-BV-05	Cooling coil isolation valve	Chilled Water	Butterfly	40	40	note 1	PN6	15	thread	
03-BV-06	Cooling coil isolation valve	Chilled Water	Butterfly	40	40	note 1	PN6	15	thread	
04-BV-07	Cooling coil isolation valve	Chilled Water	Butterfly	40	40	note 1	PN6	15	flange	
04-BV-08	Cooling coil isolation valve	Chilled Water	Butterfly	40	40	note 1	PN6	15	flange	
05-BV-09	Cooling coil isolation valve	Chilled Water	Butterfly	65	65	note 1	PN6	15	flange	
05-BV-10	Cooling coil isolation valve	Chilled Water	Butterfly	65	65	note 1	PN6	15	flange	
06-BV-11	Cooling coil isolation valve	Chilled Water	Butterfly	32	32	note 1	PN6	15	flange	
06-BV-12	Cooling coil isolation valve	Chilled Water	Butterfly	32	32	note 1	PN6	15	flange	
07-BV-13	Cooling coil isolation valve	Chilled Water	Butterfly	20	20	note 1	PN6	15	thread	
07-BV-14	Cooling coil isolation valve	Chilled Water	Butterfly	20	20	note 1	PN6	15	thread	
08-BV-15	Cooling coil isolation valve	Chilled Water	Butterfly	15	15	note 1	PN6	15	thread	
08-BV-16	Cooling coil isolation valve	Chilled Water	Butterfly	15	15	note 1	PN6	15	thread	
08-BV-17	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-18	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-19	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-20	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-21	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-22	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-23	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-24	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-25	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	

Valve No	Description	Product	Valve Type	Line Size (NB)	Valve Size (NB)	Materials of Construction	Pressure Rating	Design temperature	Connection	Unit Cost (Supply & Install)
08-BV-26	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-27	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-28	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-29	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-30	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-31	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-32	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-33	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-34	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-35	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-36	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-37	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-38	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-39	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-40	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-41	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-42	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-43	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-44	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-45	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-46	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-47	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-48	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-49	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-50	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-51	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	

Valve No	Description	Product	Valve Type	Line Size (NB)	Valve Size (NB)	Materials of Construction	Pressure Rating	Design temperature	Connection	Unit Cost (Supply & Install)
08-BV-52	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-53	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-54	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-55	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-56	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-57	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-58	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-59	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-60	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-61	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-62	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-63	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-64	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-65	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-66	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-67	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-68	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-69	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-70	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-71	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-72	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-73	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-74	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-75	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	

Valve No	Description	Product	Valve Type	Line Size (NB)	Valve Size (NB)	Materials of Construction	Pressure Rating	Design temperature	Connection	Unit Cost (Supply & Install)
08-BV-76	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-77	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-78	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-79	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-80	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-81	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-82	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-83	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-84	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-85	Carbon Filter Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	
08-BV-86	Flexible line Isolation Valve	air	Butterfly	50	50	note 2	PN6	50	flange	

Notes

1 Valve Body - Ductile Iron with Epoxy Coating. Disc - Stainless Steel (SS304). Seat & Seal - EPDM. Valve Handle - Ductile Iron with Epoxy Coating.

2 Valve Body - Cast Iron with Epoxy Coating. Disc - Stainless Steel (SS304). Seat & Seal - NBR. Valve Handle - Cast Iron with Epoxy Coating.

Rev	Description	Originator	Date			Approved	Date Issued	Signature
0	Issue for Tender	BM	27-Nov-24					

P&ID No	Valve No	Name	Description	Medium	Line size	Mass flowrate	Upstream pressure	Design temperature	Attributes	Cost (Supply & Install)
					(mm NB)	kg/h	kPag	(ºC)		
45005	01-MGV-01	Motorized Globe Valve	Flow Control valve on Chilled Water Line 01-CC-01 Outlet	Chilled Water	80	42592		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45005	02-MGV-02	Motorized Globe Valve	Flow Control valve on Chilled Water Line 02-CC-02 Outlet	Chilled Water	65	23000		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45005	03-MGV-03	Motorized Globe Valve	Flow Control valve on Chilled Water Line 03-CC-03 Outlet	Chilled Water	40	7188		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45007	04-MGV-04	Motorized Globe Valve	Flow Control valve on Chilled Water Line 04-CC-04 Outlet	Chilled Water	40	9168		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45007	05-MGV-05	Motorized Globe Valve	Flow Control valve on Chilled Water Line 05-CC-05 Outlet	Chilled Water	65	20312		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45006	06-MGV-06	Motorized Globe Valve	Flow Control valve on Chilled Water Line 06-CC-06 Outlet	Chilled Water	32	4435		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45006	07-MGV-07	Motorized Globe Valve	Flow Control valve on Chilled Water Line 07-CC-07 Outlet	Chilled Water	20	1932		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45008	08-MGV-08	Motorized Globe Valve	Flow Control valve on Chilled Water Line 08-CC-08 Outlet	Chilled Water	15	1002		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	
45009	08-MGV-09	Motorized Globe Valve	Back pressure control valve	Chilled Water	150	109629		16	Two-way type; PN16, control range 0–100%; actuator with 0–10V input, bronze body, and stainless-steel trim.	

Notes 1. Externally-modulated control valves to be supplied complete with position feedback (excludes self-regulating valves)

Holds 1. Control valve sizes to be confirmed by vendors based on mass flow and pressure drop

Rev	Issue date	Originator	Description
0	27-Nov-24	BM	Issue for Tender

Item No		QTY	Type	Size	Function	Installation	Supply & Installation cost
DF-01		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-02		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-03		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-04		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-05		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-06		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-07		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-08		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-09		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-10		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-11		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-12		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-13		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-14		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-15		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-16		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-17		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-18		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-19		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-20		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-21		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-22		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-23		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-24		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-25		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	

Item No		QTY	Type	Size	Function	Installation	Supply & Installation cost
DF-26		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-27		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-28		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-29		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-30		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-31		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-32		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-33		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-34		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-35		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-36		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-37		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-38		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-39		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-40		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-41		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-42		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-43		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-44		1	Laminar Flow Diffuser	610 mm x 610 mm	Supply	Ceiling	
DF-45		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-46		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-47		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-48		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-49		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-50		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	

Item No		QTY	Type	Size	Function	Installation	Supply & Installation cost
DF-51		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-52		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-53		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-54		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-55		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-56		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-57		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-58		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-59		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-60		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-61		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-62		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-63		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-64		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
DF-65		1	Swirl Diffuser	290 mm x 290 mm	Supply	Ceiling	
RG-01		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-02		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-03		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-04		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-05		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-06		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-07		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-08		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-09		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	

Item No		QTY	Type	Size	Function	Installation	Supply & Installation cost
RG-10		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-11		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-12		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-13		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-14		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-15		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-16		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-17		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-18		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-19		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-20		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-21		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-22		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
RG-23		1	Low-Level Return Air Grille	300 mm x 300 mm	Return	Wall (Iso Panel)	
	Rev		Date	Description	Author		
	0		27-Nov-24	Issue for Tender	BM		

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		IO LIST	BCE BÜHRMANN CONSULTING ENGINEERS
		CT0340-IC-LST-0200-R0	

No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,1	01-FT-01	PLC-100	Flow Transmitter	AI	-	01-FT-01	W1986-45005-R2	IOAM/APL	1	2	70
1,2	01-FT-02	PLC-100	Flow Transmitter	AI	-	01-FT-02	W1986-45005-R2	IOAM/APL	1	2	70
1,3	01-HE-01	PLC-100	Electric Heating Element	DO	-	01-HE-01	W1986-45005-R2	OAM/APL	1	2	35
1,4	01-HIC-01	PLC-100	Humidity Indicator Controller	AI	-	01-HIC-01	W1986-45005-R2	IOAM/APL	1	2	70
1,5	01-MGV-01	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	01-MGV-01	W1986-45005-R2	IOAM/APL	1	4	35
1,6	01-MGV-02	PLC-100	Motorized Globe Valve - Steam Line	AO	-	01-MGV-02	W1986-45005-R2	IOAM/APL	1	4	35
1,7	01-TIC-01	PLC-100	Temperature Indicator Controller	AI	-	01-TIC-01	W1986-45005-R2	IOAM/APL	1	2	70
1,8	01-TIC-02	PLC-100	Temperature Indicator Controller	AI	-	01-TIC-02	W1986-45005-R2	IOAM/APL	1	2	70
1,9	01-TIC-03	PLC-100	Temperature Indicator Controller	AI	-	01-TIC-03	W1986-45005-R2	IOAM/APL	1	2	70
1,10	02-FT-03	PLC-100	Flow Transmitter	AI	-	02-FT-03	W1986-45005-R2	IOAM/APL	1	2	50
1,11	02-FT-04	PLC-100	Flow Transmitter	AI	-	02-FT-04	W1986-45005-R2	IOAM/APL	1	2	50
1,12	02-FT-05	PLC-100	Flow Transmitter	AI	-	02-FT-05	W1986-45005-R2	IOAM/APL	1	2	50
1,13	02-FT-06	PLC-100	Flow Transmitter	AI	-	02-FT-06	W1986-45005-R2	IOAM/APL	1	2	50
1,14	02-FT-07	PLC-100	Flow Transmitter	AI	-	02-FT-07	W1986-45005-R2	IOAM/APL	1	2	50
1,15	02-HE-02	PLC-100	Electric Heating Element	DO	-	02-HE-02	W1986-45005-R2	OAM/APL	1	2	35
1,16	02-HIC-02	PLC-100	Humidity Indicator Controller	AI	-	02-HIC-02	W1986-45005-R2	IOAM/APL	1	2	50
1,17	02-HIC-03	PLC-100	Humidity Indicator Controller	AI	-	02-HIC-03	W1986-45005-R2	IOAM/APL	1	2	50
1,18	02-HIC-04	PLC-100	Humidity Indicator Controller	AI	-	02-HIC-04	W1986-45005-R2	IOAM/APL	1	2	50
1,19	02-HIC-05	PLC-100	Humidity Indicator Controller	AI	-	02-HIC-05	W1986-45005-R2	IOAM/APL	1	2	50
1,20	02-MGV-03	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	02-MGV-03	W1986-45005-R2	IOAM/APL	1	4	35
1,21	02-MGV-04	PLC-100	Motorized Globe Valve - Steam Line	AO	-	02-MGV-04	W1986-45005-R2	IOAM/APL	1	4	35
1,22	02-TIC-04	PLC-100	Temperature Indicator Controller	AI	-	02-TIC-04	W1986-45005-R2	IOAM/APL	1	2	50
1,23	02-TIC-05	PLC-100	Temperature Indicator Controller	AI	-	02-TIC-05	W1986-45005-R2	IOAM/APL	1	2	50
1,24	02-TIC-06	PLC-100	Temperature Indicator Controller	AI	-	02-TIC-06	W1986-45005-R2	IOAM/APL	1	2	50
1,25	03-FT-08	PLC-100	Flow Transmitter	AI	-	03-FT-08	W1986-45005-R2	IOAM/APL	1	2	50
1,26	03-FT-09	PLC-100	Flow Transmitter	AI	-	03-FT-09	W1986-45005-R2	IOAM/APL	1	2	50

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	CT0340-IC-LST-0200-R0	

No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,27	03-HE-03	PLC-100	Electric Heating Element	DO	-	03-HE-03	W1986-45005-R2	OAM/APL	1	2	35
1,28	03-HIC-06	PLC-100	Humidity Indicator Controller	AI	-	03-HIC-06	W1986-45005-R2	IOAM/APL	1	2	50
1,29	03-HIC-07	PLC-100	Humidity Indicator Controller	AI	-	03-HIC-07	W1986-45005-R2	IOAM/APL	1	2	50
1,30	03-HIC-08	PLC-100	Humidity Indicator Controller	AI	-	03-HIC-08	W1986-45005-R2	IOAM/APL	1	2	50
1,31	03-MGV-05	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	03-MGV-05	W1986-45005-R2	IOAM/APL	1	4	35
1,32	03-MGV-06	PLC-100	Motorized Globe Valve - Steam Line	AO	-	03-MGV-06	W1986-45005-R2	IOAM/APL	1	4	35
1,33	03-TIC-07	PLC-100	Temperature Indicator Controller	AI	-	03-TIC-07	W1986-45005-R2	IOAM/APL	1	2	50
1,34	03-TIC-08	PLC-100	Temperature Indicator Controller	AI	-	03-TIC-08	W1986-45005-R2	IOAM/APL	1	2	50
1,35	04-FT-10	PLC-100	Flow Transmitter	AI	-	04-FT-10	W1986-45007-R2	IOAM/APL	1	2	50
1,36	04-FT-11	PLC-100	Flow Transmitter	AI	-	04-FT-11	W1986-45007-R2	IOAM/APL	1	2	50
1,37	04-HE-04	PLC-100	Electric Heating Element	DO	-	04-HE-04	W1986-45007-R2	OAM/APL	1	2	35
1,38	04-HIC-09	PLC-100	Humidity Indicator Controller	AI	-	04-HIC-09	W1986-45007-R2	IOAM/APL	1	2	50
1,39	04-MGV-07	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	04-MGV-07	W1986-45007-R2	IOAM/APL	1	4	35
1,40	04-MGV-08	PLC-100	Motorized Globe Valve - Steam Line	AO	-	04-MGV-08	W1986-45007-R2	IOAM/APL	1	4	35
1,41	04-TIC-09	PLC-100	Temperature Indicator Controller	AI	-	04-TIC-09	W1986-45007-R2	IOAM/APL	1	2	50
1,42	05-FT-12	PLC-100	Flow Transmitter	AI	-	05-FT-12	W1986-45007-R2	IOAM/APL	1	2	60
1,43	05-HE-05	PLC-100	Electric Heating Element	DO	-	05-HE-05	W1986-45007-R2	OAM/APL	1	2	35
1,44	05-HIC-10	PLC-100	Humidity Indicator Controller	AI	-	05-HIC-10	W1986-45007-R2	IOAM/APL	1	2	60
1,45	05-MGV-09	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	05-MGV-09	W1986-45007-R2	IOAM/APL	1	4	35
1,46	05-MGV-10	PLC-100	Motorized Globe Valve - Steam Line	AO	-	05-MGV-10	W1986-45007-R2	IOAM/APL	1	4	35
1,47	05-TIC-10	PLC-100	Temperature Indicator Controller	AI	-	05-TIC-10	W1986-45007-R2	IOAM/APL	1	2	60
1,48	06-FT-13	PLC-100	Flow Transmitter	AI	-	06-FT-13	W1986-45006-R2	IOAM/APL	1	2	70
1,49	06-FT-14	PLC-100	Flow Transmitter	AI	-	06-FT-14	W1986-45006-R2	IOAM/APL	1	2	70
1,50	06-HE-06	PLC-100	Electric Heating Element	DO	-	06-HE-06	W1986-45006-R2	OAM/APL	1	2	35
1,51	06-HIC-11	PLC-100	Humidity Indicator Controller	AI	-	06-HIC-11	W1986-45006-R2	IOAM/APL	1	2	70
1,52	06-MGV-11	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	06-MGV-11	W1986-45006-R2	IOAM/APL	1	4	35

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No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,53	06-MGV-12	PLC-100	Motorized Globe Valve - Steam Line	AO	-	06-MGV-12	W1986-45006-R2	IOAM/APL	1	4	35
1,54	06-TIC-11	PLC-100	Temperature Indicator Controller	AI	-	06-TIC-11	W1986-45006-R2	IOAM/APL	1	2	70
1,55	07-FT-15	PLC-100	Flow Transmitter	AI	-	07-FT-15	W1986-45006-R2	IOAM/APL	1	2	70
1,56	07-FT-16	PLC-100	Flow Transmitter	AI	-	07-FT-16	W1986-45006-R2	IOAM/APL	1	2	70
1,57	07-HE-07	PLC-100	Electric Heating Element	DO	-	07-HE-07	W1986-45006-R2	OAM/APL	1	2	35
1,58	07-HIC-12	PLC-100	Humidity Indicator Controller	AI	-	07-HIC-12	W1986-45006-R2	IOAM/APL	1	2	70
1,59	07-MGV-13	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	07-MGV-13	W1986-45006-R2	IOAM/APL	1	4	35
1,60	07-MGV-14	PLC-100	Motorized Globe Valve - Steam Line	AO	-	07-MGV-14	W1986-45006-R2	IOAM/APL	1	4	35
1,61	07-TIC-12	PLC-100	Temperature Indicator Controller	AI	-	07-TIC-12	W1986-45006-R2	IOAM/APL	1	2	70
1,62	07-TIC-13	PLC-100	Temperature Indicator Controller	AI	-	07-TIC-13	W1986-45006-R2	IOAM/APL	1	2	70
1,63	08-FT-17	PLC-100	Flow Transmitter	AI	-	08-FT-17	W1986-45008-R0	IOAM/APL	1	2	50
1,64	08-FT-18	PLC-100	Flow Transmitter	AI	-	08-FT-18	W1986-45008-R0	IOAM/APL	1	2	50
1,65	08-HE-08	PLC-100	Electric Heating Element	DO	-	08-HE-08	0	OAM/APL	1	2	35
1,66	08-HIC-13	PLC-100	Humidity Indicator Controller	AI	-	08-HIC-13	0	IOAM/APL	1	2	50
1,67	08-MGV-15	PLC-100	Motorized Globe Valve - Chilled Water Line	AO	-	08-MGV-15	0	IOAM/APL	1	4	35
1,68	08-MGV-16	PLC-100	Motorized Globe Valve - Steam Line	AO	-	08-MGV-16	0	IOAM/APL	1	4	35
1,69	08-TIC-14	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-14	W1986-45008-R0	IOAM/APL	1	2	50
1,70	08-TIC-15	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-15	W1986-45008-R0	IOAM/APL	1	2	50
1,71	08-TIC-16	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-16	W1986-45008-R0	IOAM/APL	1	2	50
1,72	08-TIC-17	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-17	W1986-45008-R0	IOAM/APL	1	2	50
1,73	08-TIC-18	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-18	W1986-45008-R0	IOAM/APL	1	2	50
1,74	08-TIC-19	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-19	W1986-45008-R0	IOAM/APL	1	2	50
1,75	08-TIC-20	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-20	W1986-45008-R0	IOAM/APL	1	2	50
1,76	08-TIC-21	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-21	W1986-45008-R0	IOAM/APL	1	2	50
1,77	08-TIC-22	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-22	W1986-45008-R0	IOAM/APL	1	2	50
1,78	08-TIC-23	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-23	W1986-45008-R0	IOAM/APL	1	2	50

No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,79	08-TIC-24	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-24	W1986-45008-R0	IOAM/APL	1	2	50
1,80	08-TIC-25	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-25	W1986-45008-R0	IOAM/APL	1	2	50
1,81	08-TIC-26	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-26	W1986-45005-R2	IOAM/APL	1	2	35
1,82	08-TIC-27	PLC-100	Temperature Indicator Controller	AI	-	08-TIC-27	W1986-45005-R2	IOAM/APL	1	2	35
1,83	01-PDT-01	PLC-100	Pressure Differential Transmitter	AI	-	01-PDT-01	W1986-45008-R0	IOAM/APL	1	2	50
1,84	01-PDT-02	PLC-100	Pressure Differential Transmitter	AI	-	01-PDT-02	W1986-45005-R2	IOAM/APL	1	2	35
1,85	02-PDT-03	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-03	W1986-45005-R2	IOAM/APL	1	2	35
1,86	02-PDT-04	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-04	W1986-45005-R2	IOAM/APL	1	2	35
1,87	02-PDT-05	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-05	W1986-45005-R2	IOAM/APL	1	2	35
1,88	02-PDT-06	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-06	W1986-45005-R2	IOAM/APL	1	2	35
1,89	02-PDT-07	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-07	W1986-45005-R2	IOAM/APL	1	2	35
1,90	02-PDT-08	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-08	W1986-45007-R2	IOAM/APL	1	2	35
1,91	02-PDT-09	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-09	W1986-45007-R2	IOAM/APL	1	2	35
1,92	02-PDT-10	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-10	W1986-45007-R2	IOAM/APL	1	2	35
1,93	02-PDT-11	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-11	W1986-45007-R2	IOAM/APL	1	2	35
1,94	03-PDT-12	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-12	W1986-45005-R2	IOAM/APL	1	2	35
1,95	03-PDT-13	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-13	W1986-45005-R2	IOAM/APL	1	2	35
1,96	03-PDT-14	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-14	W1986-45005-R2	IOAM/APL	1	2	35
1,97	03-PDT-15	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-15	W1986-45005-R2	IOAM/APL	1	2	35
1,98	03-PDT-16	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-16	W1986-45007-R2	IOAM/APL	1	2	35
1,99	03-PDT-17	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-17	W1986-45008-R0	IOAM/APL	1	2	50
1,100	04-PDT-18	PLC-100	Pressure Differential Transmitter	AI	-	04-PDT-18	W1986-45008-R0	IOAM/APL	1	2	50
1,101	05-PDT-19	PLC-100	Pressure Differential Transmitter	AI	-	05-PDT-19	W1986-45008-R0	IOAM/APL	1	2	50
1,102	06-PDT-20	PLC-100	Pressure Differential Transmitter	AI	-	06-PDT-20	W1986-45008-R0	IOAM/APL	1	2	50
1,103	07-PDT-21	PLC-100	Pressure Differential Transmitter	AI	-	07-PDT-21	W1986-45005-R2	IOAM/APL	1	2	35
1,104	07-PDT-22	PLC-100	Pressure Differential Transmitter	AI	-	07-PDT-22	W1986-45005-R2	IOAM/APL	1	2	35

No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,105	08-PDT-23	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-23	W1986-45005-R2	IOAM/APL	1	2	35
1,106	08-PDT-24	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-24	W1986-45005-R2	IOAM/APL	1	2	35
1,107	08-PDT-25	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-25	W1986-45005-R2	IOAM/APL	1	2	35
1,108	08-PDT-26	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-26	W1986-45005-R2	IOAM/APL	1	2	35
1,109	08-PDT-27	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-27	W1986-45007-R2	IOAM/APL	1	2	35
1,110	08-PDT-28	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-28	W1986-45007-R2	IOAM/APL	1	2	35
1,111	08-PDT-29	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-29	W1986-45007-R2	IOAM/APL	1	2	35
1,112	08-PDT-30	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-30	W1986-45005-R2	IOAM/APL	1	2	35
1,113	08-PDT-31	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-31	W1986-45005-R2	IOAM/APL	1	2	35
1,114	08-PDT-32	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-32	W1986-45005-R2	IOAM/APL	1	2	35
1,115	08-PDT-33	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-33	W1986-45005-R2	IOAM/APL	1	2	35
1,116	08-PDT-34	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-34	W1986-45005-R2	IOAM/APL	1	2	35
1,117	08-PDT-35	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-35	W1986-45005-R2	IOAM/APL	1	2	35
1,118	08-PDT-36	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-36	W1986-45007-R2	IOAM/APL	1	2	35
1,119	08-PDT-37	PLC-100	Pressure Differential Transmitter	AI	-	08-PDT-37	W1986-45007-R2	IOAM/APL	1	2	35
1,120	02-PDT-38	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-38	W1986-45007-R2	IOAM/APL	1	2	35
1,121	02-PDT-39	PLC-100	Pressure Differential Transmitter	AI	-	02-PDT-39	W1986-45007-R2	IOAM/APL	1	2	35
1,122	03-PDT-40	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-40	W1986-45007-R2	IOAM/APL	1	2	35
1,123	03-PDT-41	PLC-100	Pressure Differential Transmitter	AI	-	03-PDT-41	W1986-45006-R2	IOAM/APL	1	2	35
1,124	SV-01	PLC-100	Damper Actuator	DO	-	SV-01	W1986-45005-R2	OAM/APL	1	2	35
1,125	SV-02	PLC-100	Damper Actuator	DO	-	SV-02	W1986-45005-R2	OAM/APL	1	2	35
1,126	SV-03	PLC-100	Damper Actuator	DO	-	SV-03	W1986-45007-R2	OAM/APL	1	2	35
1,127	SV-04	PLC-100	Damper Actuator	DO	-	SV-04	W1986-45007-R2	OAM/APL	1	2	35
1,128	SV-05	PLC-100	Damper Actuator	DO	-	SV-05	W1986-45007-R2	OAM/APL	1	2	35
1,129	SV-06	PLC-100	Damper Actuator	DO	-	SV-06	W1986-45007-R2	OAM/APL	1	2	35
1,130	SV-07	PLC-100	Damper Actuator	DO	-	SV-07	W1986-45006-R2	OAM/APL	1	2	35

No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,131	SV-08	PLC-100	Damper Actuator	DO	-	SV-08	W1986-45006-R2	OAM/APL	1	2	35
1,132	SV-09	PLC-100	Damper Actuator	DO	-	SV-09	W1986-45006-R2	OAM/APL	1	2	35
1,133	SV-10	PLC-100	Damper Actuator	DO	-	SV-10	W1986-45006-R2	OAM/APL	1	2	35
1,134	SV-11	PLC-100	Damper Actuator	DO	-	SV-11	W1986-45007-R2	OAM/APL	1	2	35
1,135	SV-12	PLC-100	Damper Actuator	DO	-	SV-12	W1986-45007-R2	OAM/APL	1	2	35
1,136	SV-13	PLC-100	Damper Actuator	DO	-	SV-13	W1986-45007-R2	OAM/APL	1	2	35
1,137	SV-14	PLC-100	Damper Actuator	DO	-	SV-14	W1986-45007-R2	OAM/APL	1	2	35
1,138	SV-15	PLC-100	Damper Actuator	DO	-	SV-15	W1986-45006-R2	OAM/APL	1	2	35
1,139	SV-16	PLC-100	Damper Actuator	DO	-	SV-16	W1986-45005-R2	OAM/APL	1	2	35
1,140	SV-17	PLC-100	Damper Actuator	DO	-	SV-17	W1986-45005-R2	OAM/APL	1	2	35
1,141	SV-18	PLC-100	Damper Actuator	DO	-	SV-18	W1986-45005-R2	OAM/APL	1	2	35
1,142	SV-19	PLC-100	Damper Actuator	DO	-	SV-19	W1986-45005-R2	OAM/APL	1	2	35
1,143	SV-20	PLC-100	Damper Actuator	DO	-	SV-20	W1986-45005-R2	OAM/APL	1	2	35
1,144	SV-21	PLC-100	Damper Actuator	DO	-	SV-21	W1986-45005-R2	OAM/APL	1	2	35
1,145	SV-22	PLC-100	Damper Actuator	DO	-	SV-22	W1986-45007-R2	OAM/APL	1	2	35
1,146	SV-23	PLC-100	Damper Actuator	DO	-	SV-23	W1986-45007-R2	OAM/APL	1	2	35
1,147	SV-24	PLC-100	Damper Actuator	DO	-	SV-24	W1986-45007-R2	OAM/APL	1	2	35
1,148	SV-25	PLC-100	Damper Actuator	DO	-	SV-25	W1986-45007-R2	OAM/APL	1	2	35
1,149	SV-26	PLC-100	Damper Actuator	DO	-	SV-26	W1986-45006-R2	OAM/APL	1	2	35
1,150	SV-27	PLC-100	Damper Actuator	DO	-	SV-27	W1986-45006-R2	OAM/APL	1	2	35
1,151	SV-28	PLC-100	Damper Actuator	DO	-	SV-28	W1986-45006-R2	OAM/APL	1	2	35
1,152	SV-29	PLC-100	Damper Actuator	DO	-	SV-29	W1986-45005-R2	OAM/APL	1	2	35
1,153	SV-30	PLC-100	Damper Actuator	DO	-	SV-30	W1986-45005-R2	OAM/APL	1	2	35
1,154	SV-31	PLC-100	Damper Actuator	DO	-	SV-31	W1986-45007-R2	OAM/APL	1	2	35
1,155	SV-32	PLC-100	Damper Actuator	DO	-	SV-32	W1986-45007-R2	OAM/APL	1	2	35
1,156	SV-33	PLC-100	Damper Actuator	DO	-	SV-33	W1986-45007-R2	OAM/APL	1	2	35

NRF National Research Foundation / iThemba LABS Laboratory for Accelerator Based Sciences	**iTHEMBA HVAC**	PROJECT ASSIGNMENTS Process & Project Engineers
	IO LIST	BCE BÜHRMANN CONSULTING ENGINEERS
	CT0340-IC-LST-0200-R0	

No	Tag Number	From	Description	IO Type	Signal Type	Equipment Number	P&ID Number	Cable Type	Size mm²	Pairs	Length (m)
1,157	SV-34	PLC-100	Damper Actuator	DO	-	SV-34	W1986-45007-R2	OAM/APL	1	2	35
1,158	SV-35	PLC-100	Damper Actuator	DO	-	SV-35	W1986-45006-R2	OAM/APL	1	2	35
1,159	SV-36	PLC-100	Damper Actuator	DO	-	SV-36	W1986-45006-R2	OAM/APL	1	2	35
1,160	SV-37	PLC-100	Damper Actuator	DO	-	SV-37	W1986-45006-R2	OAM/APL	1	2	35
1,161	SV-38	PLC-100	Damper Actuator	DO	-	SV-38	W1986-45006-R2	OAM/APL	1	2	35
1,162	SV-39	PLC-100	Damper Actuator	DO	-	SV-39	W1986-45006-R2	OAM/APL	1	2	35
1,163	SV-40	PLC-100	Damper Actuator	DO	-	SV-40	W1986-45005-R2	OAM/APL	1	2	35

Tag Abbreviations

AI	-	Analogue Input
AO	-	Analogue Output
DI	-	Digital Input
DO	-	Digital Output

I/O Count

	I/O Signals			
PLC Panel	**DI**	**DO**	**AI**	**AO**
PLC-100	0	48	99	16

iThemba LABS — National Research Foundation — Laboratory for Accelerator Based Sciences	iTHEMBA HVAC CABLE SCHEDULE CT0340-EL-LST-0100-R0	PROJECT ASSIGNMENTS — Process & Project Engineers BCE BÜHRMANN CONSULTING ENGINEERS

Cable Tag	From	Cubicle No.	To	Description	Conductor Type	Size (mm)	Cores	Cable Qty	Phases	Load (kW)	Power Factor	Load (kVA)	Voltage (V)	Load (A)	Length (m)
Feeder															
UPS-MDB-01 / MCC-100	UPS-MDB-01	-	MCC-100	MCC-100 Feeder	PVC SWA Cu	185	4	4	3	766	0,8	958	415	1332	110
E4 Extract Fans															
MCC-100 / E4A-VSD	MCC-100	-	E4A-VSD	E4 Duty VSD	PVC SWA Cu	70	4	1	3	90	0,8	113	415	157	35
E4A-VSD / E4A	E4A-VSD	-	E4A	E4 Duty Extract Fan	PVC SWA Cu	70	4	1	3	90	0,8	113	415	157	50
MCC-100 / E4A-VSD(Ctrl)	MCC-100	-	E4A-VSD(Ctrl)	E4 Duty Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	35
MCC-100 / E4A-VSD(Eth)	MCC-100	-	E4A-VSD(Eth)	E4 Duty Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	35
MCC-100 / E4B-VSD	MCC-100	-	E4B-VSD	E4 VSD Standby	PVC SWA Cu	70	4	1	3	90	0,8	113	415	157	35
E4B-VSD / E4B	E4B-VSD	-	E4B	E4 Standby Extract Fan	PVC SWA Cu	70	4	1	3	90	0,8	113	415	157	50
MCC-100 / E4B-VSD(Ctrl)	MCC-100	-	E4B-VSD(Ctrl)	E4 Standby Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	35
MCC-100 / E4B-VSD(Eth)	MCC-100	-	E4B-VSD(Eth)	E4 Standby Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	35
MCC-100 / E4	MCC-100	-	E4	E4 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	50
E5 Extract Fans															
MCC-100 / E5A-VSD	MCC-100	-	E5A-VSD	E5 Duty VSD	PVC SWA Cu	120	4	1	3	132	0,8	165	415	230	35
E5A-VSD / E5A	E5A-VSD	-	E5A	E5 Duty Extract Fan	PVC SWA Cu	120	4	1	3	132	0,8	165	415	230	50
MCC-100 / E5A-VSD(Ctrl)	MCC-100	-	E5A-VSD(Ctrl)	E5 Duty Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	35
MCC-100 / E5A-VSD(Eth)	MCC-100	-	E5A-VSD(Eth)	E5 Duty Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	35
MCC-100 / E5B-VSD	MCC-100	-	E5B-VSD	E5 VSD Standby	PVC SWA Cu	120	4	1	3	132	0,8	165	415	230	35
E5B-VSD / E5B	E5B-VSD	-	E5B	E5 Standby Extract Fan	PVC SWA Cu	120	4	1	3	132	0,8	165	415	230	50
MCC-100 / E5B-VSD(Ctrl)	MCC-100	-	E5B-VSD(Ctrl)	E5 Standby Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	35
MCC-100 / E5B-VSD(Eth)	MCC-100	-	E5B-VSD(Eth)	E5 Standby Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	35
MCC-100 / E5	MCC-100	-	E5	E5 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	50
E6 Extract Fans															
MCC-100 / E6A	MCC-100	-	E6A	E6 Duty Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	85
MCC-100 / E6B	MCC-100	-	E6B	E6 Standby Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	85

iThemba LABS — National Research Foundation — Laboratory for Accelerator Based Sciences	iTHEMBA HVAC CABLE SCHEDULE CT0340-EL-LST-0100-R0	PROJECT ASSIGNMENTS — Process & Project Engineers BCE BÜHRMANN CONSULTING ENGINEERS

Cable Tag	From	Cubicle No.	To	Description	Conductor Type	Size (mm)	Cores	Cable Qty	Phases	Load (kW)	Power Factor	Load (kVA)	Voltage (V)	Load (A)	Length (m)
MCC-100 / E6	MCC-100	-	E6	E6 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	85
E7 Extract Fans															
MCC-100 / E7A	MCC-100	-	E7A	E7 Duty Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	85
MCC-100 / E7B	MCC-100	-	E7B	E7 Standby Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	85
MCC-100 / E7	MCC-100	-	E7	E7 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	85
E8 Extract Fans															
MCC-100 / E8A	MCC-100	-	E8A	E8 Duty Extract Fan	PVC SWA Cu	4	4	1	3	15	0,8	19	415	26	85
MCC-100 / E8B	MCC-100	-	E8B	E8 Standby Extract Fan	PVC SWA Cu	4	4	1	3	15	0,8	19	415	26	85
MCC-100 / E8	MCC-100	-	E8	E8 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	85
E9 Extract Fans															
MCC-100 / E9A	MCC-100	-	E9A	E9 Duty Extract Fan	PVC SWA Cu	4	4	1	3	15	0,8	19	415	26	85
MCC-100 / E9B	MCC-100	-	E9B	E9 Standby Extract Fan	PVC SWA Cu	4	4	1	3	15	0,8	19	415	26	85
MCC-100 / E9	MCC-100	-	E9	E9 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	85
E10 Extract Fans															
MCC-100 / E10A	MCC-100	-	E10A	E10 Duty Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	85
MCC-100 / E10B	MCC-100	-	E10B	E10 Standby Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	85
MCC-100 / E10	MCC-100	-	E10	E10 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	85
AHU1															
MCC-100 / SF-1A-VSD	MCC-100	-	SF-1A-VSD	SF-1 Duty VSD	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	30
SF-1A-VSD / SF-1A	SF-1A-VSD	-	SF-1A	SF-1 Duty Extract Fan	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	5
MCC-100 / SF-1A-VSD(Ctrl)	MCC-100	-	SF-1A-VSD(Ctrl)	SF-1 Duty Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	30
MCC-100 / SF-1A-VSD(Eth)	MCC-100	-	SF-1A-VSD(Eth)	SF-1 Duty Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	30
MCC-100 / SF-1B-VSD	MCC-100	-	SF-1B-VSD	SF-1 VSD Standby	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	30
SF-1B-VSD / SF-1B	SF-1B-VSD	-	SF-1B	SF-1 Standby Extract Fan	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	5
MCC-100 / SF-1B-VSD(Ctrl)	MCC-100	-	SF-1B-VSD(Ctrl)	SF-1 Standby Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	30

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CABLE SCHEDULE

CT0340-EL-LST-0100-R0

PROJECT ASSIGNMENTS
Process & Project Engineers

BCE BÜHRMANN
CONSULTING ENGINEERS

Cable Tag	From	Cubicle No.	To	Description	Conductor Type	Size (mm)	Cores	Cable Qty	Phases	Load (kW)	Power Factor	Load (kVA)	Voltage (V)	Load (A)	Length (m)
MCC-100 / SF-1B-VSD(Eth)	MCC-100	-	SF-1B-VSD(Eth)	SF-1 Standby Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	30
MCC-100 / SF-1	MCC-100	-	SF-1	SF-1 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	30
MCC-100 / HE-1	MCC-100	-	HE-1	AHU 1 Heating Element	PVC SWA Cu	150	4	1	3	160	1	160	415	223	30
AHU2															
MCC-100 / SF-2A-VSD	MCC-100	-	SF-2A-VSD	SF-2 Duty VSD	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	38
SF-2A-VSD / SF-2A	SF-2A-VSD	-	SF-2A	SF-2 Duty Extract Fan	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	5
MCC-100 / SF-2A-VSD(Ctrl)	MCC-100	-	SF-2A-VSD(Ctrl)	SF-2 Duty Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	38
MCC-100 / SF-2A-VSD(Eth)	MCC-100	-	SF-2A-VSD(Eth)	SF-2 Duty Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	38
MCC-100 / SF-2B-VSD	MCC-100	-	SF-2B-VSD	SF-2 VSD Standby	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	38
SF-2B-VSD / SF-2B	SF-2B-VSD	-	SF-2B	SF-2 Standby Extract Fan	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	5
MCC-100 / SF-2B-VSD(Ctrl)	MCC-100	-	SF-2B-VSD(Ctrl)	SF-2 Standby Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	38
MCC-100 / SF-2B-VSD(Eth)	MCC-100	-	SF-2B-VSD(Eth)	SF-2 Standby Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	38
MCC-100 / SF-2	MCC-100	-	SF-2	SF-2 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	38
MCC-100 / HE-2	MCC-100	-	HE-2	AHU 2 Heating Element	PVC SWA Cu	95	4	1	3	120	1	120	415	167	38
AHU3															
SF-3A-VSD / SF-3A	SF-3A-VSD	-	SF-3A	SF-3 Duty Extract Fan	PVC SWA Cu	2,5	4	1	3	11	0,8	14	415	19	60
SF-3B-VSD / SF-3B	SF-3B-VSD	-	SF-3B	SF-3 Standby Extract Fan	PVC SWA Cu	2,5	4	1	3	11	0,8	14	415	19	60
MCC-100 / SF-3	MCC-100	-	SF-3	SF-3 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	60
MCC-100 / HE-3	MCC-100	-	HE-3	AHU 3 Heating Element	PVC SWA Cu	16	4	1	3	36	1	36	415	50	60
AHU4															
SF-4A-VSD / SF-4A	SF-4A-VSD	-	SF-4A	SF-4 Duty Extract Fan	PVC SWA Cu	2,5	4	1	3	5,5	0,8	7	415	10	40
SF-4B-VSD / SF-4B	SF-4B-VSD	-	SF-4B	SF-4 Standby Extract Fan	PVC SWA Cu	2,5	4	1	3	5,5	0,8	7	415	10	40
MCC-100 / SF-4	MCC-100	-	SF-4	SF-4 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	40
MCC-100 / HE-4	MCC-100	-	HE-4	AHU 4 Heating Element	PVC SWA Cu	35	4	1	3	48	1	48	415	67	40
AHU5															

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BCE BÜHRMANN
CONSULTING ENGINEERS

Cable Tag	From	Cubicle No.	To	Description	Conductor Type	Size (mm)	Cores	Cable Qty	Phases	Load (kW)	Power Factor	Load (kVA)	Voltage (V)	Load (A)	Length (m)
MCC-100 / SF-5A-VSD	MCC-100	-	SF-5A-VSD	SF-5 Duty VSD	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	36
SF-5A-VSD / SF-5A	SF-5A-VSD	-	SF-5A	SF-5 Duty Extract Fan	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	5
MCC-100 / SF-5A-VSD(Ctrl)	MCC-100	-	SF-5A-VSD(Ctrl)	SF-5 Duty Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	36
MCC-100 / SF-5A-VSD(Eth)	MCC-100	-	SF-5A-VSD(Eth)	SF-5 Duty Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	36
MCC-100 / SF-5B-VSD	MCC-100	-	SF-5B-VSD	SF-5 VSD Standby	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	36
SF-5B-VSD / SF-5B	SF-5B-VSD	-	SF-5B	SF-5 Standby Extract Fan	PVC SWA Cu	25	4	1	3	45	0,8	56	415	78	5
MCC-100 / SF-5B-VSD(Ctrl)	MCC-100	-	SF-5B-VSD(Ctrl)	SF-5 Standby Extract Fan Control Cable	PVC Cu	1,5	12	1	1	-	-	-	110	-	36
MCC-100 / SF-5B-VSD(Eth)	MCC-100	-	SF-5B-VSD(Eth)	SF-5 Standby Extract Fan Ethernet Cable	Ethernet Cat6	-	-	1	-	-	-	-	-	-	36
MCC-100 / SF-5	MCC-100	-	SF-5	SF-5 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	36
MCC-100 / HE-5	MCC-100	-	HE-5	AHU 5 Heating Element	PVC SWA Cu	70	4	1	3	97	1	97	415	135	36
AHU6															
SF-6A-VSD / SF-6A	SF-6A-VSD	-	SF-6A	SF-6 Duty Extract Fan	PVC SWA Cu	1,5	4	1	3	2	0,8	3	415	3	30
SF-6B-VSD / SF-6B	SF-6B-VSD	-	SF-6B	SF-6 Standby Extract Fan	PVC SWA Cu	1,5	4	1	3	2	0,8	3	415	3	30
MCC-100 / SF-6	MCC-100	-	SF-6	SF-6 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	30
MCC-100 / HE-6	MCC-100	-	HE-6	AHU 6 Heating Element	PVC SWA Cu	2,5	4	1	3	4	1	4	415	6	30
AHU7															
SF-7A-VSD / SF-7A	SF-7A-VSD	-	SF-7A	SF-7 Duty Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	45
SF-7B-VSD / SF-7B	SF-7B-VSD	-	SF-7B	SF-7 Standby Extract Fan	PVC SWA Cu	1,5	4	1	3	3	0,8	4	415	5	45
MCC-100 / SF-7	MCC-100	-	SF-7	SF-7 Extract Fan Field Station	PVC SWA Cu	2,5	5	1	1	-	-	-	230	-	45
MCC-100 / HE-7	MCC-100	-	HE-7	AHU 7 Heating Element	PVC SWA Cu	6	4	1	3	10	1	10	415	14	45
AHU8															
	MCC-100	-	HE-8	AHU 7 Heating Element	PVC SWA Cu	1,5	4	1	3	5,2	1	5	415	7	33

Notes

1. Earth cables are not shown on the cable list, but must be installed by the contractor. 4-Core cables must use the 4th core for earth.
2. Cable lengths must be measured on site before ordering and/or cutting cables.

Annexure E – Drawings

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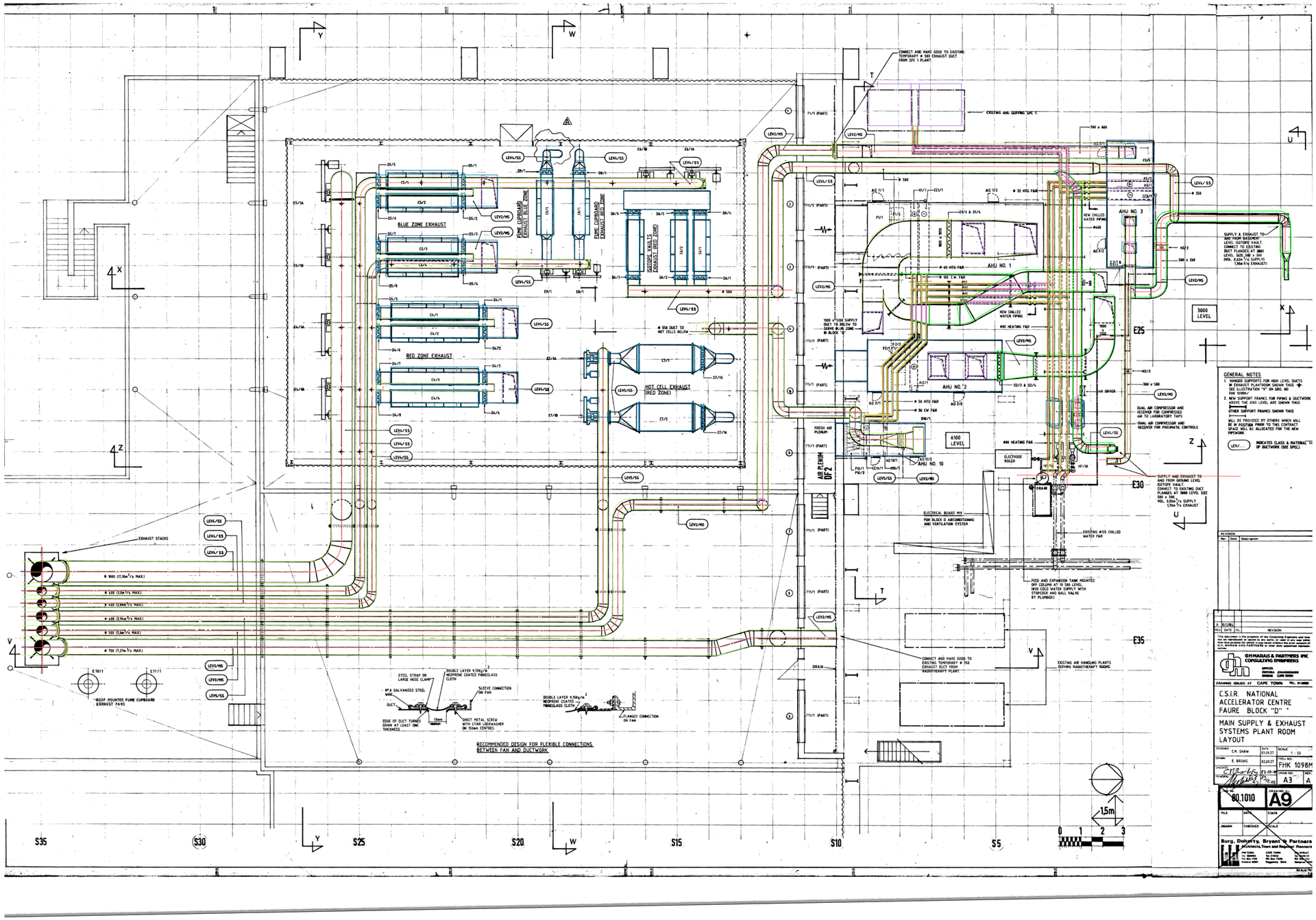

KEYPLAN

NOTES

1. -

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	09.04.24	GvdH	SA	22.11.24	-

REVISIONS

DRG No	TITLE
-	-

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986-iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA LABS
EXISTING 6 METER LEVEL
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:100	09.04.2024	MNR	GvdH

DRG. No.	REV.	SHEET SIZE
W1986-FSK-001	0	A1

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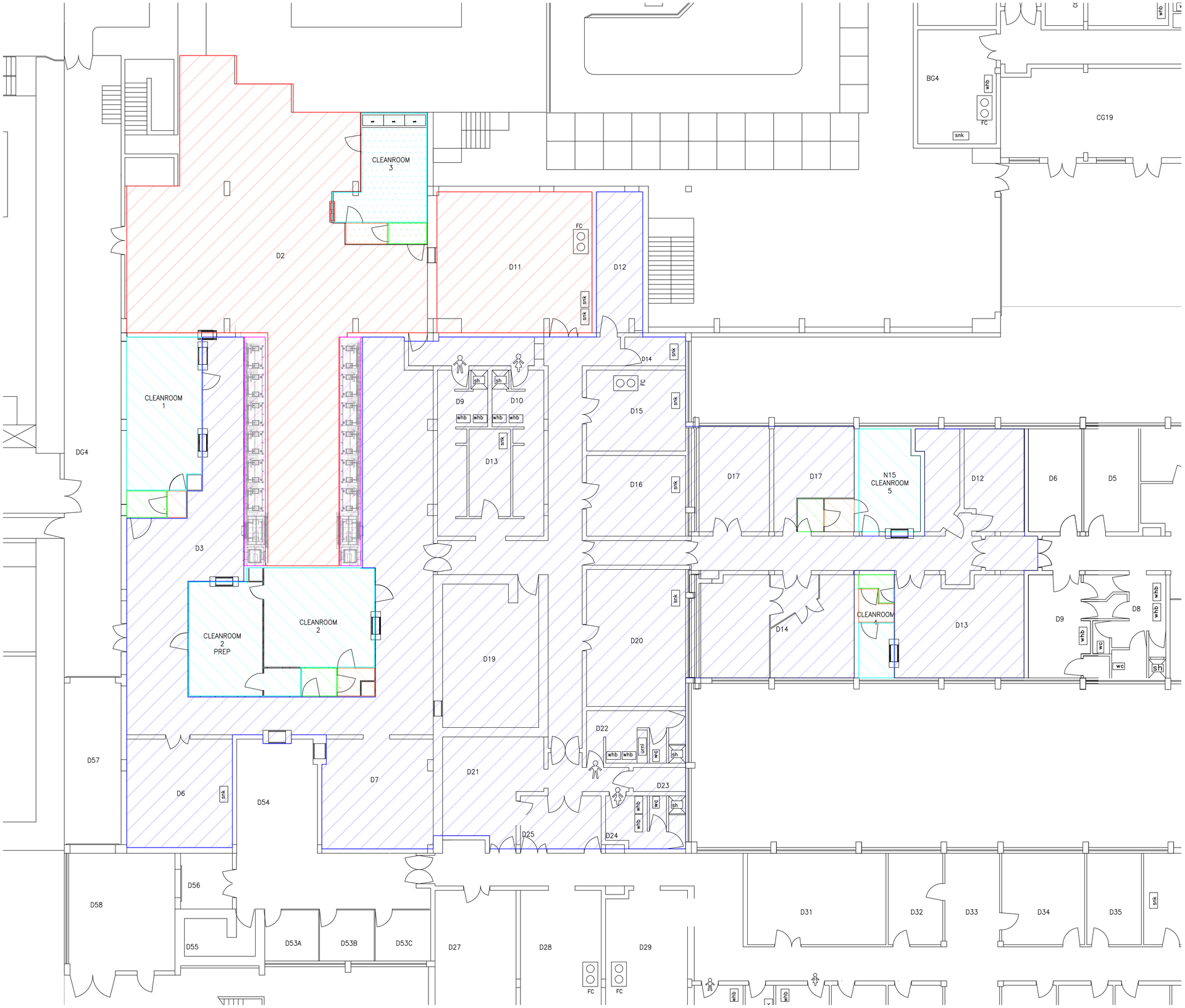

KEYPLAN

NOTES

1. BASEMENT & VAULTS SET AT −80Pa.

LEGEND

- −5Pa
- −10Pa
- −20Pa
- −40Pa
- −45Pa
- −50Pa
- −60Pa
- −80Pa
- −200Pa

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
2	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
1	SCOPE UPDATED	MNR	02.11.24	BM	SA	04.11.24	–
0	FIRST ISSUE	MNR	22.10.24	BM	GC	23.10.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA
GROUND FLOOR PRESURE CASCADES
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:75	10.22.2024	MNR	GvdH

DRG. No.	REV.	SHEET SIZE
W1986–59007	2	A1

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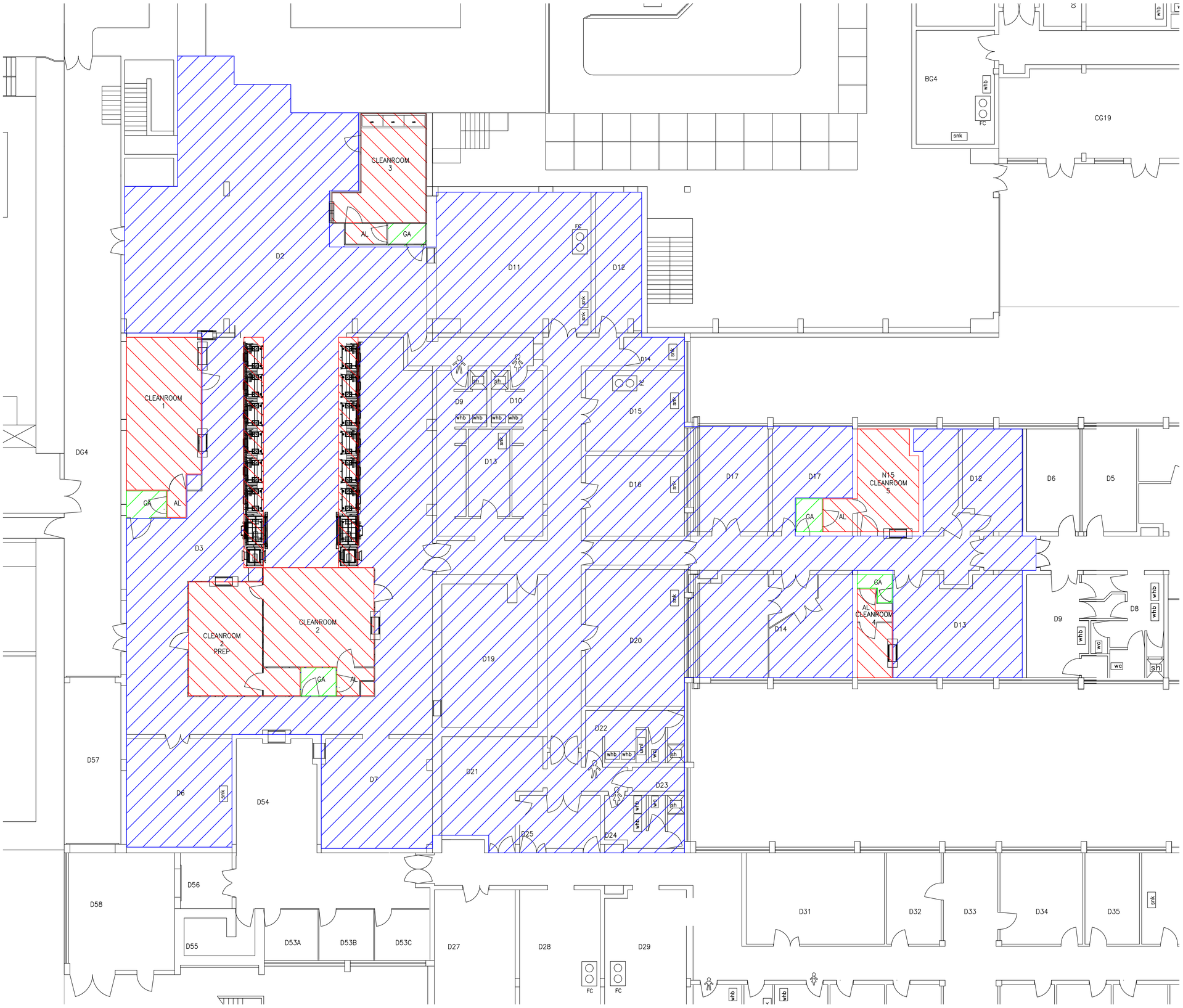

KEYPLAN

NOTES

1. THE BASEMENT IS GRADE D CLASSIFICATION.

LEGEND

- B CLASSIFICATION
- C CLASSIFICATION
- D CLASSIFICATION

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
3	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
2	SCOPE UPDATED	MNR	22.10.24	BM	SA	23.10.24	–
1	SCOPE UPDATED	MNR	24.06.24	BM	GC	24.06.24	–
0	FIRST ISSUE	MNR	22.05.24	BM	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA LABS
AIR CLASSIFICATION GROUND FLOOR
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:75	22.05.2024	MNR	GC

DRG. No.	REV.	SHEET SIZE
W1986–59006	3	A1

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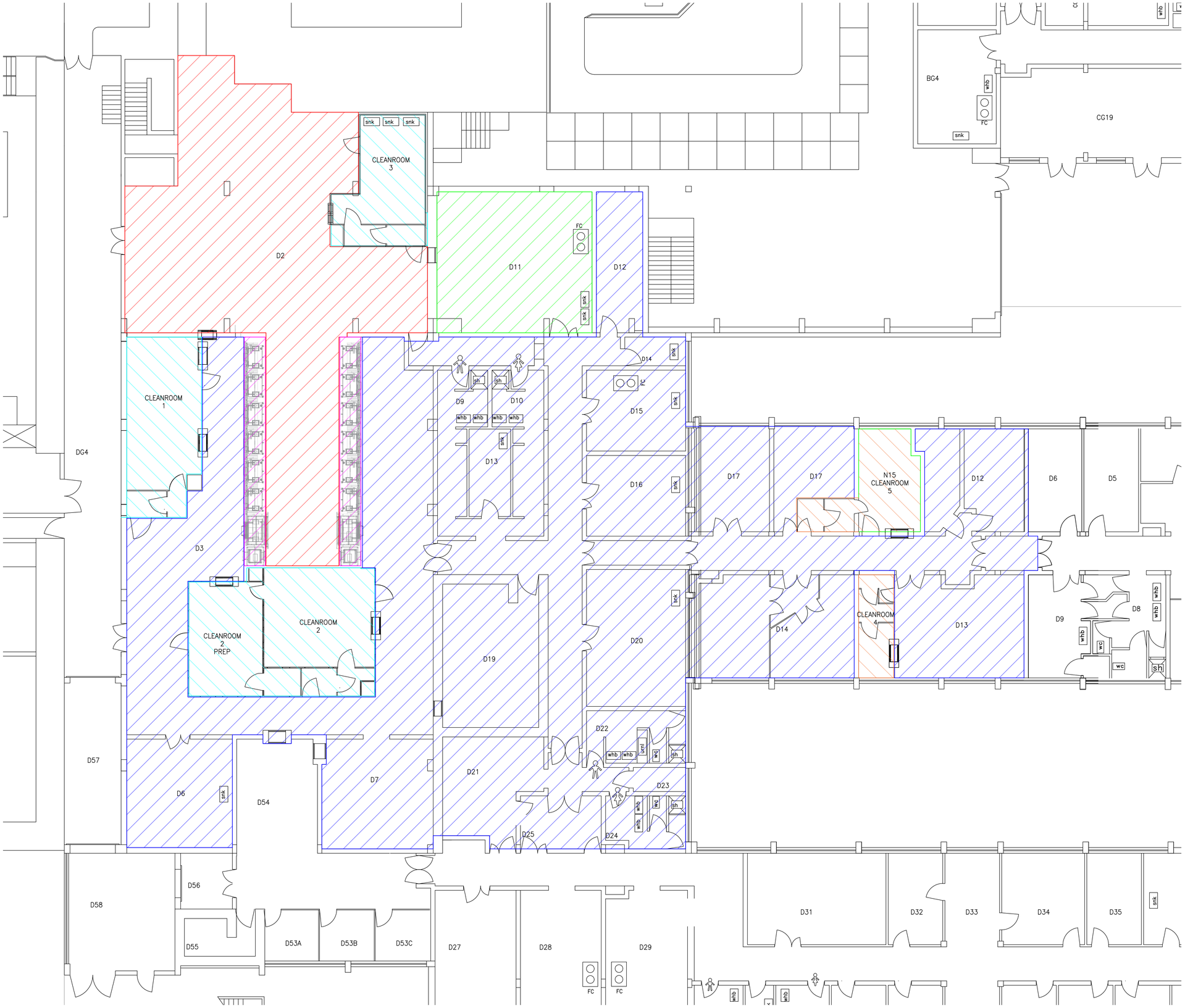

KEYPLAN

NOTES

1. THE BASEMENT IS FED BY AHU5.
2. THE VAULTS IS FED BY AHU7.

LEGEND

- AHU1: BLUE ZONE GROUND FLOOR
- AHU2: CLEAN ROOM 1, 2 & 3
- AHU3: CLEAN ROOM 4 & 5
- AHU4: RED ZONE GROUND FLOOR
- AHU6: CYCLOTRON
- AHU8: HOT CELLS

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
3	ISSUE FOR TENDER	MNR	14.15.24	BM	SA	22.11.24	–
2	SCOPE UPDATED	MNR	21.10.24	BM	SA	23.10.24	–
1	SCOPE UPDATED	MNR	20.06.24	BM	GC	21.06.24	–
0	FIRST ISSUE	MNR	20.05.24	BM	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA
BLOCK D GROUND FLOOR
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:75	09.04.2024	MNR	GvdH

DRG. No.	REV.	SHEET SIZE
W1986–59005	3	A1

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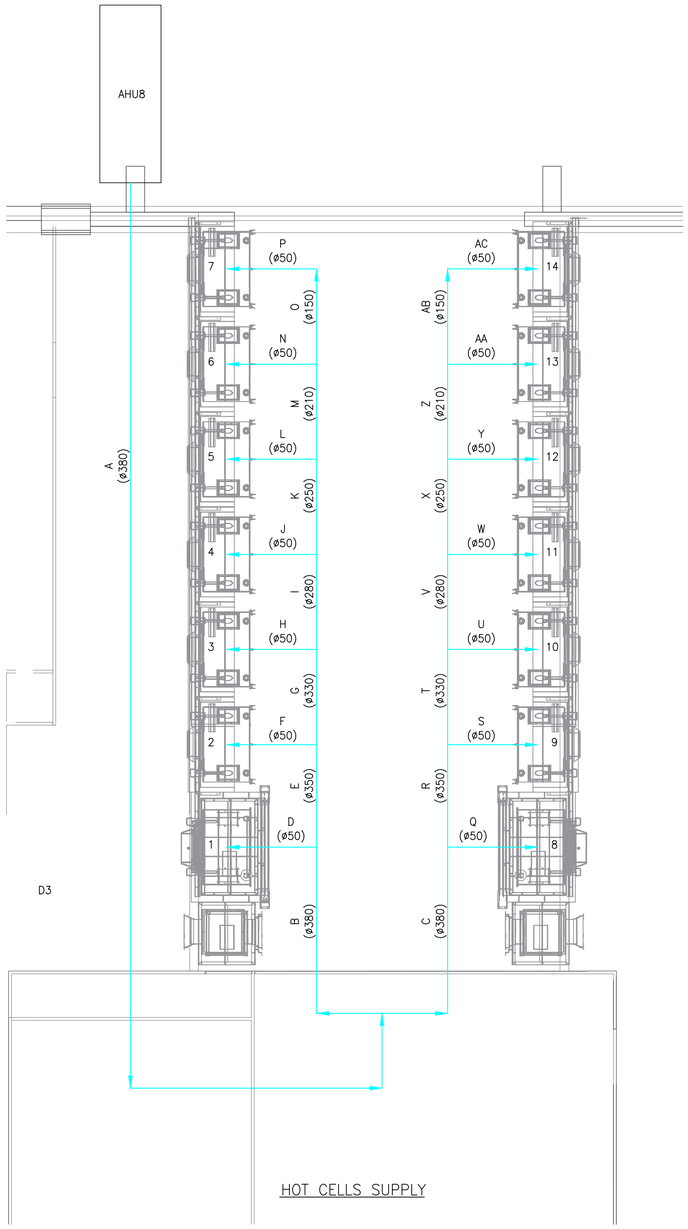
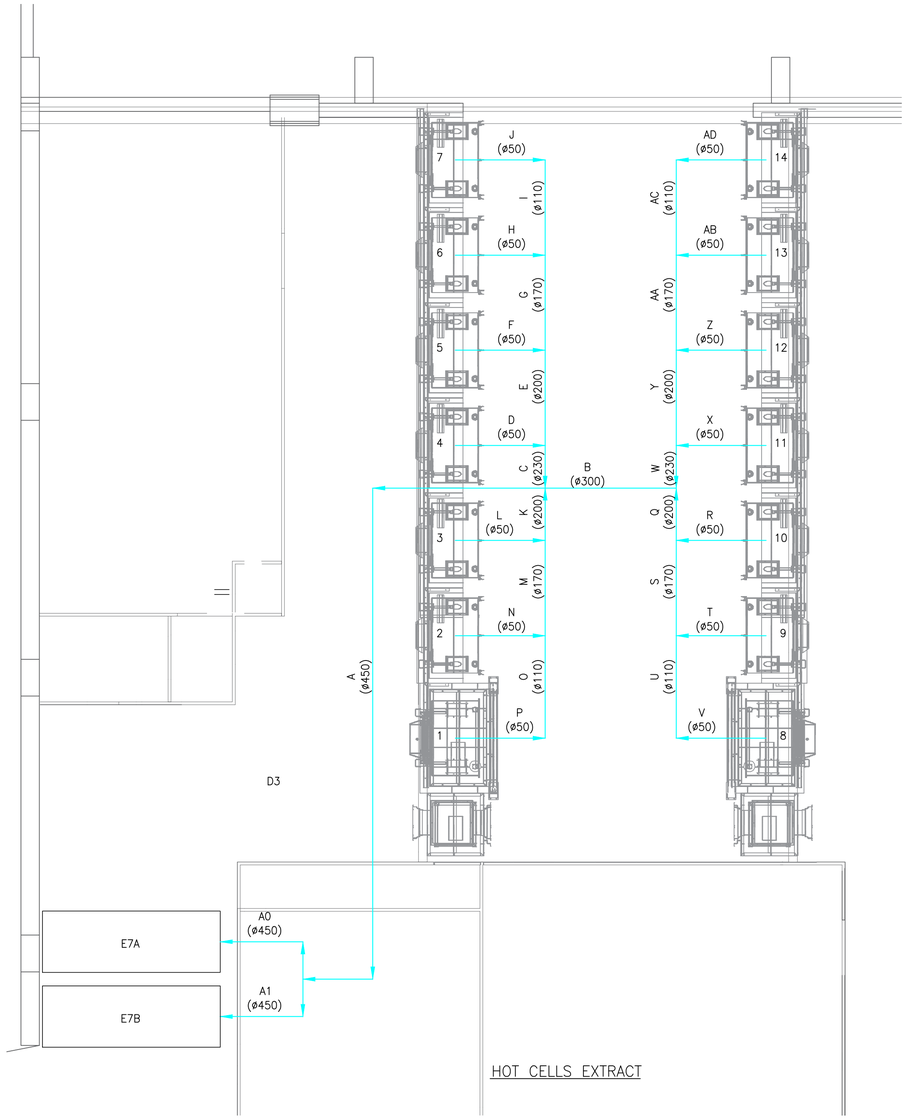


HOT CELLS SUPPLY



HOT CELLS EXTRACT

NOTES

1.

HOLDS

1.

FOR TENDER 21.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	13.11.24	BM	SA	21.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
HOT CELLS SUPPLU & EXTRACTION
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	13.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57013	0	A1

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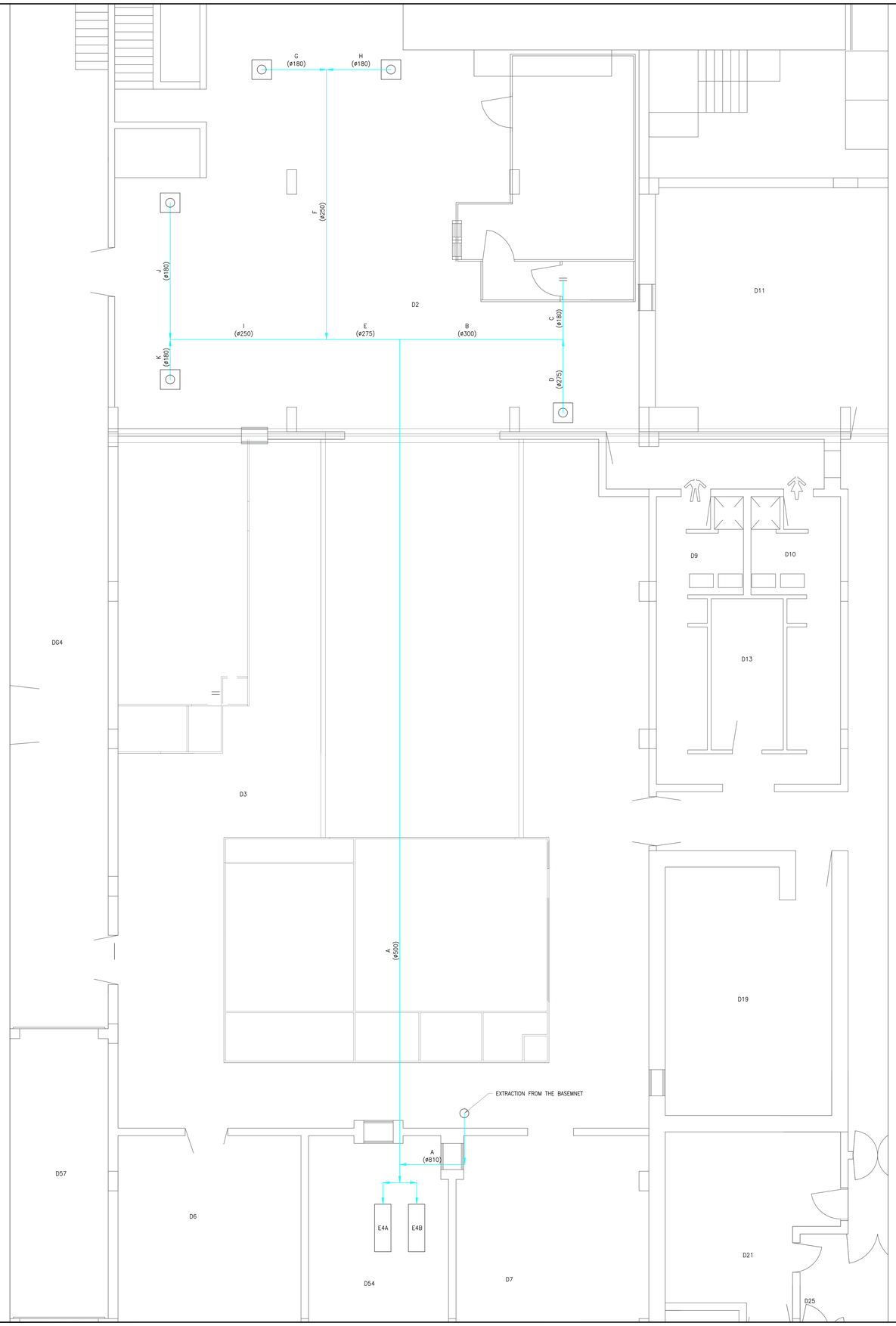

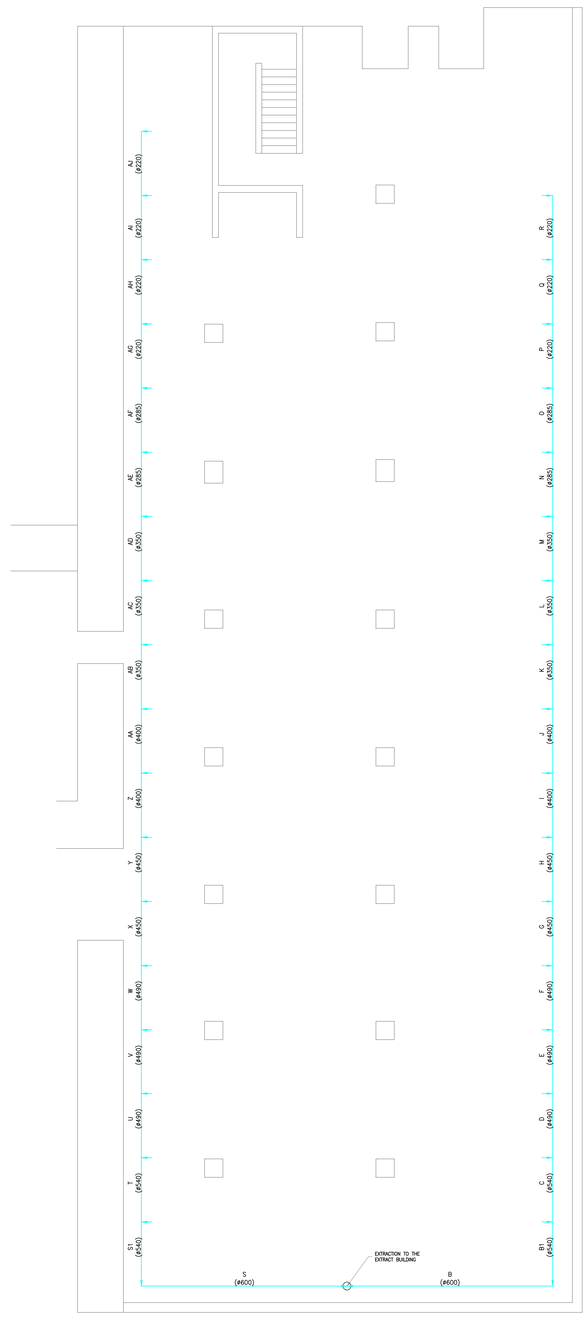

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
15.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	15.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT:

\4.6 – Client Logo\Screenshot 2024-01-30 120824.png

TITLE:
iTHEMBA LABS HVAC
RED AREA & BASEMENT EXTRACTION
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-57012	0	A0

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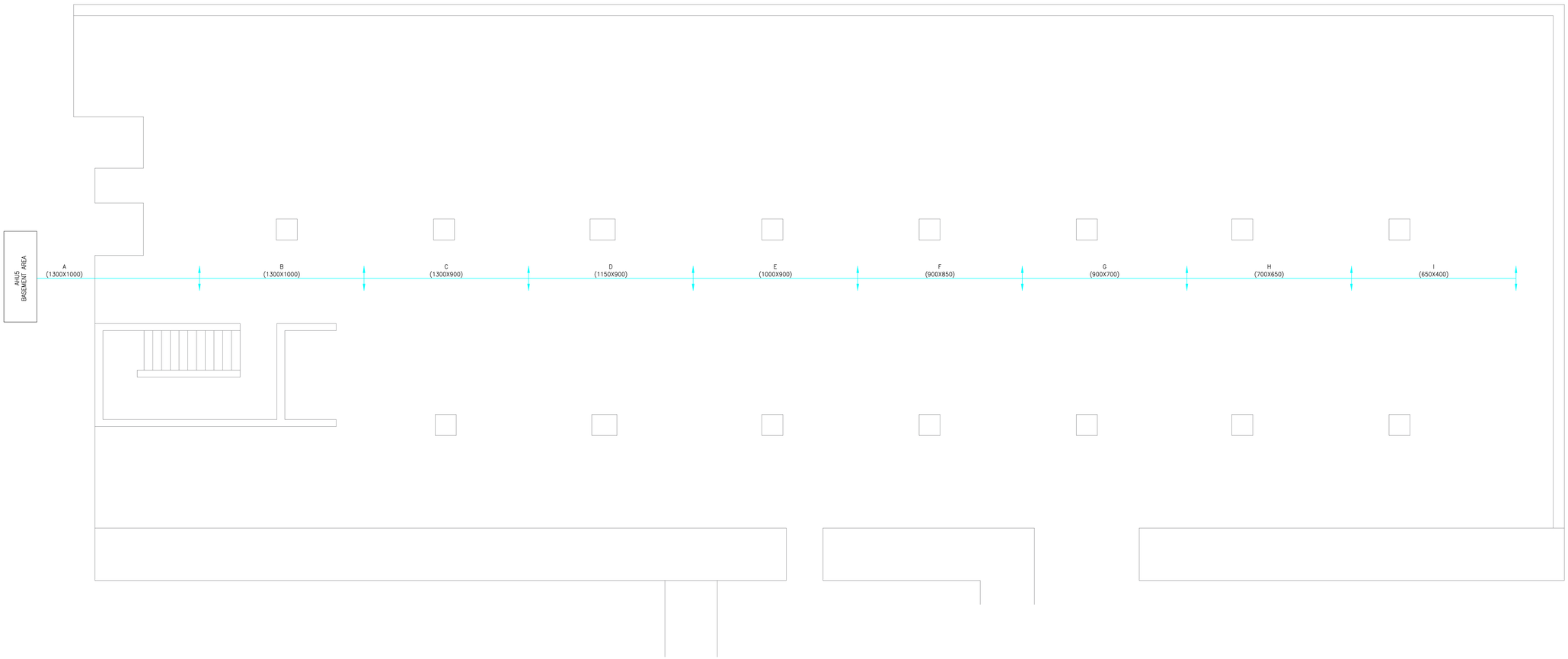

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT:

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA LABS HVAC
BASEMENT SUPPLY
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57011	0	A0

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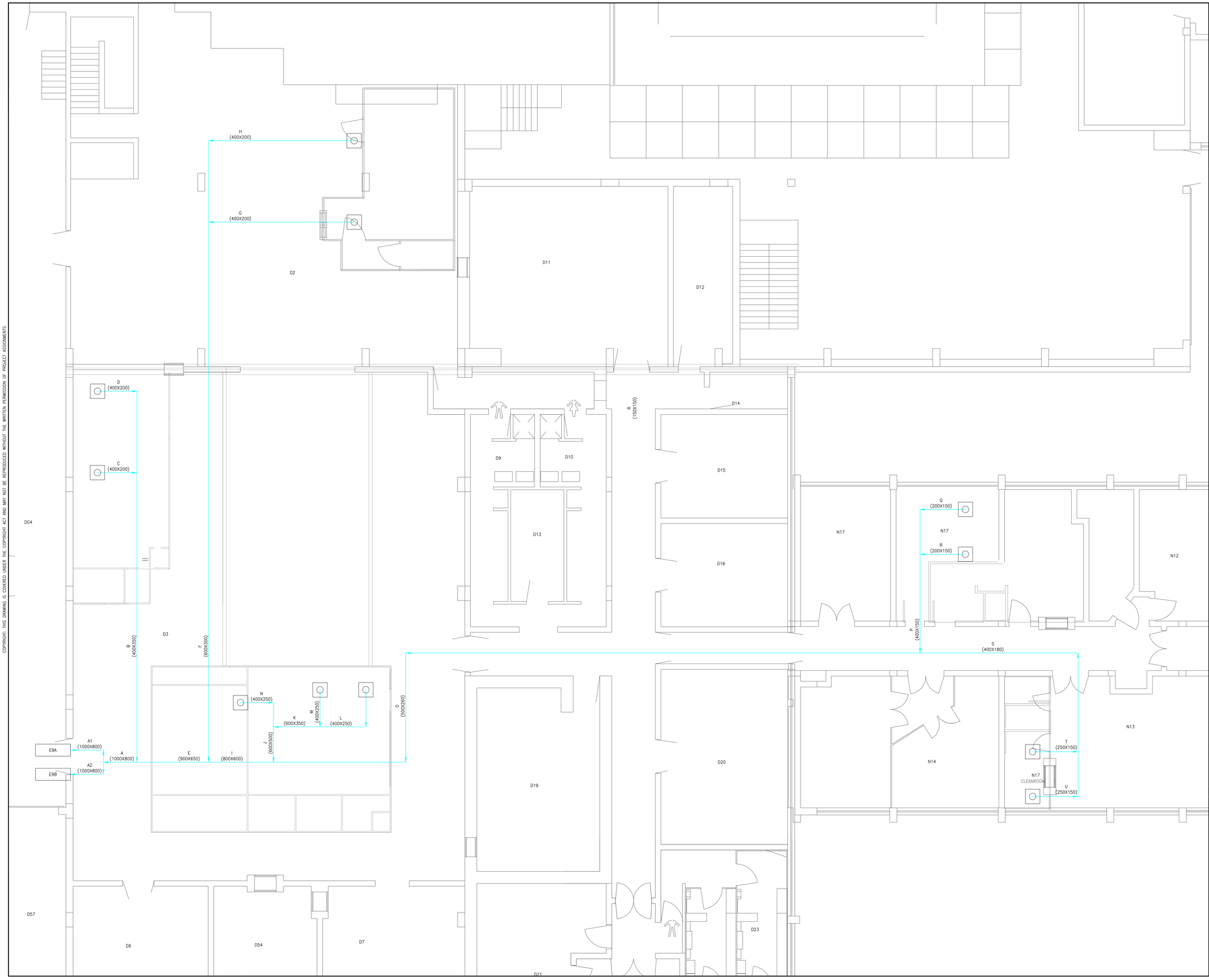

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
15.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	15.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: iTHEMBA LABS HVAC CLEANROOMS EXTRACTION SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57010	0	AO

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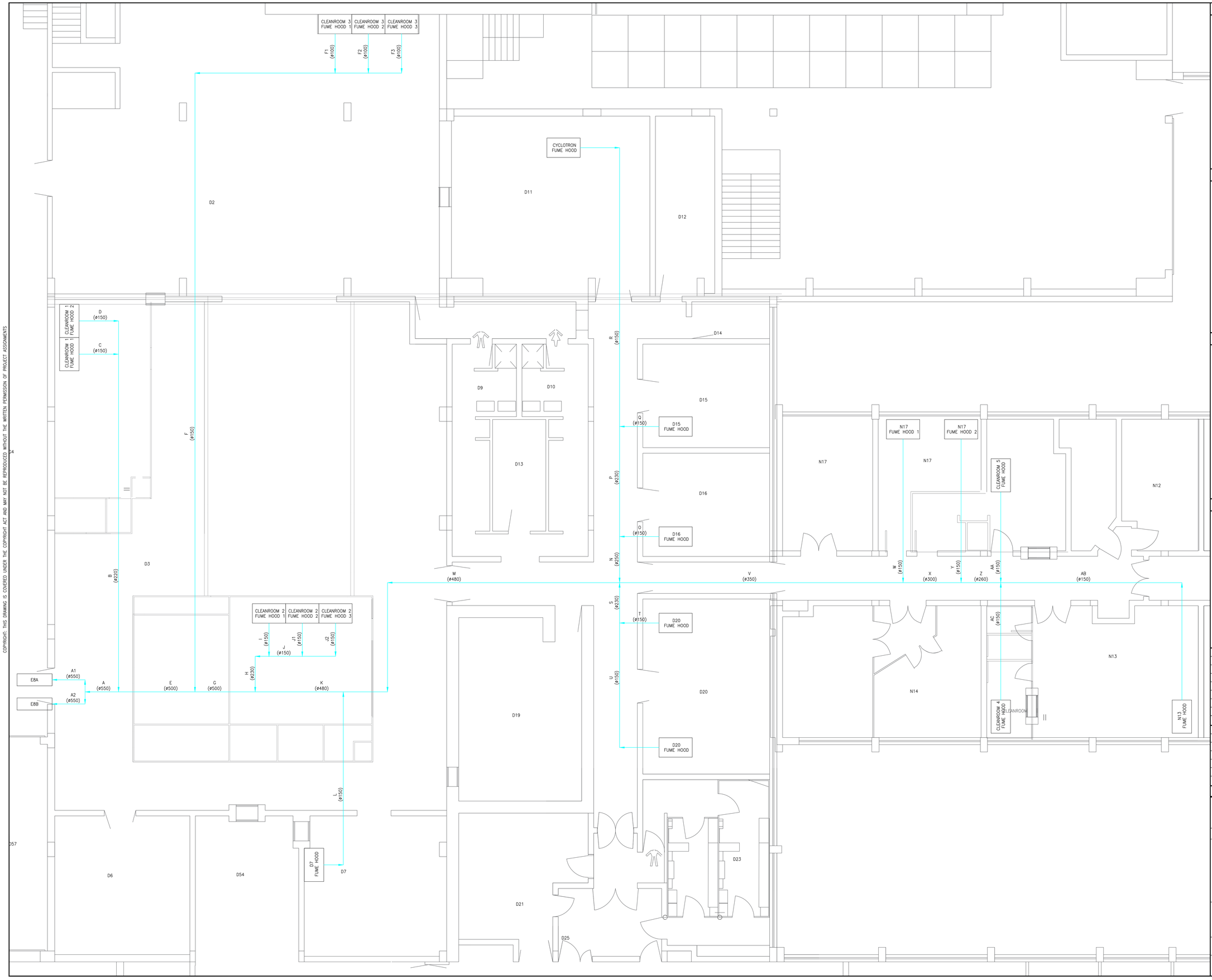

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	22.11.24	–

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–	–

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PROJECT ASSIGNMENTS
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Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: iTHEMBA LABS HVAC
FUME HOODS EXTRACTION SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57009	0	A0

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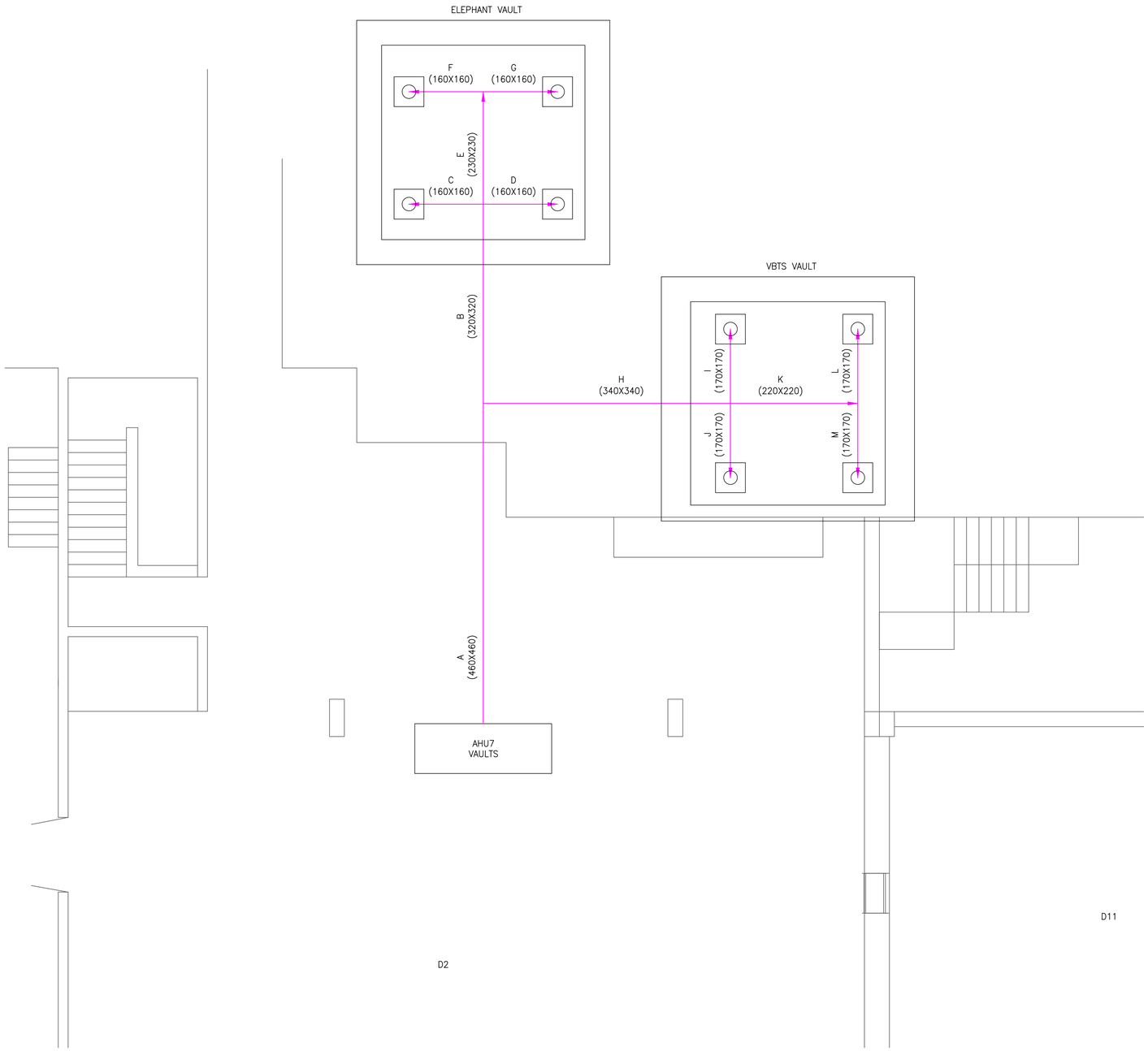

NOTES

1.

HOLDS

1.

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	22.11.24	–

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DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
VAULTS SUPPLY
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57008	0	A1

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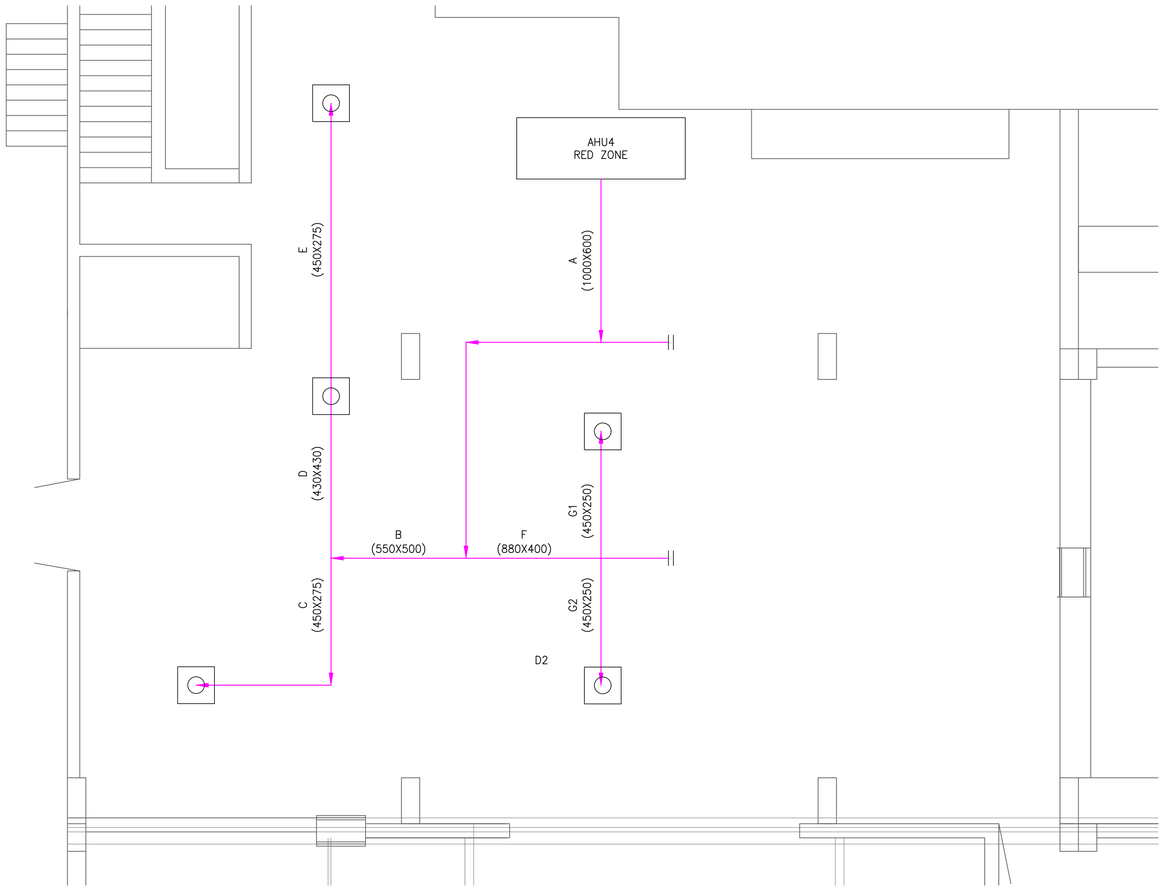

NOTES

1.

HOLDS

1.

FOR TENDER
15.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	15.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT:

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA LABS HVAC
RED ZONE SUPPLY
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57007	0	A0

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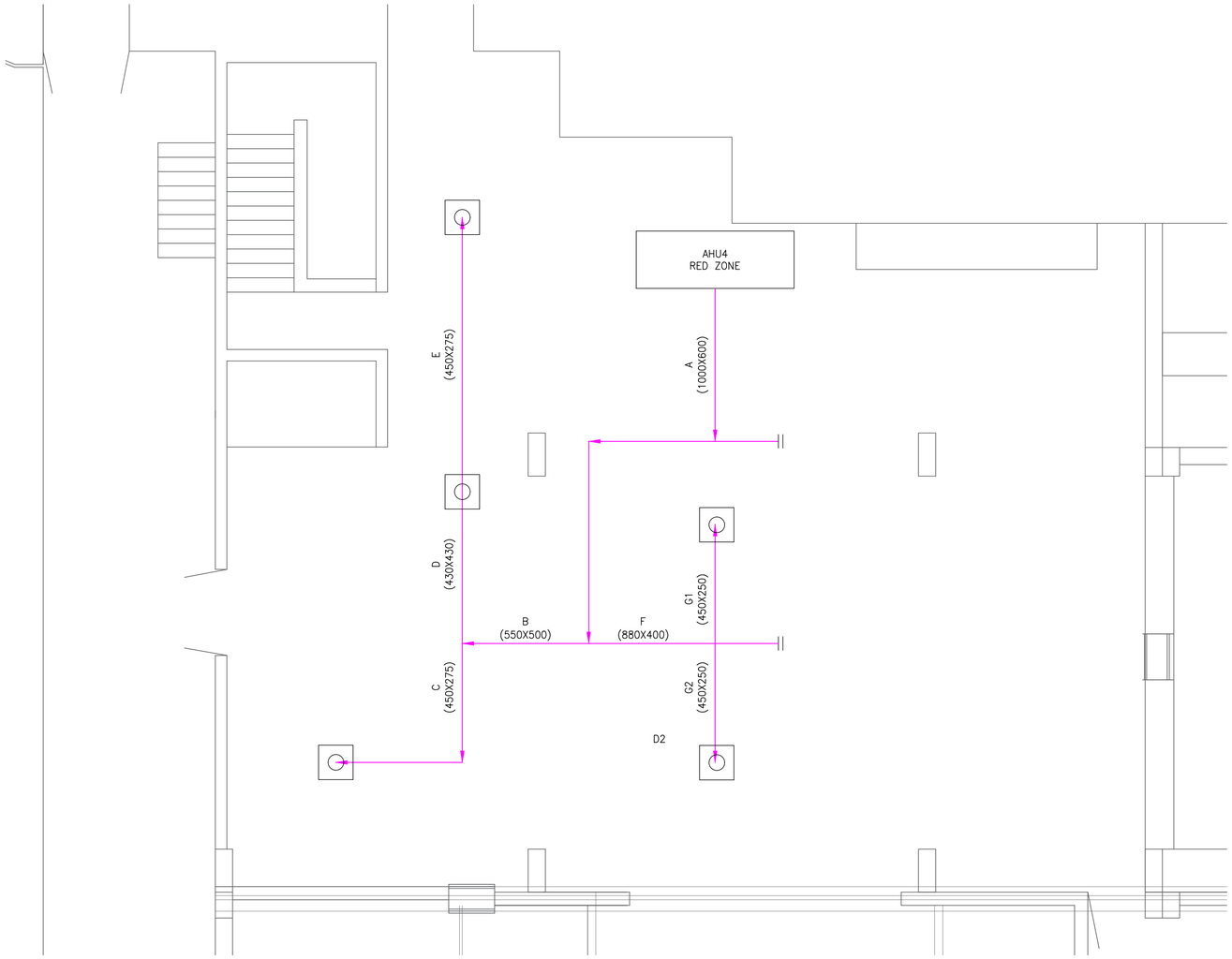

NOTES

1.

HOLDS

1.

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
RED ZONE GROUND FLOOR
SUPPLY SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57007	0	A1

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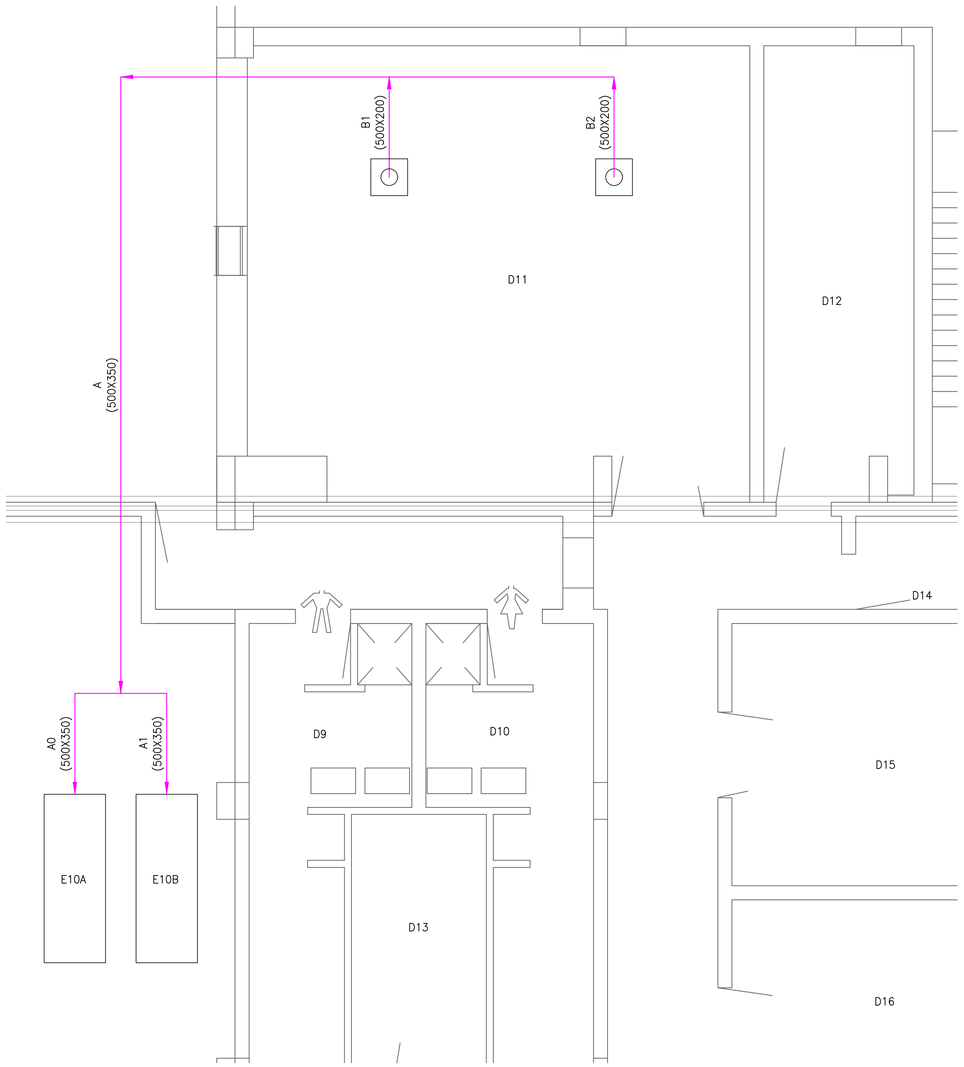

NOTES

1.

HOLDS

1.

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	22.11.24	–

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–	–

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PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
CYCLOTRON EXTRACTION
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57006	0	A1

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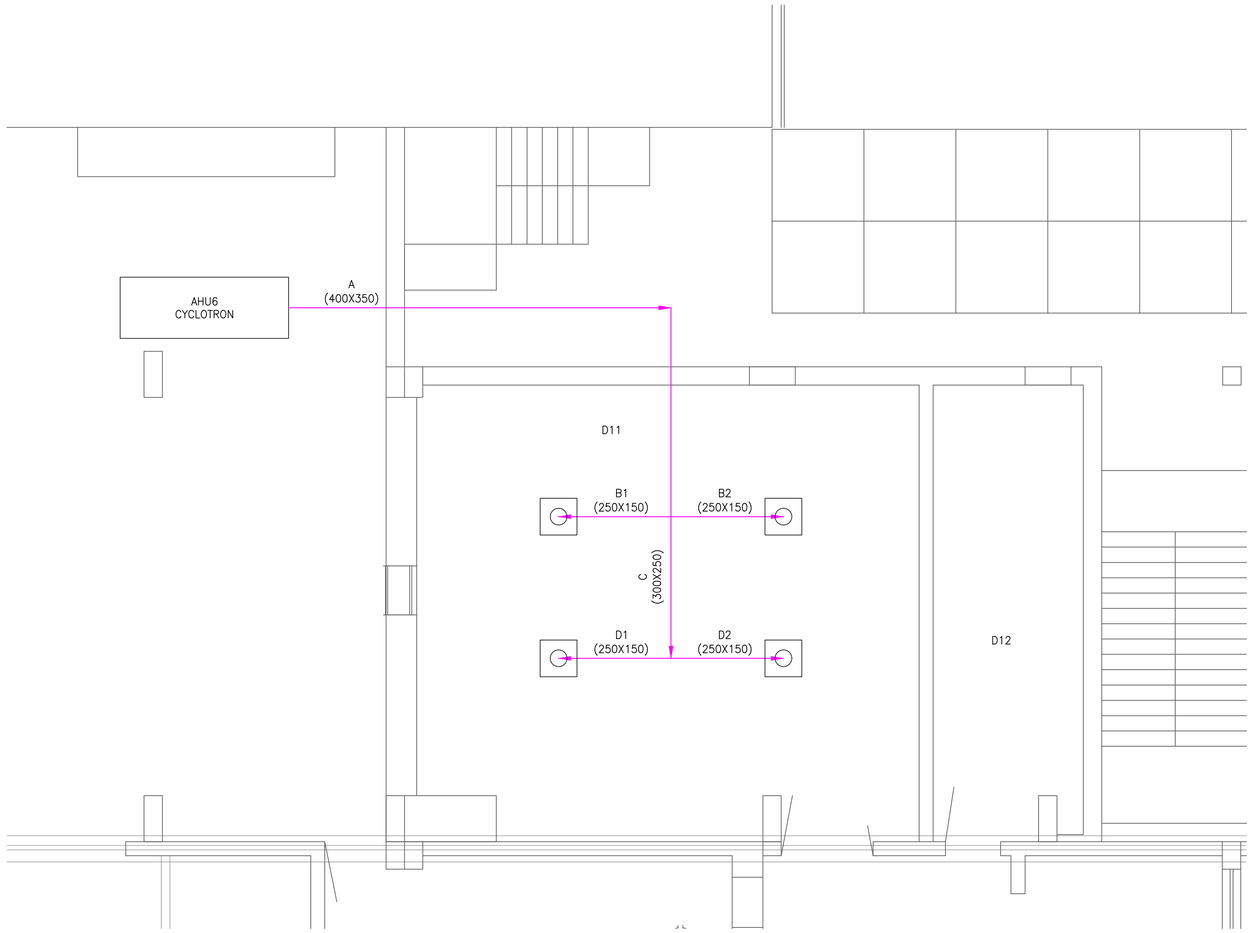


NOTES

1.

HOLDS

1. CONTINUATION DRAWING NUMBERS.
2. EQUIPMENT DETAILS.

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	04.11.24	BM	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

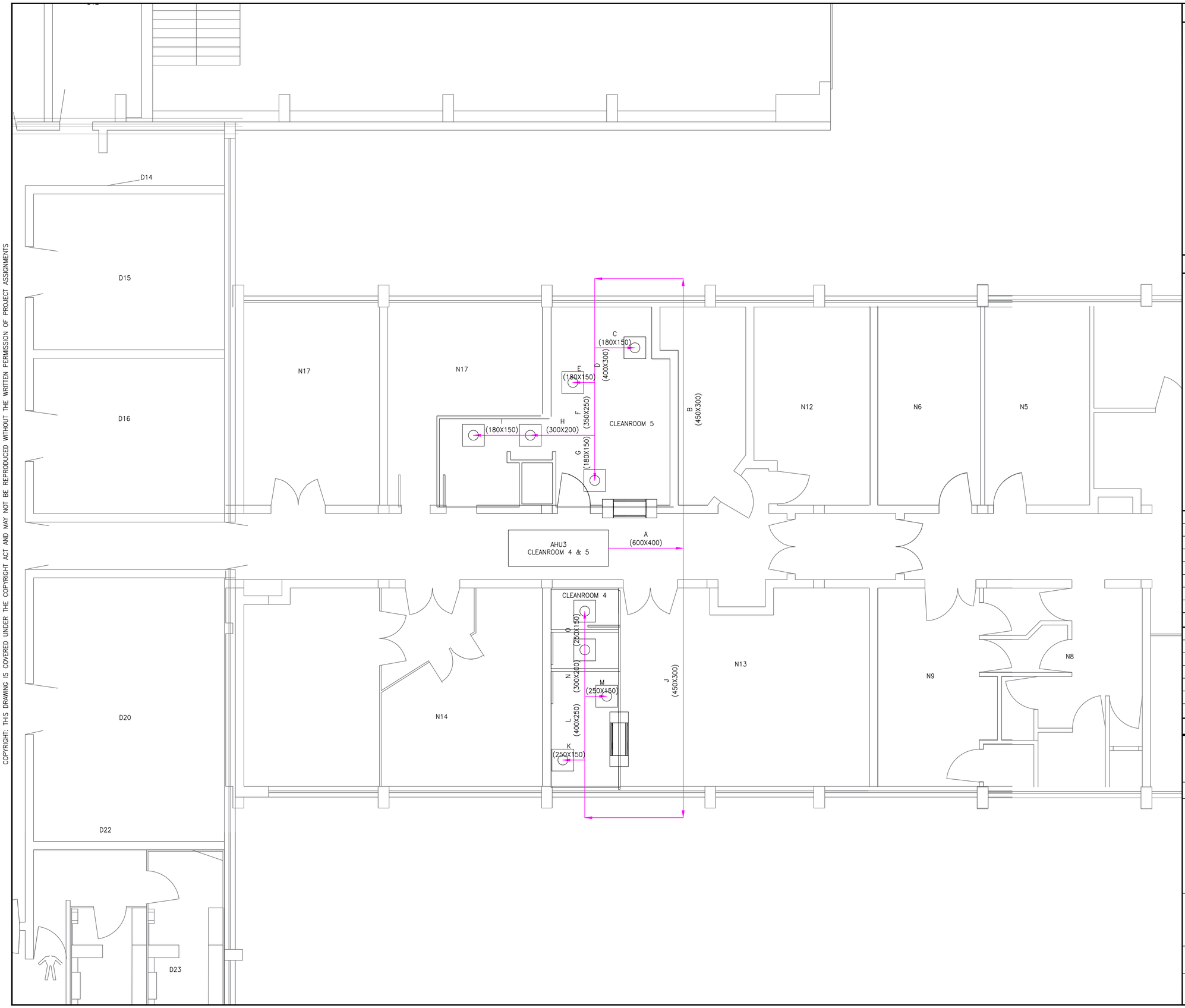
PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
CYCLOTRON SUPPLY
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	04.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57005	0	A1



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NOTES

1.

HOLDS

1.

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	30.10.24	BM	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
CLEANROOM 4 & 5 SUPPLY
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	30.10.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57004	0	A1

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DUCTING SIZE TABLE	
A	1000X800
B	550X500
C	550X400
D1	280X180
D2	280X180
E	400X110
F1	250X200
F2	250X200
G	300X200
H	200X150
I	900X650
J	650X310
K	300X250
L	400X310
M	350X150
N	180X150
O	200X150
P	750X500
Q	700X450
R	250X180
S	600X400
T	250X180
U	500X400
V	250X150
W	450X350
X1	250X180
X2	250X180
Y	300X250
Z1	250X180
Z2	250X180
AA	450X300
AB	250X180
AC	350X250
AD	250X180
AE	280X200
AF	180X180
AG	180X180

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
CLEANROOM 1, 2 & 3 SUPPLY
SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	30.10.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-57003	0	A0

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KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
21.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	30.10.24	BM	SA	21.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
BLUE AREA EXTRACTION SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	30.10.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-57002	0	A0

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KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN.	DATE	CHKD	ENG.	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	30.10.24	BM	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT:

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
BLUE AREA SUPPLY SCHEMATIC

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	30.10.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–57001	0	A0

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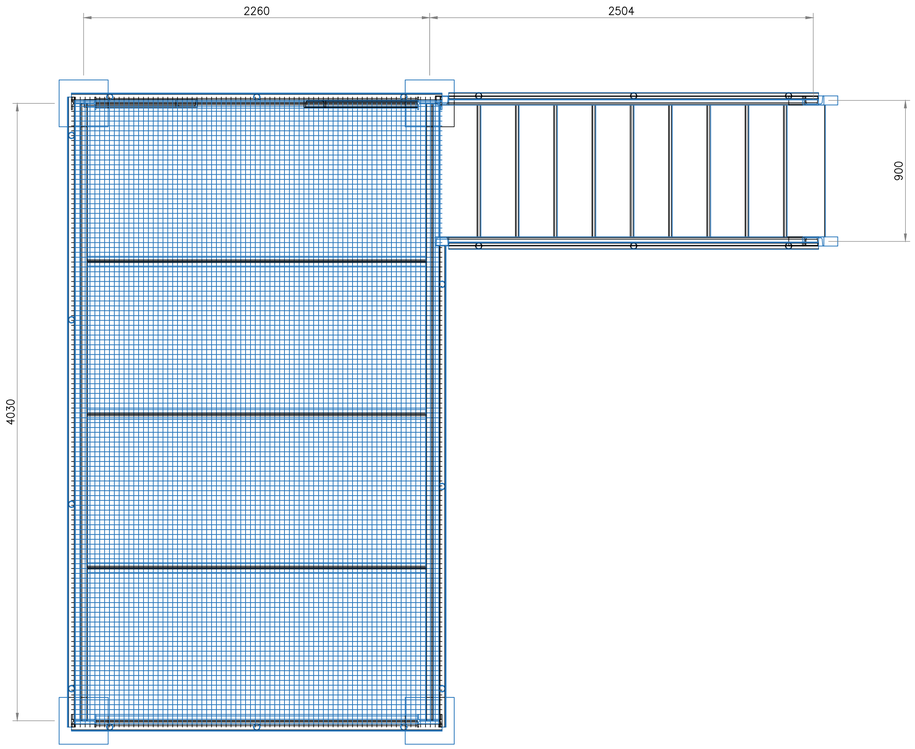
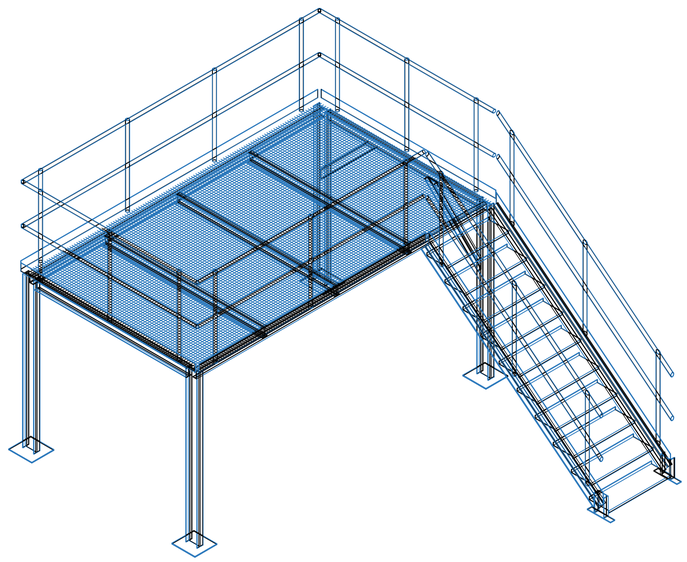
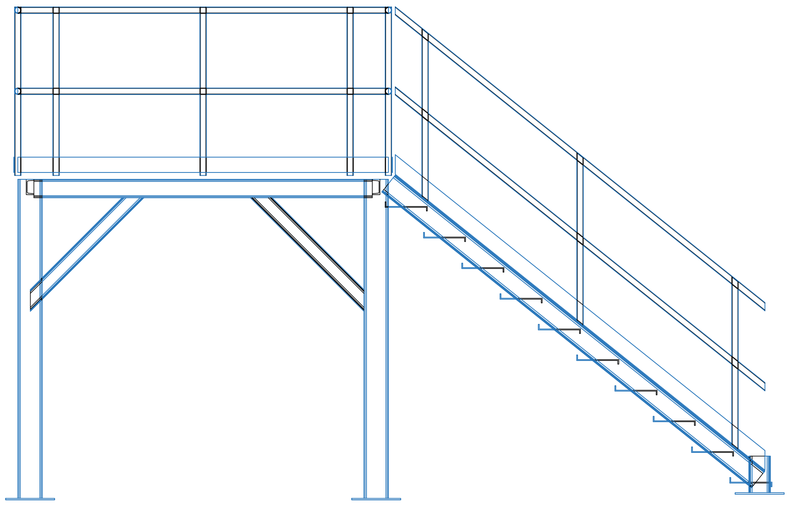


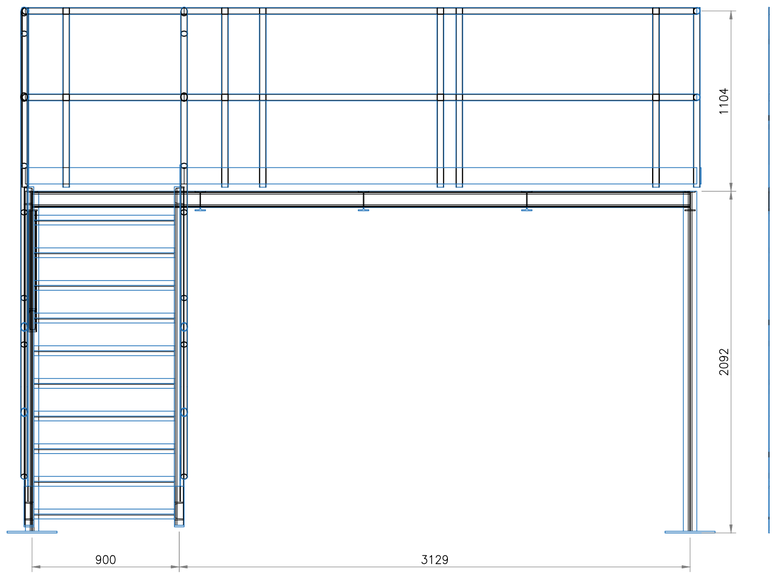
PLAN ON
SCALE 1:20



ISOMETRIC VIEW
SCALE 1:30



SIDE VIEW
SCALE 1:20



FRONT VIEW
SCALE 1:20

KEYPLAN

NOTES

1. –

LEGEND

FOR TENDER
27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
EXTRATION PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:20	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56011	0	A1

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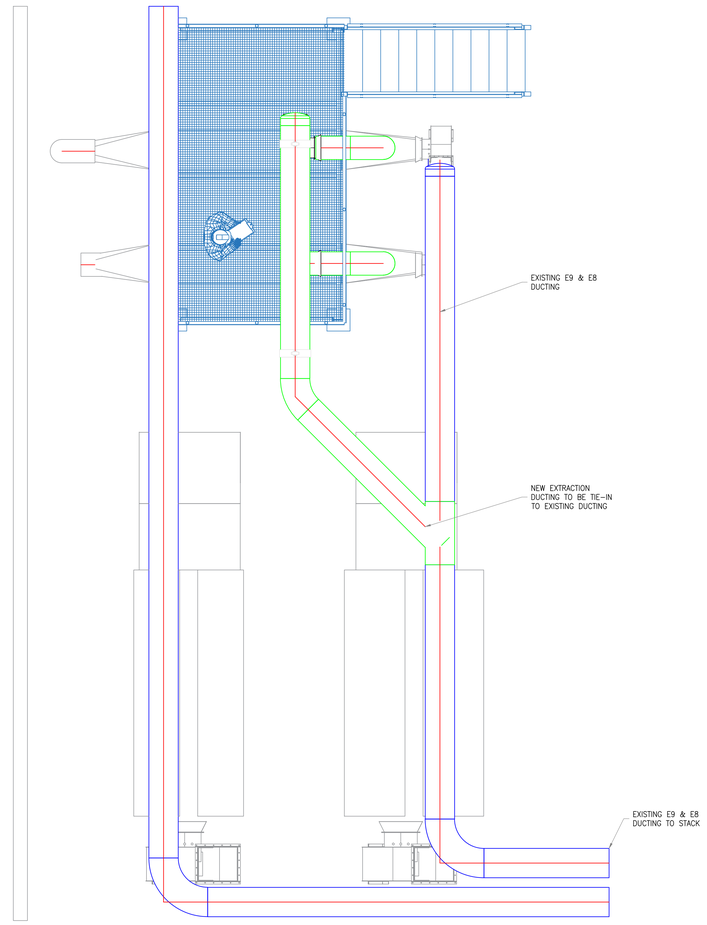
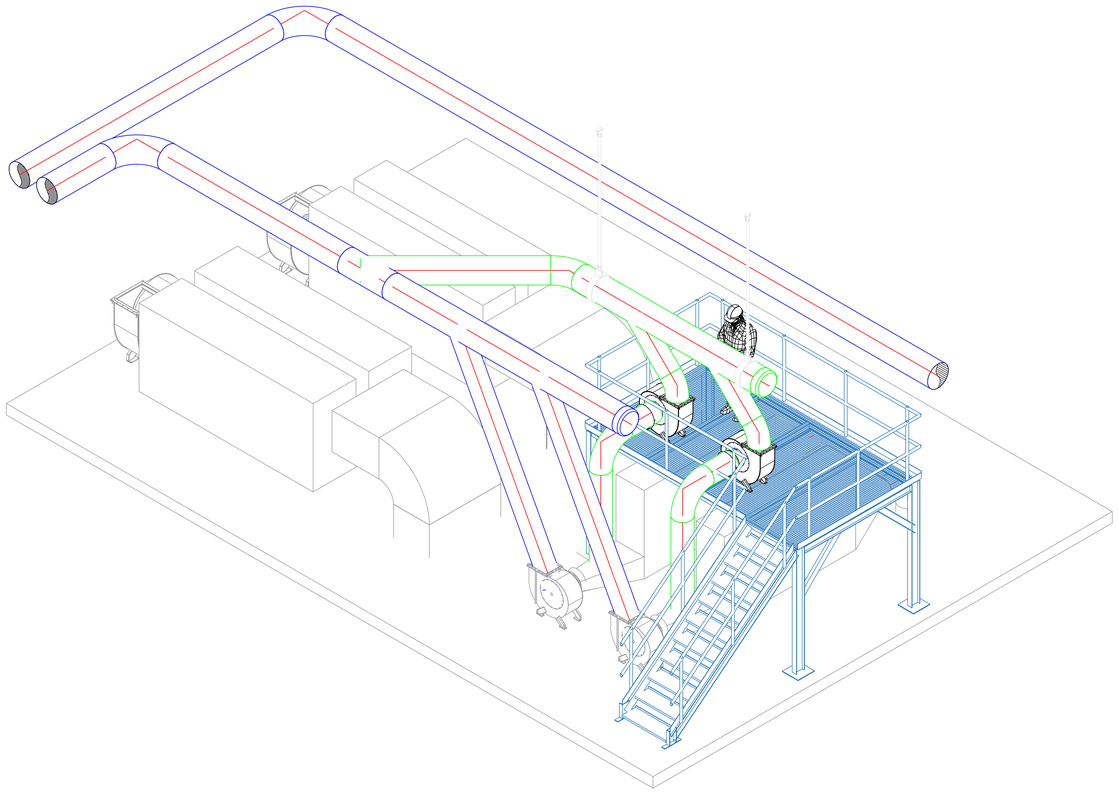
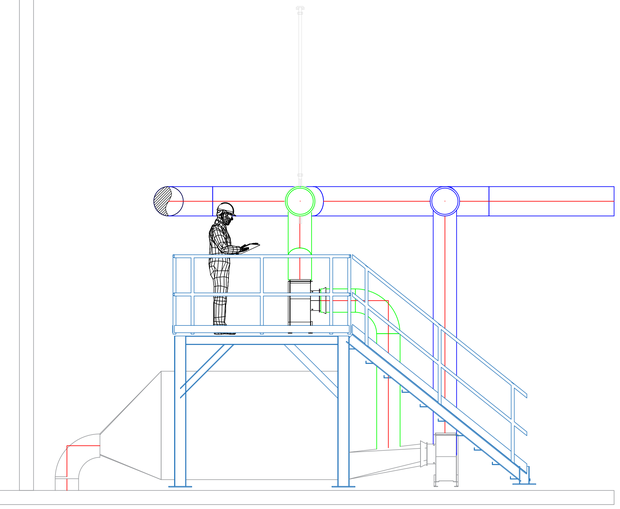


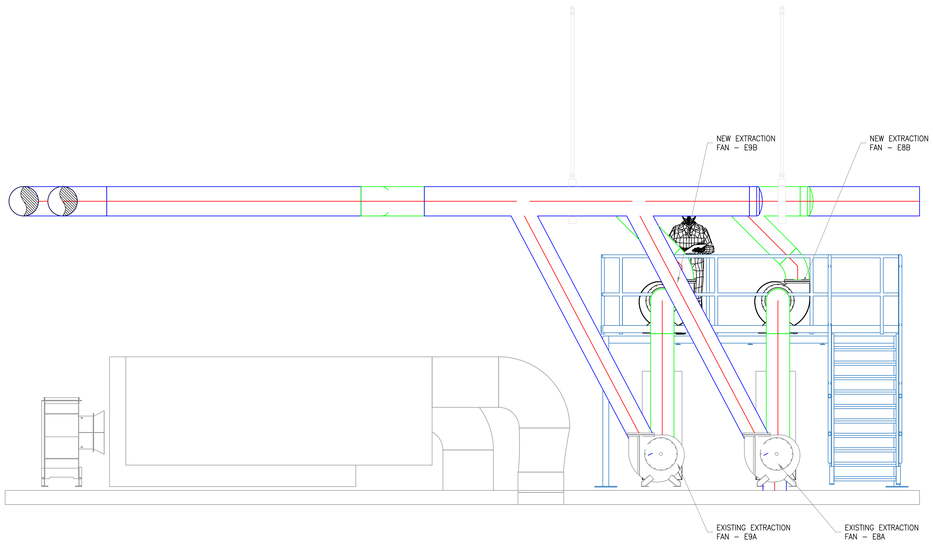
TOP VIEW
SCALE 1:30



ISOMETRIC VIEW
SCALE 1:30



SIDE VIEW
SCALE 1:30



FRONT VIEW
SCALE 1:30

KEYPLAN

NOTES

HOLDS

1. –

LEGEND

- EXISTING
- NEW DUCTING
- NEW EQUIPMENT
- NEW STEELWORKS

FOR TENDER
28.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	28.11.24	OvdH	SA	28.11.24	–

REVISIONS

DRG No	TITLE
	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC
E8 & E9 EXTRACTION
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	28.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56010	0	A1

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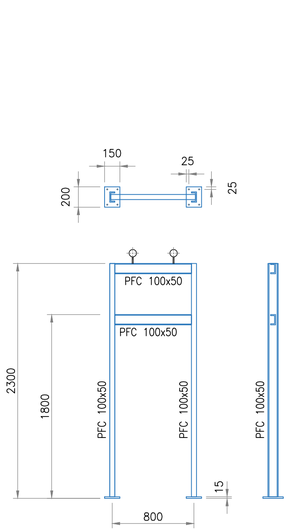

SUPPORT TYP 1
SCALE 1:30
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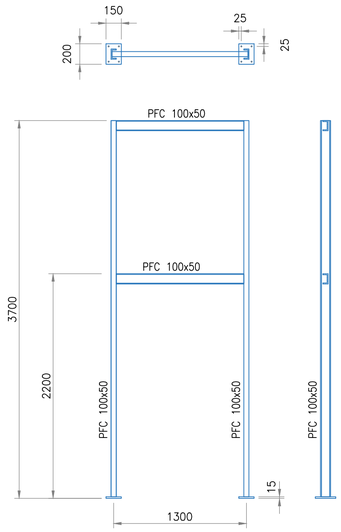

SUPPORT TYP 2
SCALE 1:30
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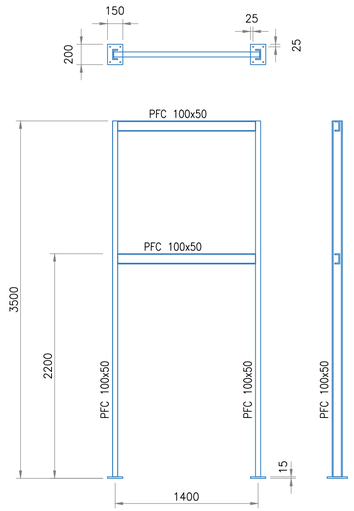

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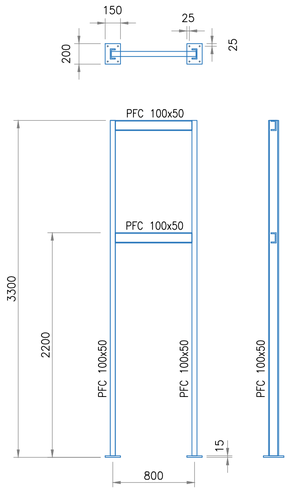

SUPPORT TYP 4
SCALE 1:30
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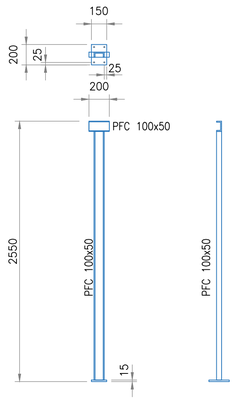

SUPPORT TYP 5
SCALE 1:30
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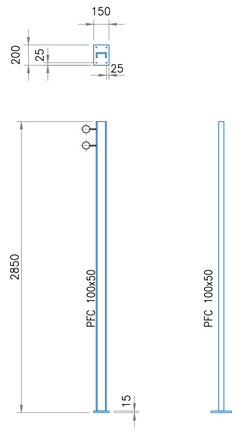

SUPPORT TYP 6
SCALE 1:30
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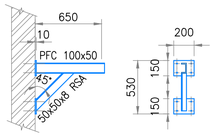

SUPPORT TYP 8
SCALE 1:30
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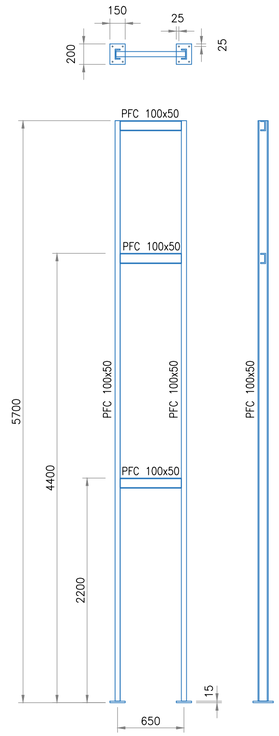
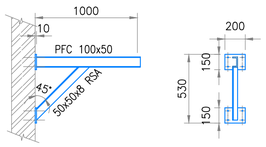


SUPPORT TYP 7
SCALE 1:30
8 OFF



SUPPORT TYP 9
SCALE 1:30
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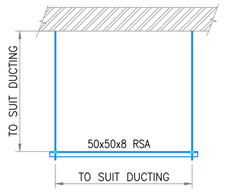

SUPPORT TYP 10
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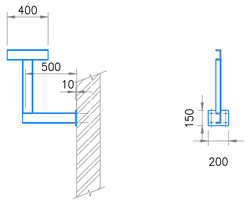

SUPPORT TYP 9
SCALE 1:30
5 OFF

KEYPLAN

NOTES

1. –

LEGEND

FOR TENDER
27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
HVAC SUPPORT DETAILS

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56009	0	A1

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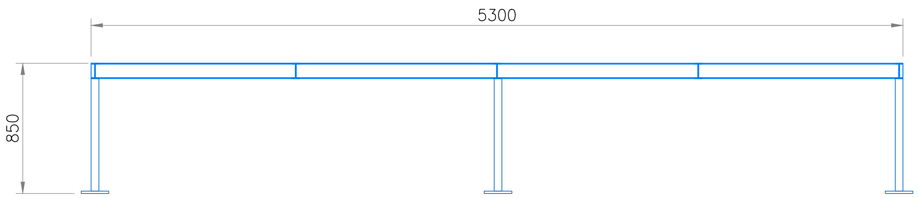
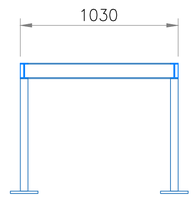
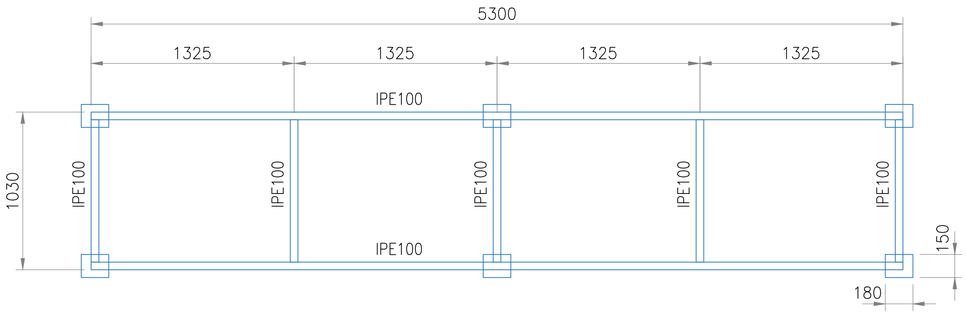


SIDE VIEW



FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED.

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
AHU8 HOTCELLS PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56008	0	A1

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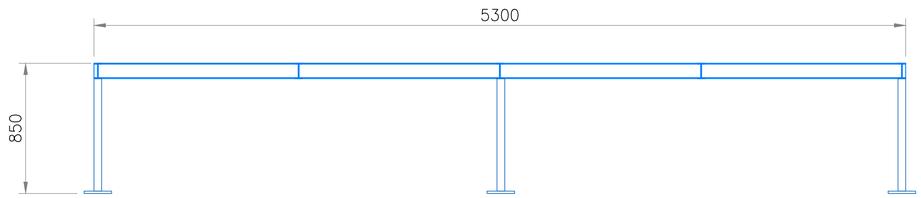
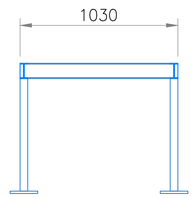


SIDE VIEW



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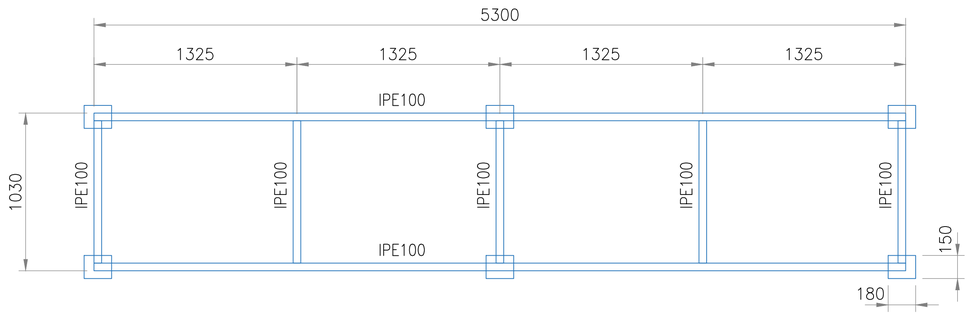

PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED.

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
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REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
AHU7 VAULTS PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56007	0	A1

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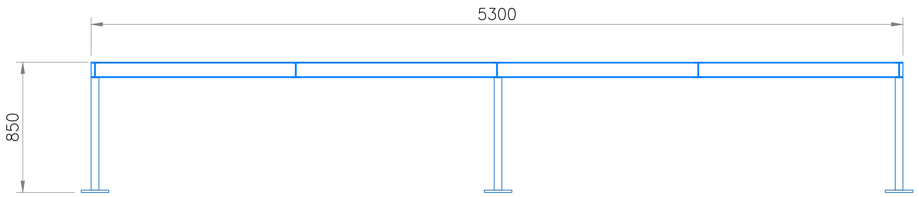
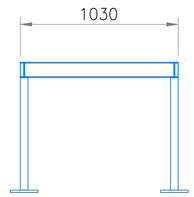
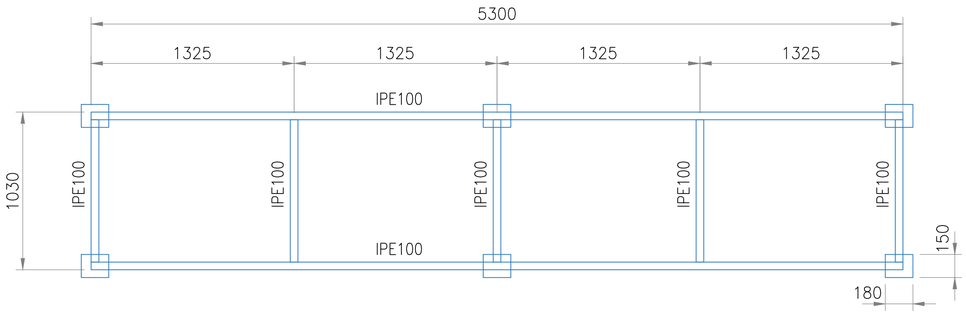


SIDE VIEW



FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
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REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA LABS
AHU6 CYCLOTRON PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56006	0	A1

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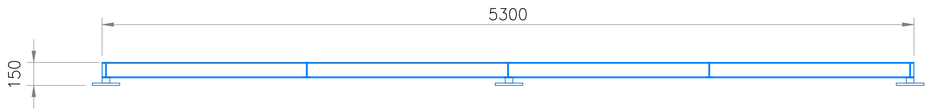
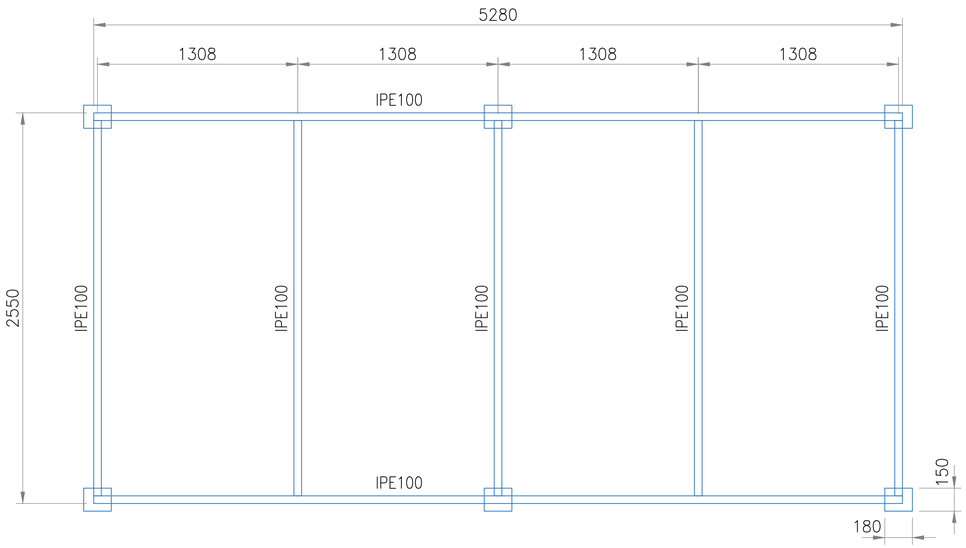


SIDE VIEW

FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED.

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
AHU5 BASEMENT PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56005	0	A1

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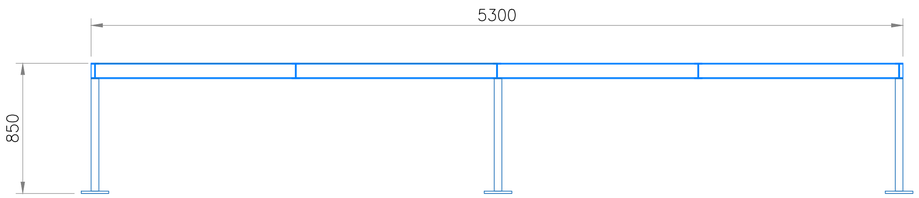
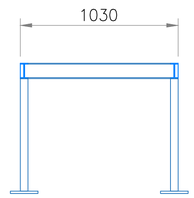
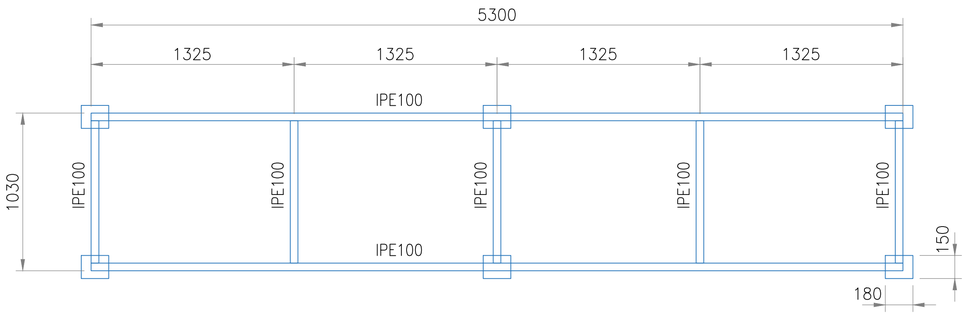


SIDE VIEW



FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED.

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA LABS
AHU4 RED AREA PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56004	0	A1

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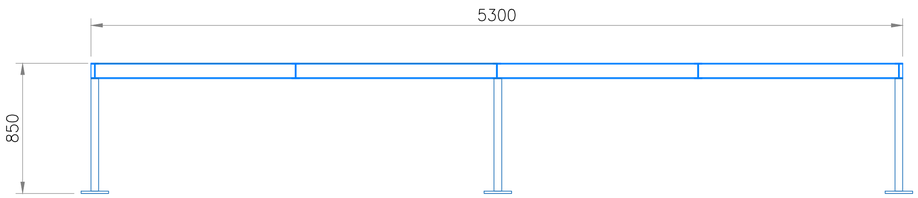
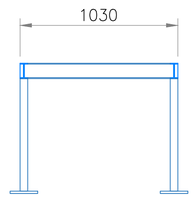
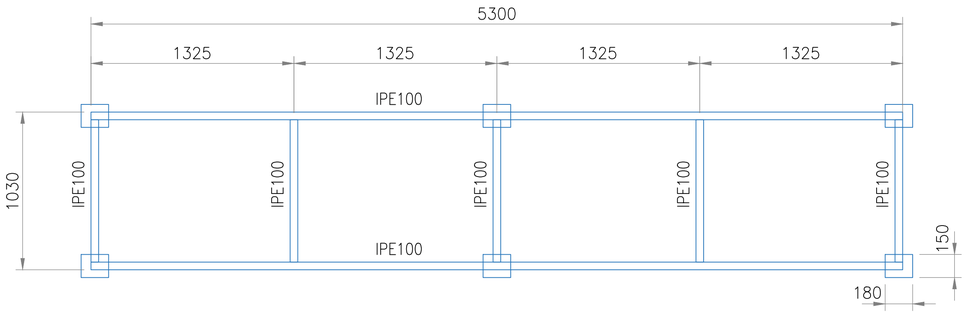


SIDE VIEW



FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED.

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

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DRG No	TITLE
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REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
AHU3 CLEANROOM 3 & 4 PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56003	0	A1

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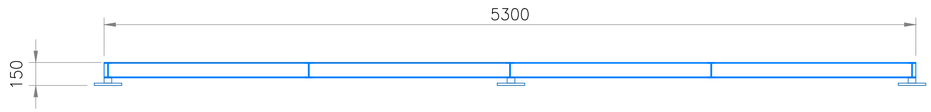
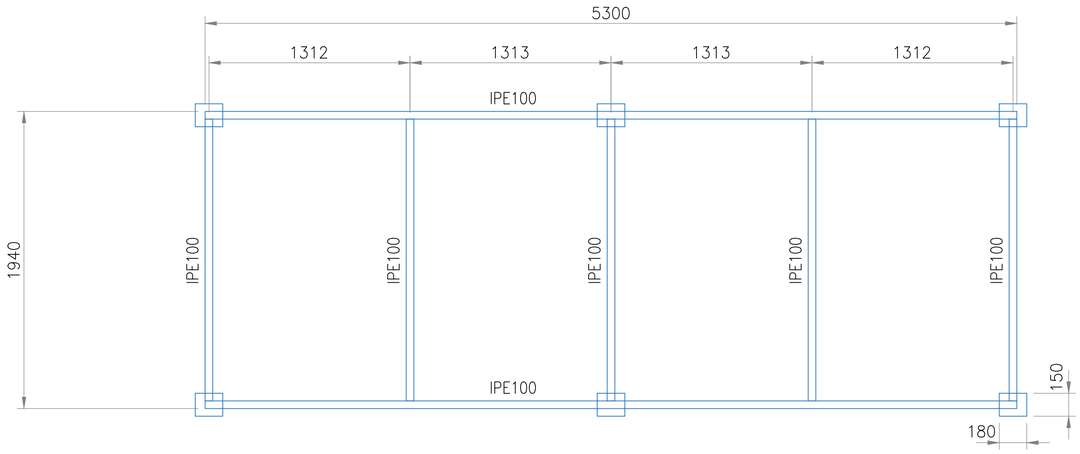


SIDE VIEW

FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED

LEGEND

FOR TENDER
27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

REVISIONS

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–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
AHU2 CLEANROOM 1, 2 &3
PLATFORM DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56002	0	A1

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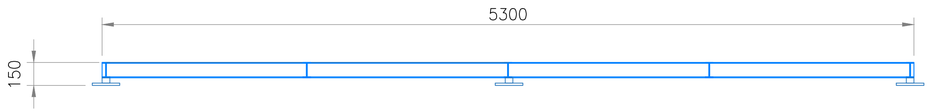
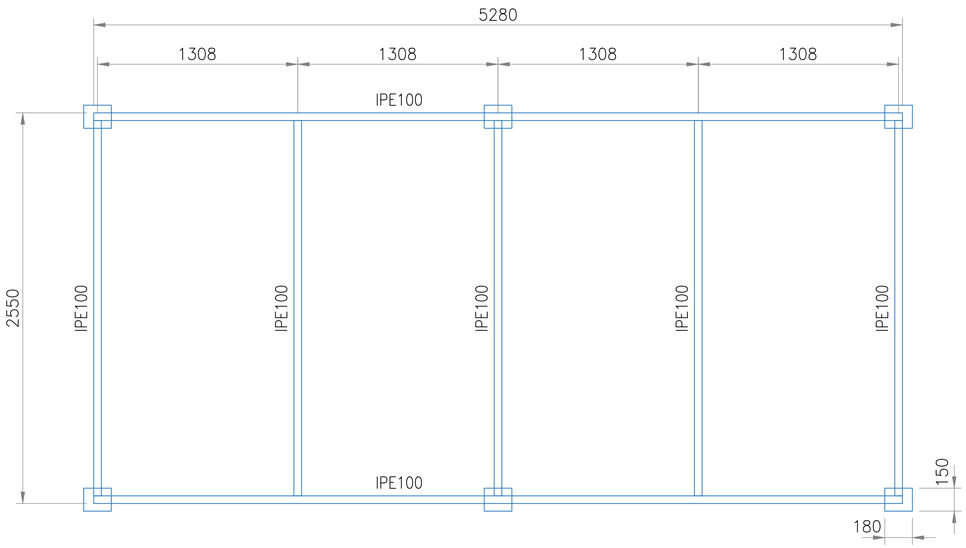


SIDE VIEW

FRONT VIEW



PLAN ON

KEYPLAN

NOTES

1. ALL STEELWORK TO BE GALVANISED MILD STEEL.
2. ALL EDGES TO BE ROUNDED.
3. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDED.
4. ALL BOLTED CONNECTIONS TO BE GR 8.8 HOT DIPPED GALVANISED.

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	26.11.24	GvdH	SA	27.11.24	–

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REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS
AHU1 – BLUE AREA PLATFORM
DETAIL

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:20	26.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–56001	0	A1

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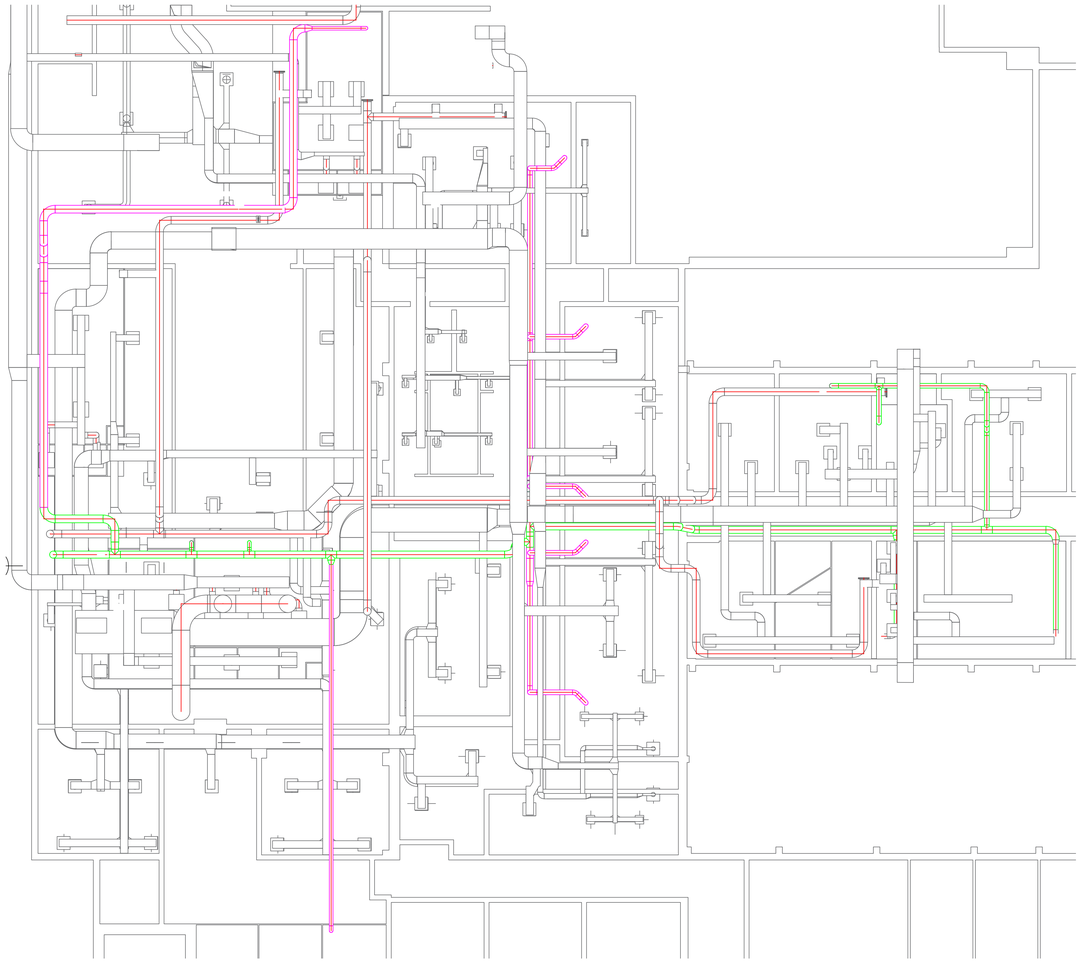
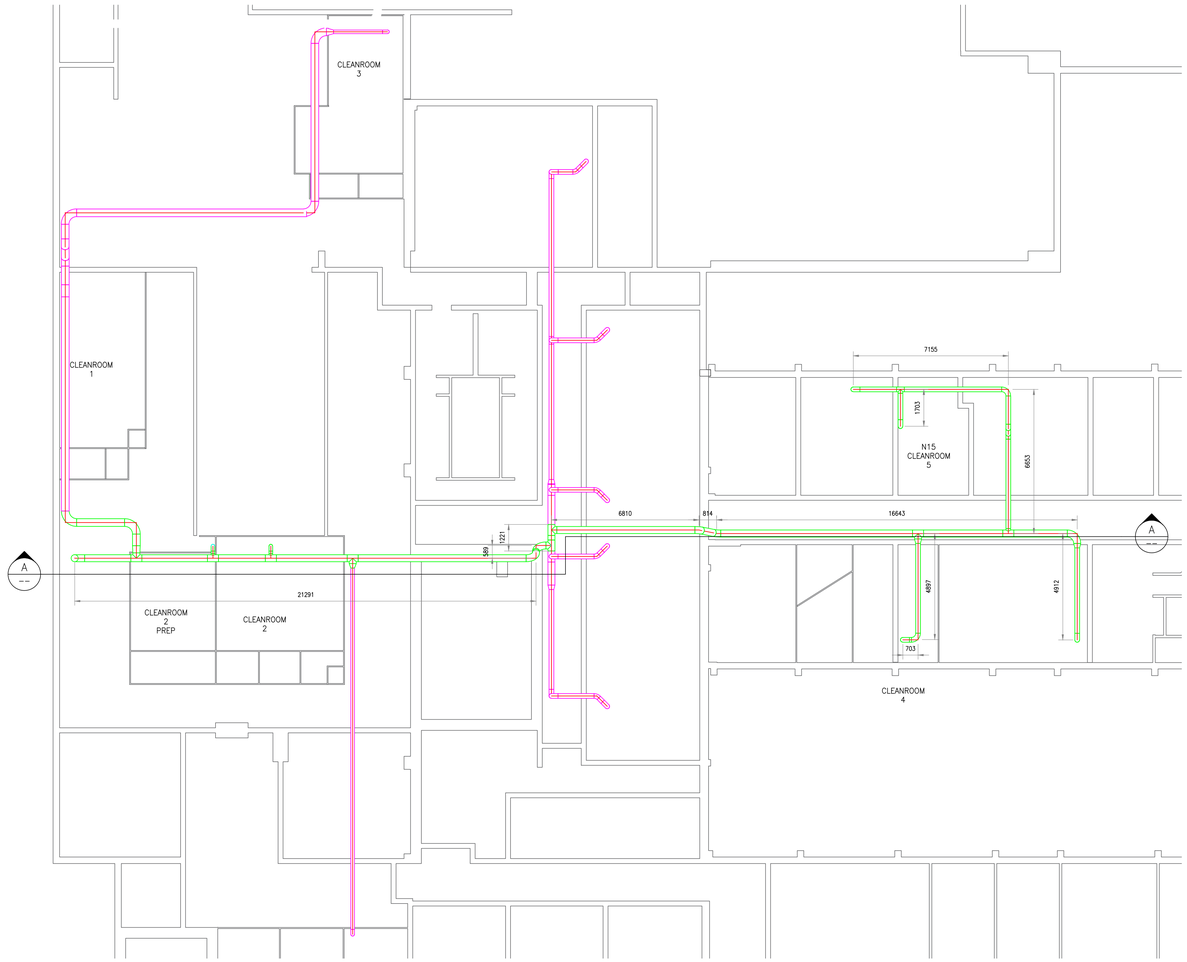
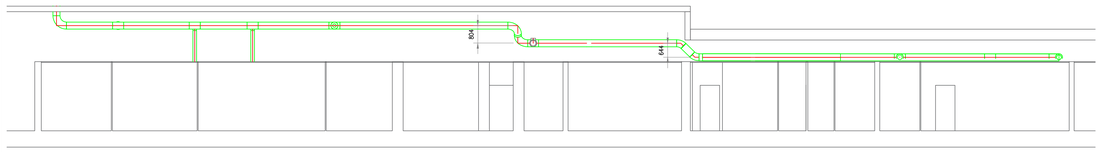


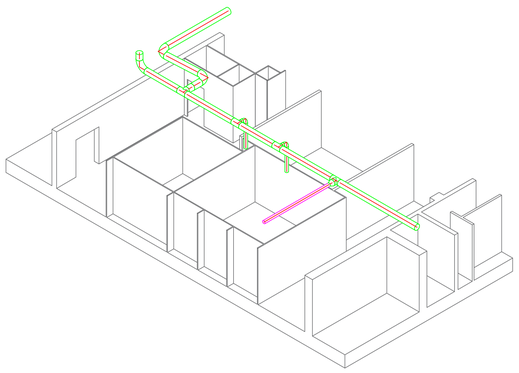
PLAN VIEW WITH EXISTING DUCTING
SCALE 1:100



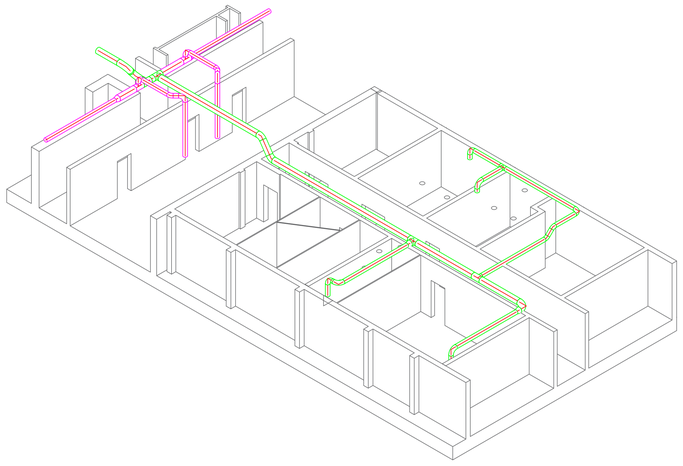
PLAN VIEW WITHOUT EXISTING DUCTING
SCALE 1:100



SECTION A
SCALE 1:100



ISOMETRIC VIEW
SCALE 1:100



ISOMETRIC VIEW
SCALE 1:100

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

EXTRACT – E9
EXISTING EXTRACT – E9

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: iTHEMBA E9 EXTRACTION LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:100	14.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–55016	0	A0

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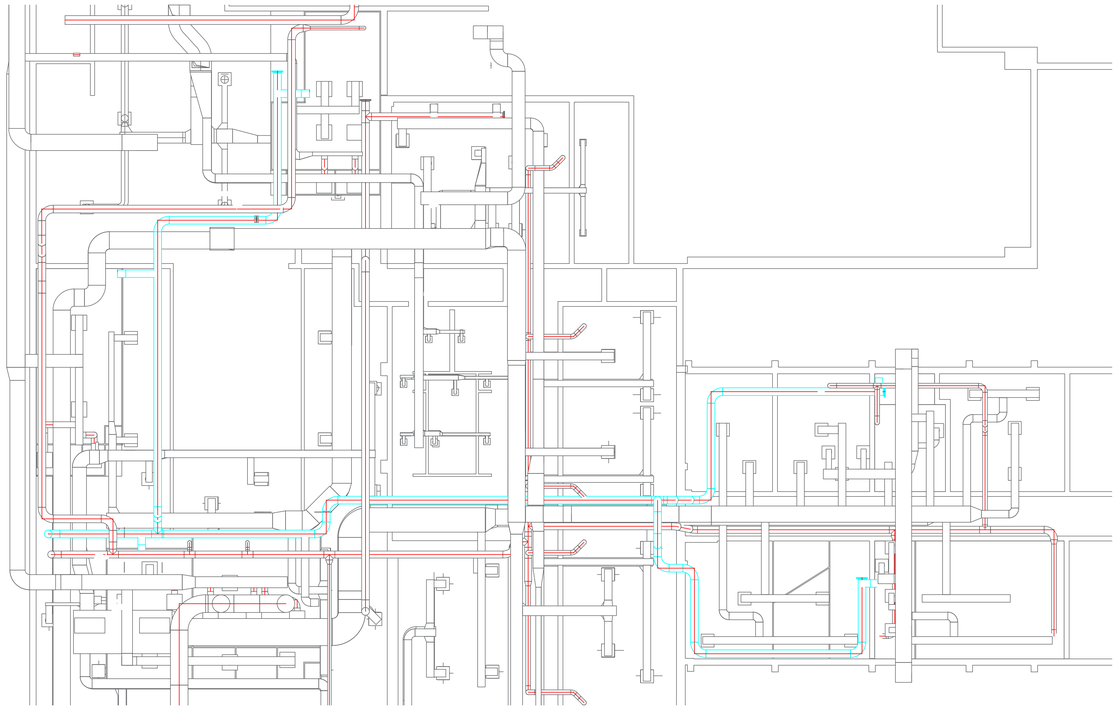
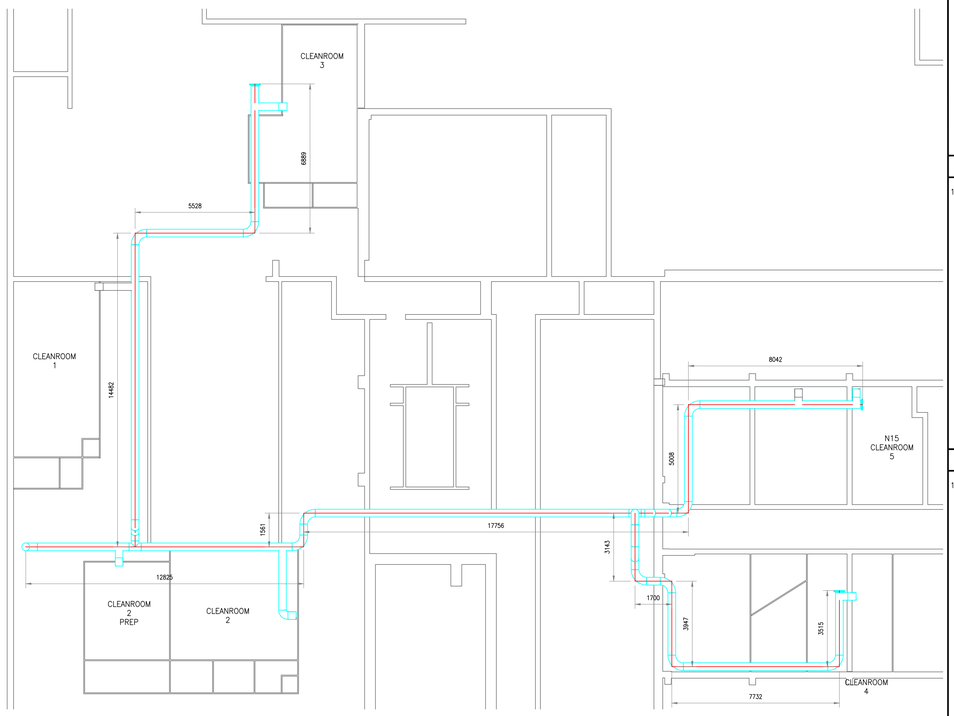


PLAN VIEW WITH EXISTING DUCTING
SCALE 1:100



PLAN VIEW WITHOUT EXISTING DUCTING
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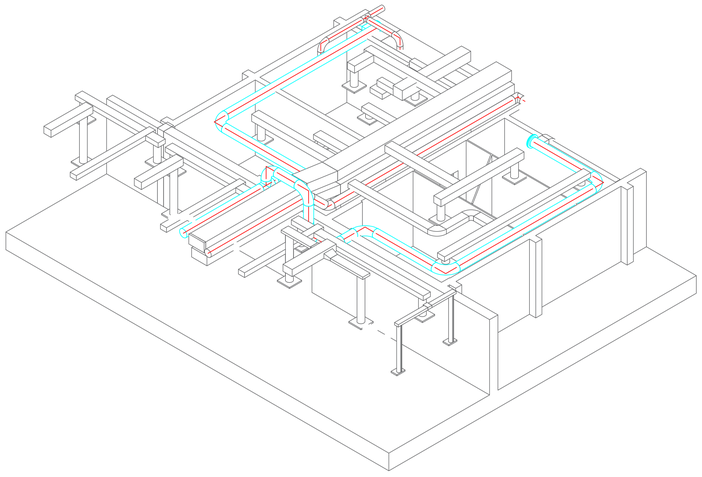
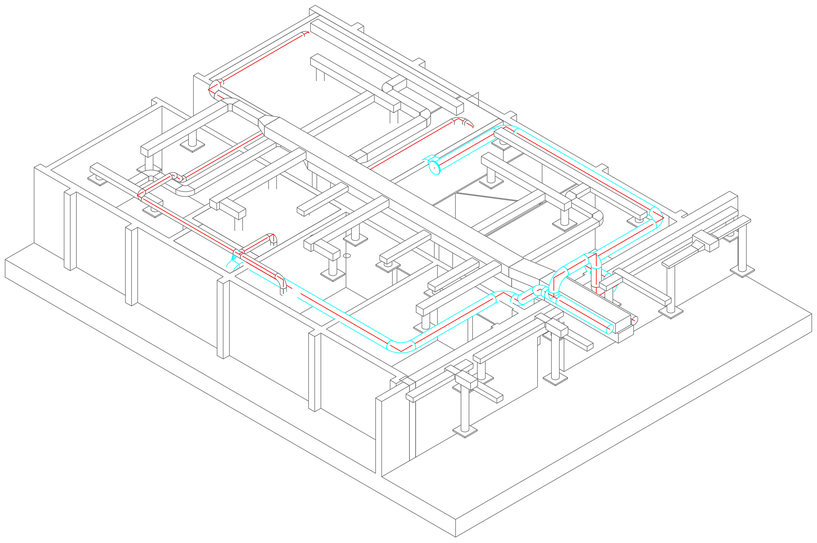
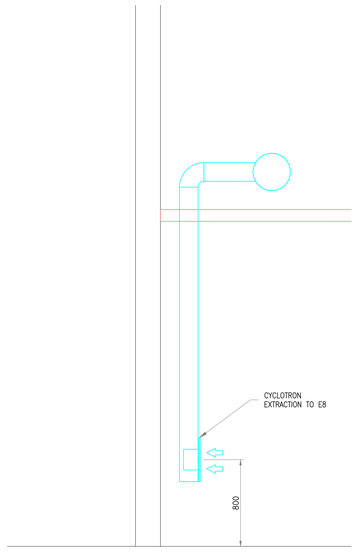


ISOMETRIC VIEW
SCALE 1:100



ISOMETRIC VIEW
SCALE 1:100



TYPICAL EXTRACTION
SCALE 1:100

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

EXTRACT – E8

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
0	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

iTHEMBA
E8 EXTRACTION
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:100	14.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–55015	0	A0

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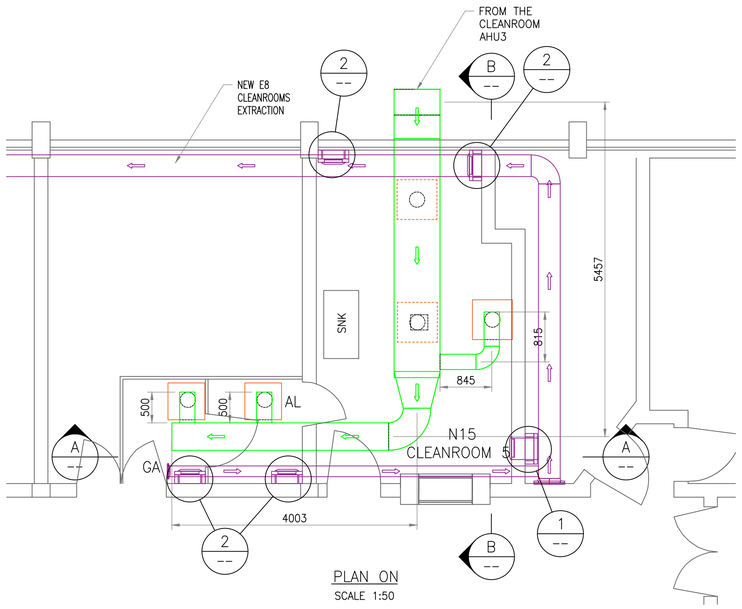
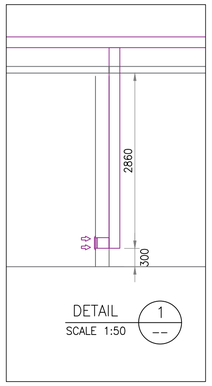
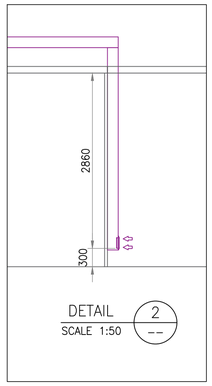


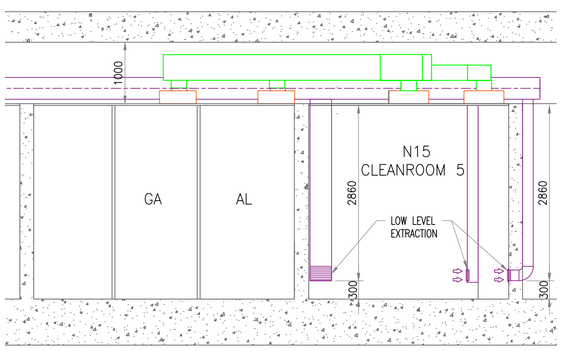
PLAN ON
SCALE 1:50



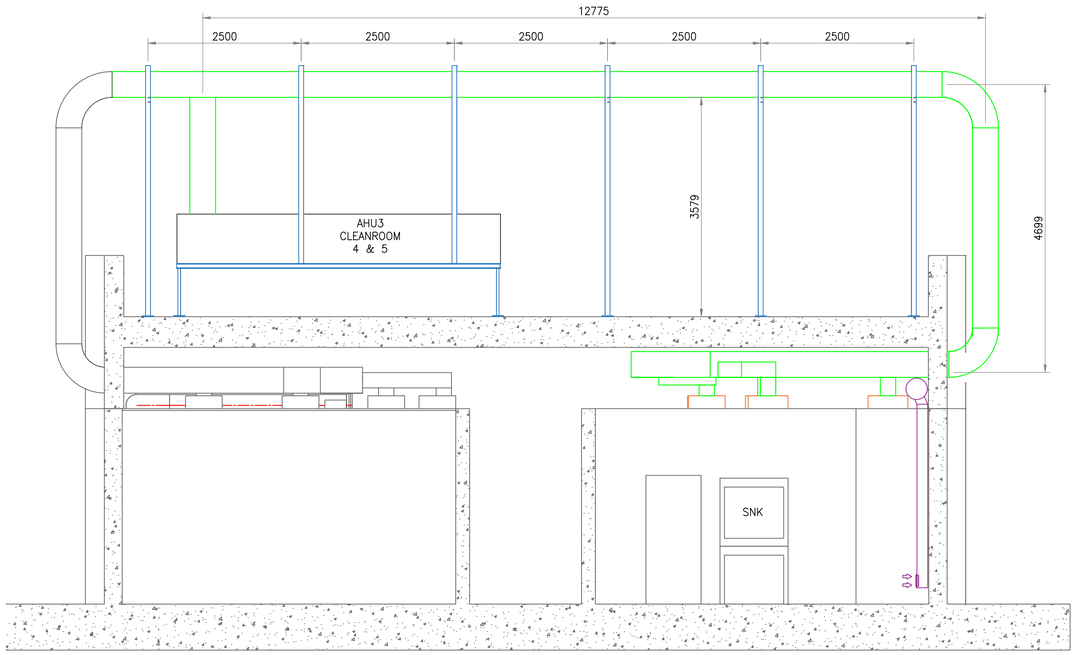
DETAIL 1
SCALE 1:50



DETAIL 2
SCALE 1:50



SECTION A
SCALE 1:50



SECTION B
SCALE 1:50

KEYPLAN

NOTES

1. –

FOR TENDER
22.11.2024

LEGEND

- AIR SUPPLY TO AHU
- EXTRACT FROM CLEANROOM 5 TO E8
- NEW CLEANROOM SUPPLY DUCTING
- EXISTING CLEANROOM EXTRACT DUCTING
- NEW CLEANROOM EXTRACT DUCTING

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
0	FIRST ISSUE	MNR	09.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC UPGRADE
N15 CLEANROOM 5 DUCTING
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	16.08.2024	MNR	GC

DRG. No.	REV.	SHEET SIZE
W1986–59007	1	A1

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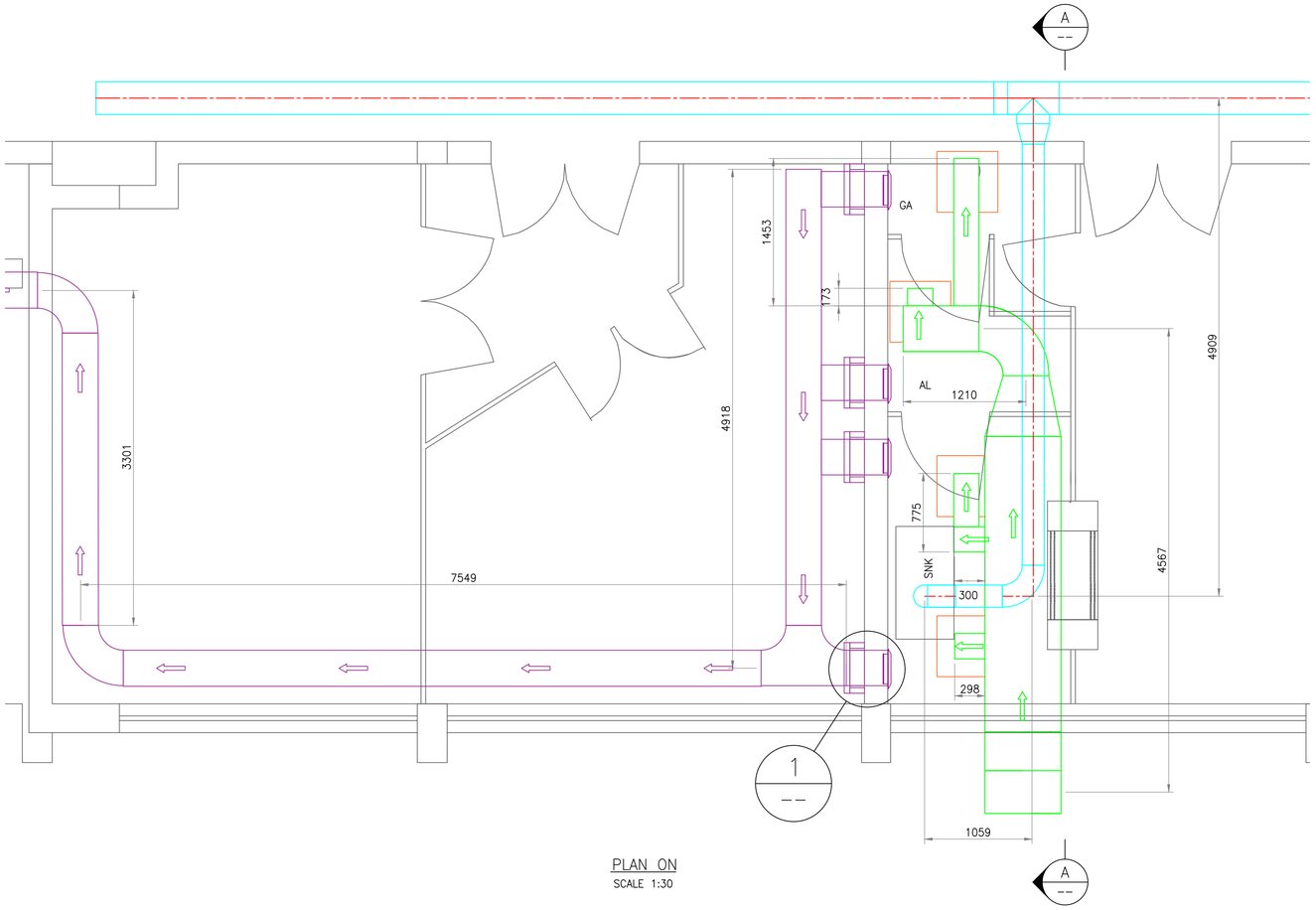
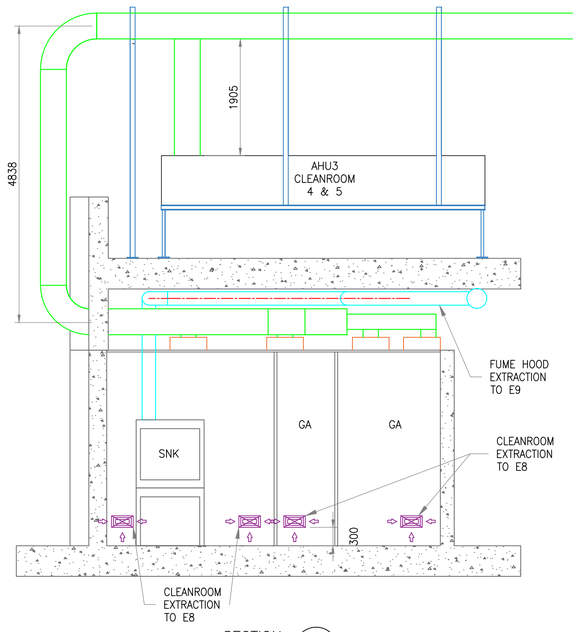
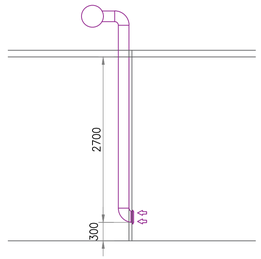


PLAN ON
SCALE 1:30



SECTION A -- SCALE 1:50



DETAIL 1 -- SCALE 1:50

KEYPLAN

NOTES

1. –

FOR TENDER
22.11.2024

LEGEND

- AIR SUPPLY TO AHU3
- EXTRACT FROM CLEANROOM 5 TO E8
- NEW CLEANROOM SUPPLY DUCTING
- EXISTING CLEANROOM EXTRACT DUCTING
- NEW CLEANROOM EXTRACT DUCTING

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
0	FIRST ISSUE	MNR	09.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC UPGRADE
N13 CLEANROOM 4 DUCTING
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:30	9.09.2024	MNR	GC

DRG. No.	REV.	SHEET SIZE
W1986–59006	1	A1

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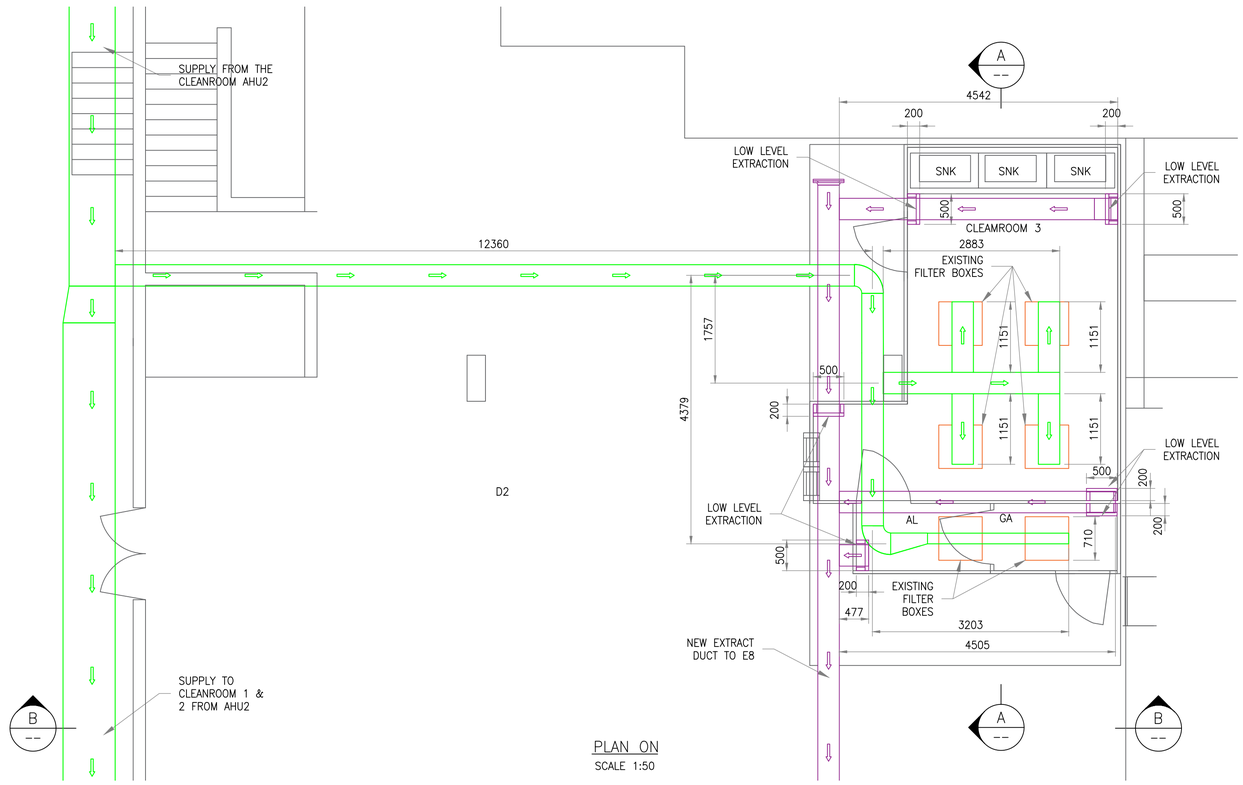
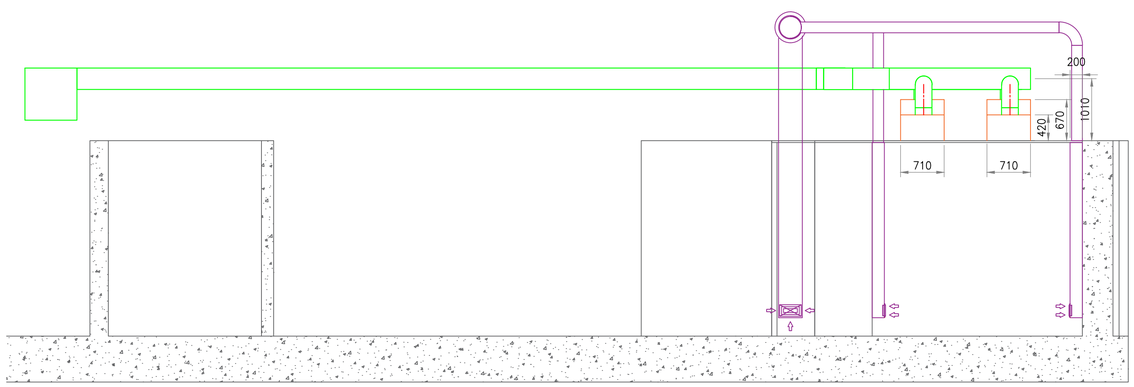


PLAN ON
SCALE 1:50



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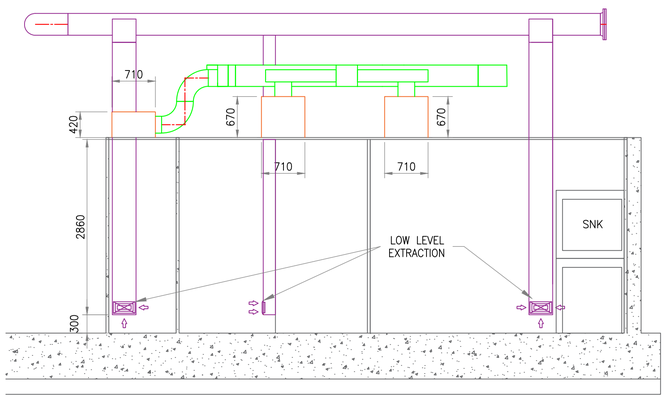

SECTION A
SCALE 1:50

KEYPLAN

NOTES

1. –

FOR TENDER
22.11.2024

LEGEND

- AIR SUPPLY TO AHU
- EXTRACT FROM CLEANROOM 3 TO EXTRACT E8
- NEW CLEANROOM SUPPLY DUCTING
- EXISTING CLEANROOM EXTRACT DUCTING
- NEW CLEANROOM EXTRACT DUCTING

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
0	FIRST ISSUE	MNR	09.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA LABS HVAC UPGRADE
CLEANROOM 3 DUCTING
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	09.9.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
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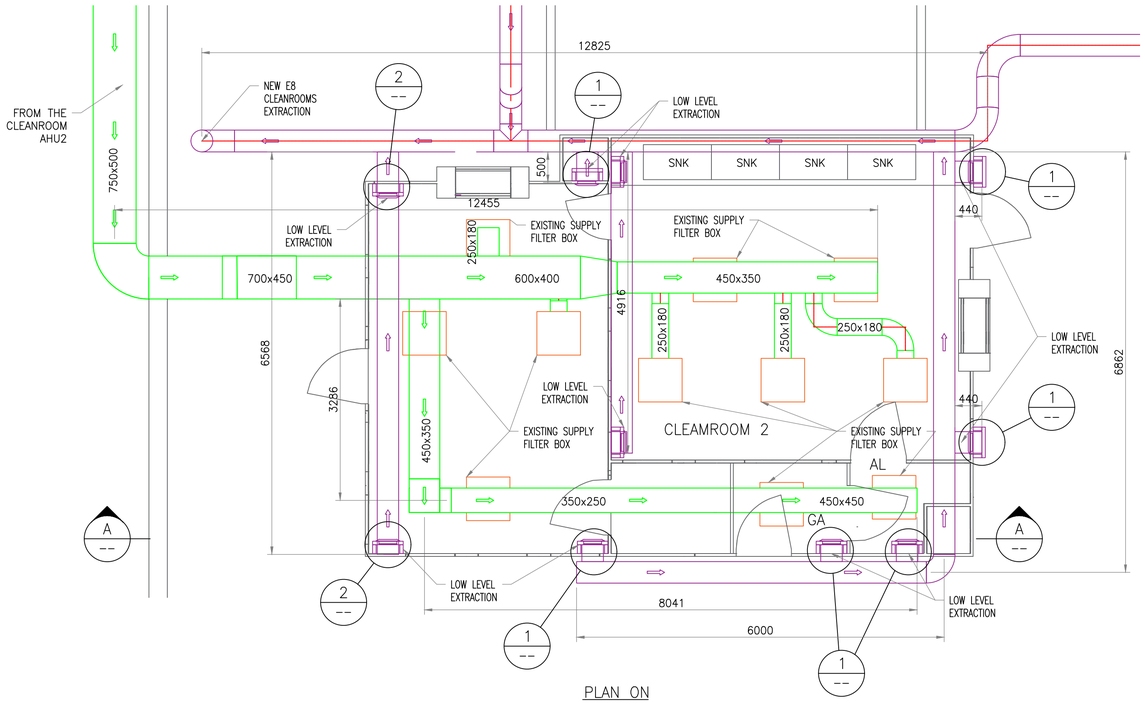

PLAN ON
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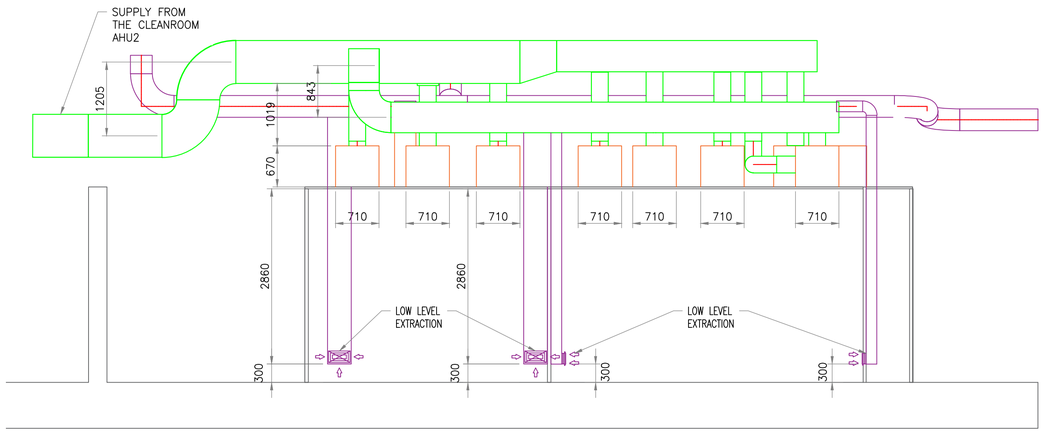

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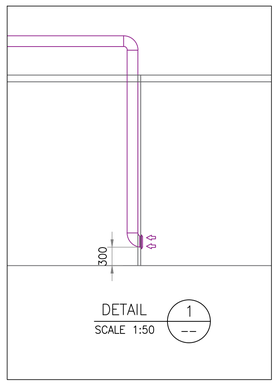
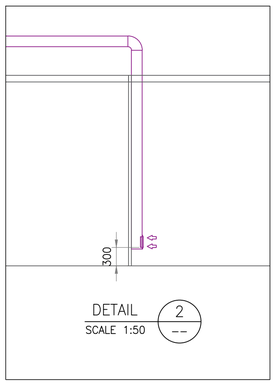


DETAIL 1
SCALE 1:50



DETAIL 2
SCALE 1:50

KEYPLAN

NOTES

1. -

FOR TENDER
22.11.2024

LEGEND

- AIR SUPPLY FROM AHU2
- EXTRACT FROM CLEANROOM 2
- NEW CLEANROOM SUPPLY DUCTING
- EXISTING CLEANROOM EXTRACT DUCTING
- NEW CLEANROOM EXTRACT DUCTING

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
0	FIRST ISSUE	MNR	09.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTDCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA LABS HVAC UPGRADE

CLIENT:

TITLE:

iTHEMBA LABS HVAC UPGRADE
CLEANROOM 2 DUCTING
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	16.08.2024	MNR	GC

DRG. No.	REV.	SHEET SIZE
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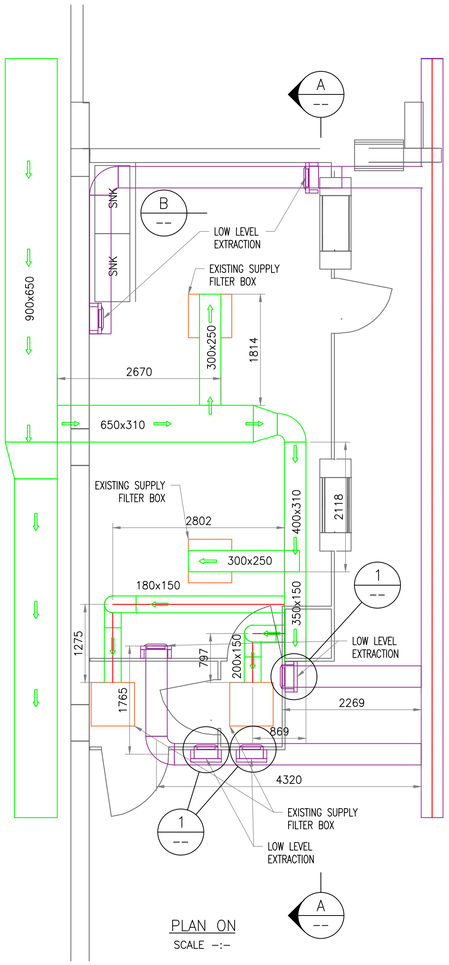
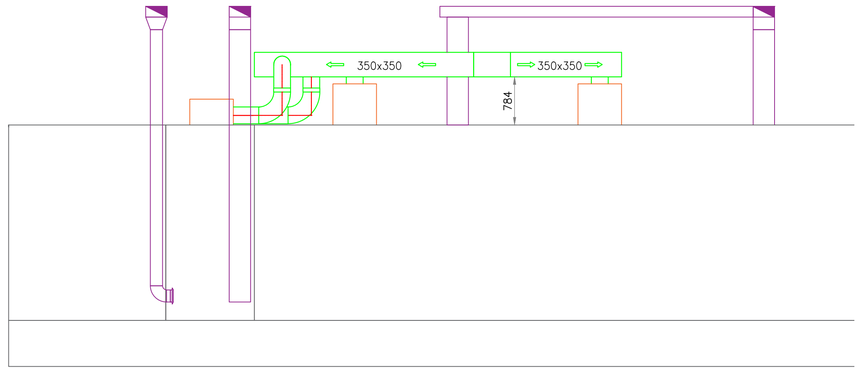
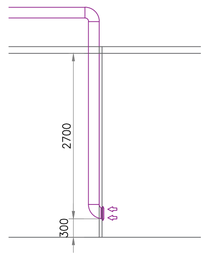


PLAN ON
SCALE –:–



SECTION A --
SCALE 1:50



DETAIL 1 --
SCALE 1:50

KEYPLAN

NOTES

1. –

FOR TENDER
22.11.2024

LEGEND

- AIR SUPPLY TO AHU
- NEW CLEANROOM SUPPLY DUCTING
- EXISTING CLEANROOM EXTRACT DUCTING
- NEW CLEANROOM EXTRACT DUCTING

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
0	FIRST ISSUE	MNR	09.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA LABS HVAC UPGRADE

CLIENT:

iThemba LABS
Laboratory for Accelerator Based Sciences
NRF National Research Foundation

TITLE:

iTHEMBA LABS HVAC UPGRADE
CLEANROOM 1 DUCTING
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	16.08.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
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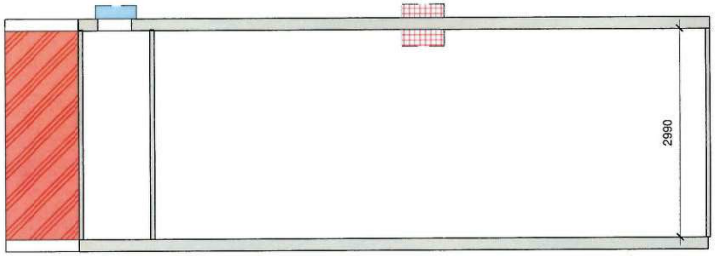
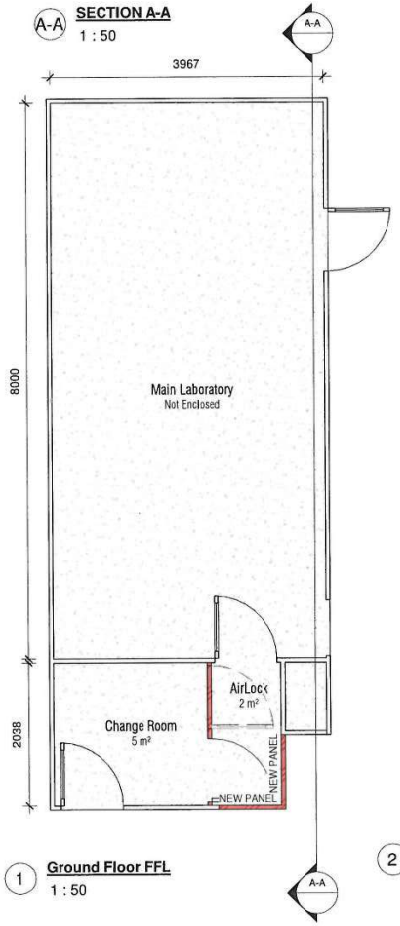
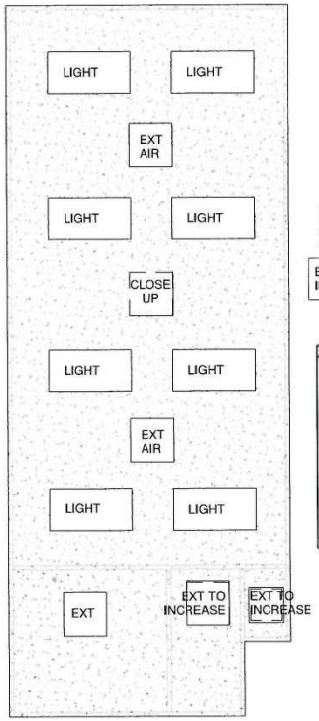


A-A **SECTION A-A**
1 : 50

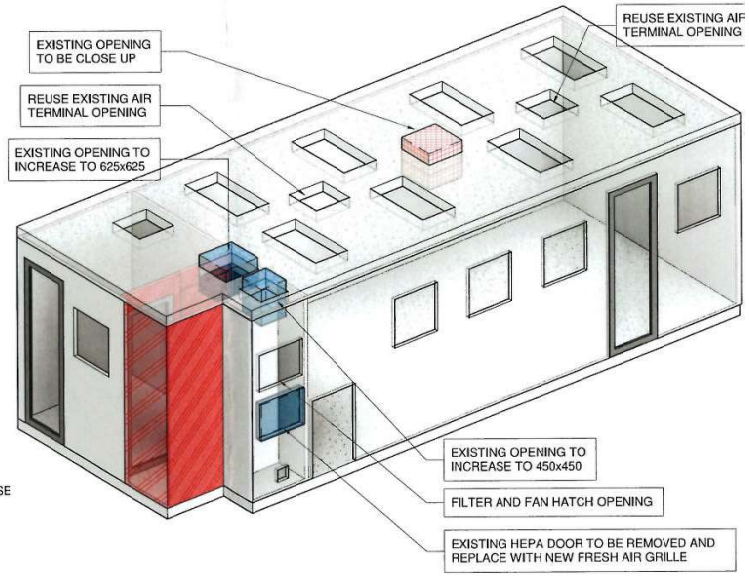


1 **Ground Floor FFL**
1 : 50



2 **Ceiling Layout**
1 : 50

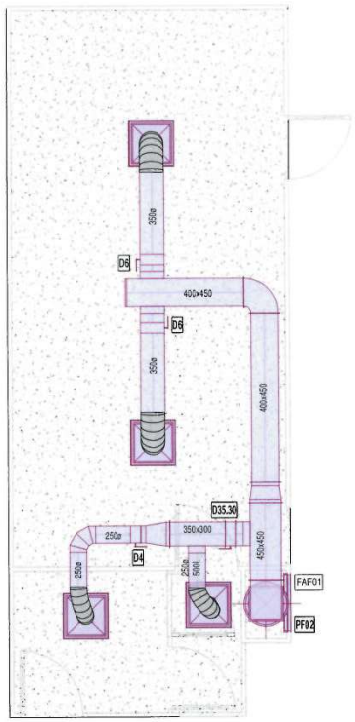
THIS IS ONLY A REPRESENTATION OF THE CLEANROOM.
FINAL OPENINGS TO MATCH EXISTING OPENINGS ONSITE.
FINAL PANEL DETAILS TO BE PROVIDED BY PANEL SUPPLIER



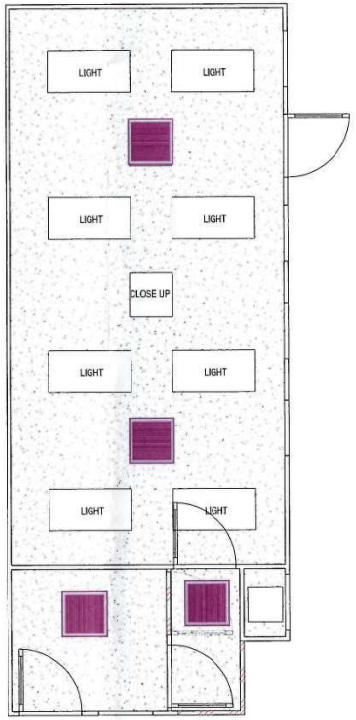
3 **3D VIEW - CLEANROOM 01**

ISSUED FOR INFORMATION

HVAC LEGEND	
	EXTRACTION AIR DUCT
	RETURN AIR DUCT
	SUPPLY AIR DUCT
	FRESH AIR DUCT



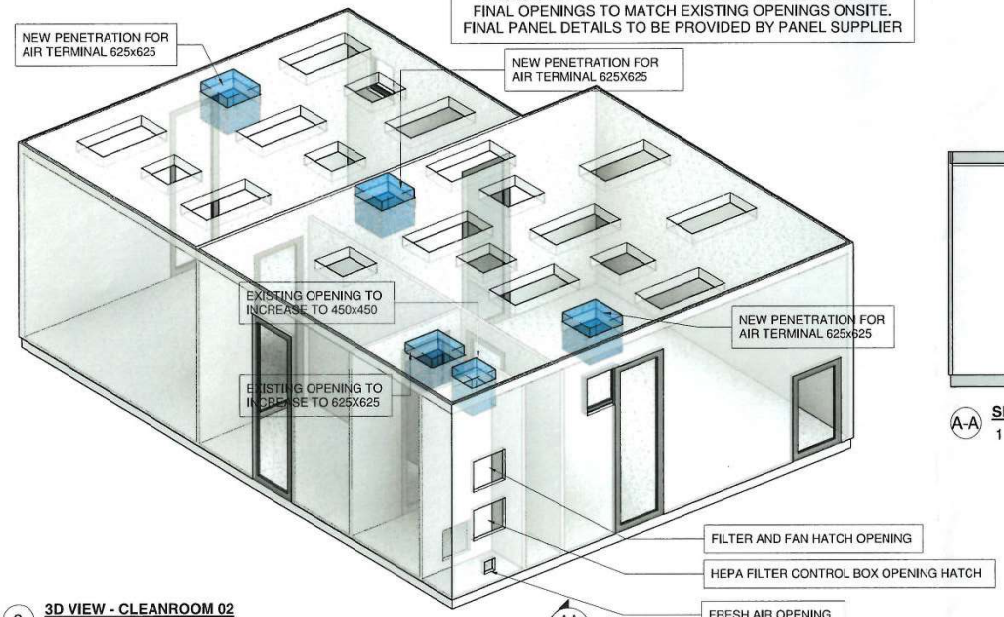
1 **HVAC - CLEANROOM 01 UPGRADE LAYOUT**
1 : 50



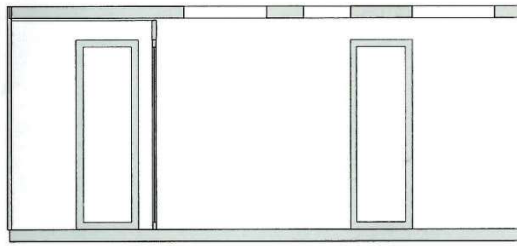
2 **CLEANROOM 01 - CEILING LAYOUT**
1 : 50

PRELIMINARY

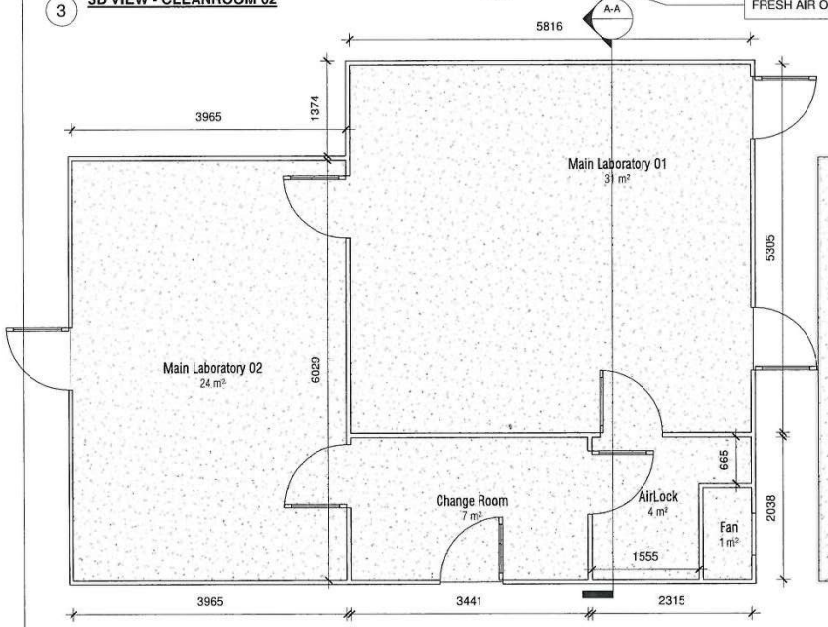
THIS IS ONLY A REPRESENTATION OF THE CLEANROOM.
FINAL OPENINGS TO MATCH EXISTING OPENINGS ONSITE.
FINAL PANEL DETAILS TO BE PROVIDED BY PANEL SUPPLIER



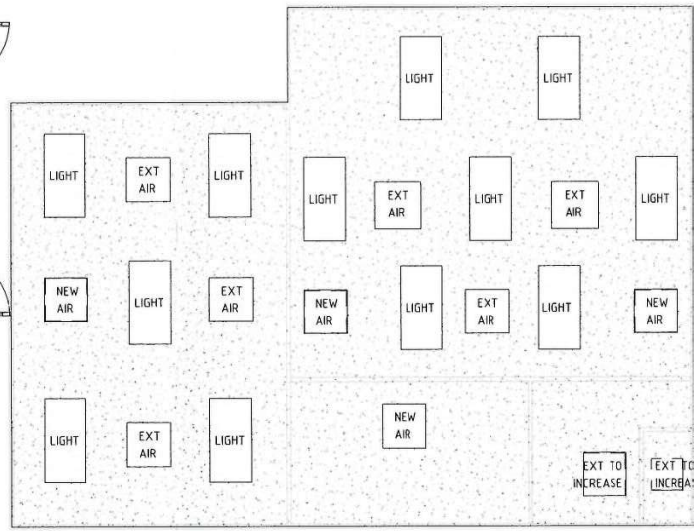
3 **3D VIEW - CLEANROOM 02**



A-A **SECTION A-A**
1 : 50



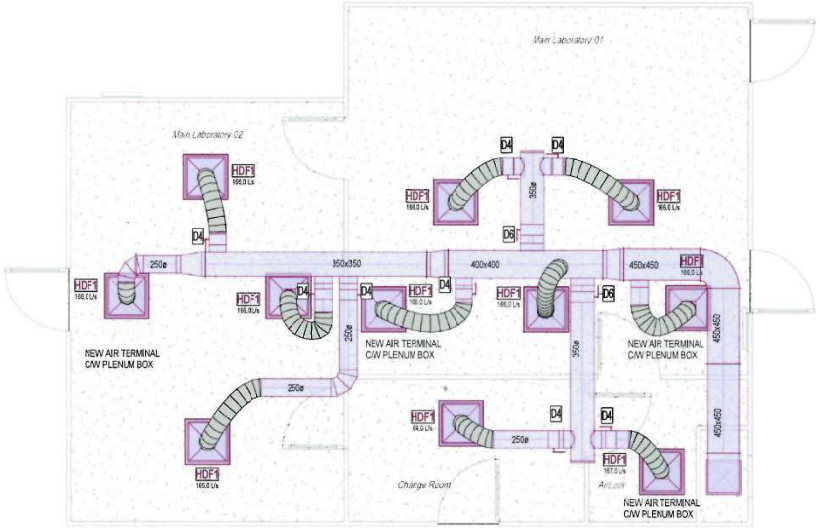
1 **Ground Floor FFL**
1 : 50



2 **Ceiling Layouts**
1 : 50

ISSUED FOR INFORMATION

2 **CLEANROOM 02 - CEILING LAYOUT**
1 : 50



1 **HVAC - CLEANROOM 02 UPGRADE LAYOUT**
1 : 50

HVAC LEGEND	
	EXTRACTION AIR DUCT
	RETURN AIR DUCT
	SUPPLY AIR DUCT
	FRESH AIR DUCT

CLEAN 02 - AIR TERMINAL SCHEDULE

REFERENCE	TYPE	SPIGOT	QTY
HDF1	NEW AIR-TERMINAL TO MATCH EXISTING C/W PLENUM BOX	250	05

CLEAN 02 - HEPA FILTER SCHEDULE

REFERENCE	MODEL	TYPE	PHYSICAL SIZE	QTY
HDF1	HTH-H' 4-AL-610x6 0-FC1/10M	GRILLE C/W HEPA FILTER AND PLENUM BOX	610x610	11

CLEAN 02 - DUCT ACCESSORIES SCHEDULE

REFERENCE	TYPE	SIZE	QTY
D4	DAMPER ROUND	Ø250	9
D6	DAMPER ROUND	Ø350	2

CLEAN 02 - DUCT FITTINGS SCHEDULE

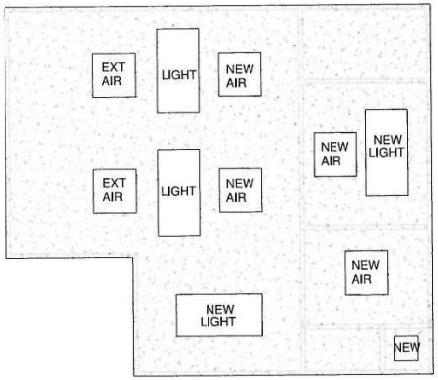
TYPE	SIZE	ANGLE	QTY
END CAP RETANGULAR	300x300		1
SPIGOT ROUND	250ø-250ø		10
SPIGOT ROUND	350ø-350ø		2
BEND ROUND	250ø-250ø	90.00°	2
BEND RETANGULAR	450x450-450x450	90.00°	2
TRANSFORMATION RETANGULAR TO ROUND	350x350-250ø		1
TRANSFORMATION RETANGULAR TO RETANGULAR	400x400-350x350		1
TRANSFORMATION RETANGULAR TO RETANGULAR	450x450-400x400		1
END CAP ROUND	350ø		2

CLEAN 02 - DUCT SCHEDULE

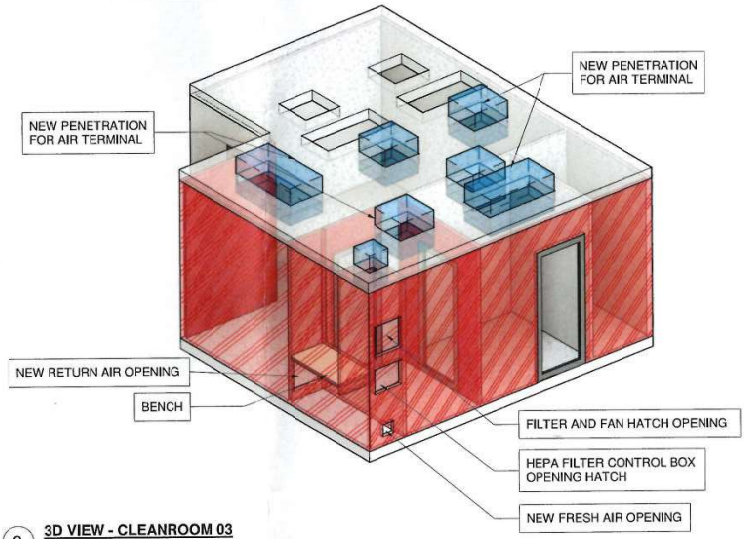
TYPE	SIZE	Area	LENGHT
RETANGULAR FLANGED DUCTING	350x350	4.49 m²	3.21 m
RETANGULAR FLANGED DUCTING	400x400	3.60 m²	2.25 m
RETANGULAR FLANGED DUCTING	450x450	8.55 m²	4.75 m
ROUND SPIRAL DUCTING	250ø	3.49 m²	4.44 m
ROUND SPIRAL DUCTING	350ø	3.87 m²	3.52 m

ISSUED FOR CONSTRUCTION

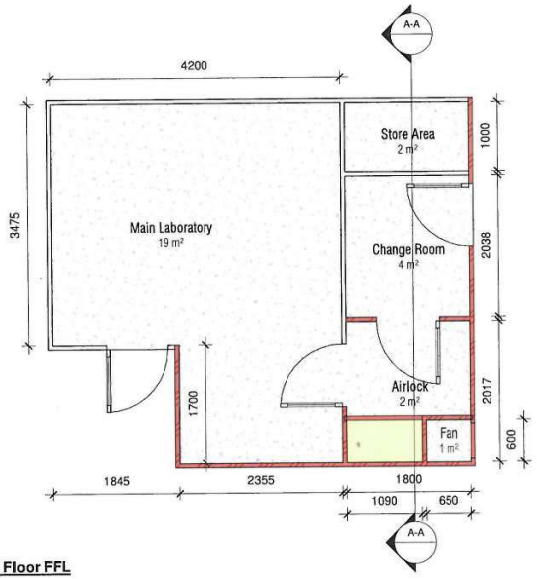
THIS IS ONLY A REPRESENTATION OF THE CLEANROOM.
FINAL OPENINGS TO MATCH EXISTING OPENINGS ONSITE.
FINAL PANEL DETAILS TO BE PROVIDED BY PANEL SUPPLIER



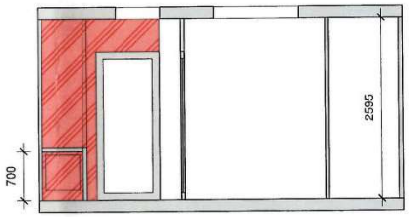
2 **CEILING LAYOUT**
1 : 50



3 **3D VIEW - CLEANROOM 03**



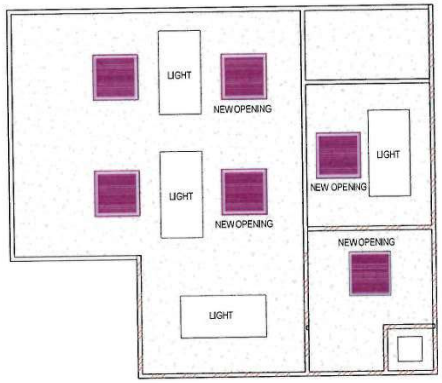
1 **Ground Floor FFL**
1 : 50



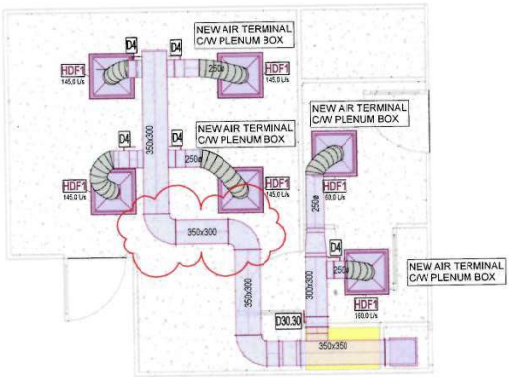
A-A **SECTION A-A**
1 : 50

ISSUED FOR INFORMATION

HVAC LEGEND	
	EXTRACTION AIR DUCT
	RETURN AIR DUCT
	SUPPLY AIR DUCT
	FRESH AIR DUCT



2 **CLEANROOM 03 - CEILING LAYOUT**
1 : 50



1 **HVAC - CLEANROOM 03 UPGRADE LAYOUT**
1 : 50

CLEAN 03 - FAN SCHEDULE

REF	MANUFACTURE	FAN TYPE	AIRFLOW	PA	QTY
FAF01	AMS OR OTHER APPROVED.	AP OR CENTRIFUGAL FAN	800	600	1

CLEAN 03 - AIR TERMINAL SCHEDULE

REFERENCE	TYPE	SPIGOT	QTY
HDF1	NEW AIR-TERMINAL TO MATCH EXISTING C/W PLENUM BOX	250	06

CLEAN 03 - HEPA FILTER SCHEDULE

REFERENCE	MODEL	TYPE	PHYSICAL SIZE	QTY
HDF1	HT-HH14-AL-610x610-FC1/10M	GRILLE C/W HEPA FILTER AND PLENUM BOX	610x610	6

CLEAN N13 - DUCT ACCESSORIES SCHEDULE

REFERENCE	TYPE	SIZE	QTY
D4	DAMPER ROUND	Ø250	3

CLEAN N13 - DUCT FITTINGS SCHEDULE

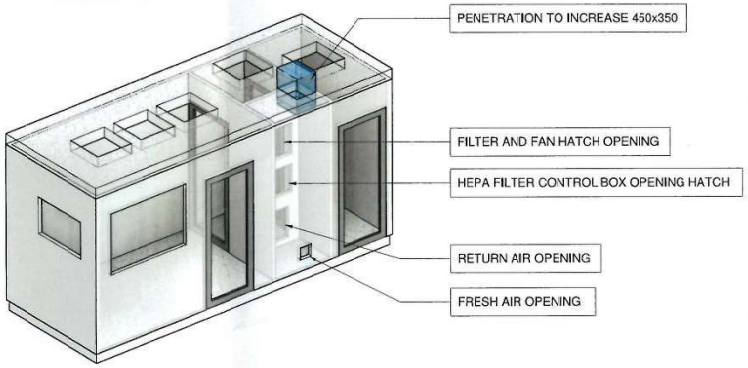
TYPE	SIZE	ANGLE	QTY
END CAP RETANGULAR	300x250		1
SPIGOT ROUND	250ø-250ø		4
SPIGOT ROUND	350ø-350ø		1
BEND RETANGULAR	350x450-350x450	90.00°	1
TRANSFORMATION RETANGULAR TO RETANGULAR	450x250-300x250		1
TRANSFORMATION RETANGULAR TO RETANGULAR	450x350-450x250		1
END CAP ROUND	350ø		1

CLEAN N13 - DUCT SCHEDULE

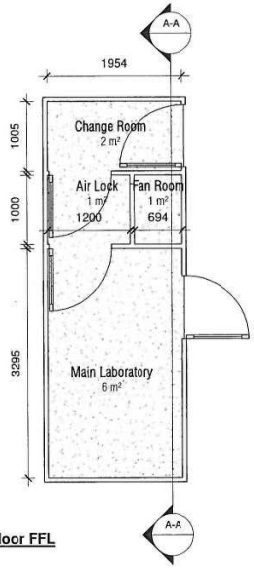
TYPE	SIZE	Area	LENGHT
RETANGULAR FLANGED DUCTING	300x250	0.94 m²	0.85 m
RETANGULAR FLANGED DUCTING	450x250	1.13 m²	0.85 m
RETANGULAR FLANGED DUCTING	450x350	1.60 m²	1.00 m
ROUND SPIRAL DUCTING	250ø	0.92 m²	1.18 m
ROUND SPIRAL DUCTING	350ø	1.04 m²	0.95 m

ISSUED FOR CONSTRUCTION

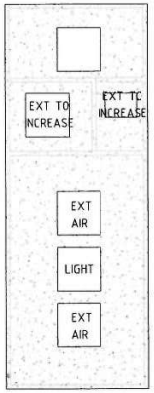
THIS IS ONLY A REPRESENTATION OF THE CLEANROOM.
FINAL OPENINGS TO MATCH EXISTING OPENINGS ONSITE.
FINAL PANEL DETAILS TO BE PROVIDED BY PANEL SUPPLIER



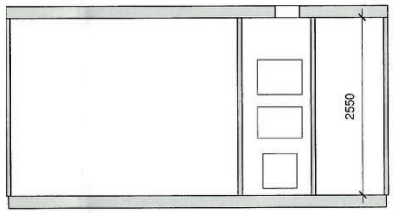
3 **3D VIEW - CLEANROOM N13**



1 **Ground Floor FFL**
1 : 50



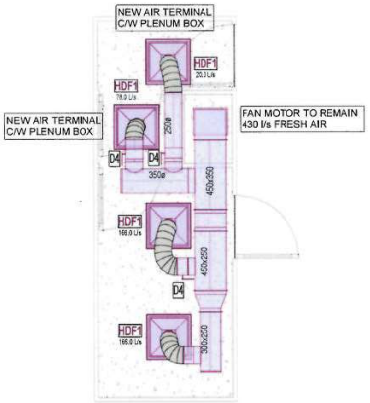
2 **Ceiling Layout**
1 : 50



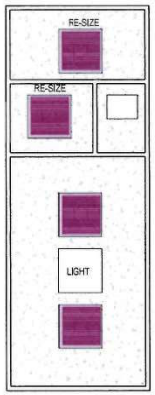
A-A **SECTION A-A**
1 : 50

ISSUED FOR INFORMATION

HVAC LEGEND	
	EXTRACTION AIR DUCT
	RETURN AIR DUCT
	SUPPLY AIR DUCT
	FRESH AIR DUCT



1 **HVAC - CLEANROOM N13 UPGRADE LAYOUT**
1 : 50



2 **CLEANROOM N13 - CEILING LAYOUT**
1 : 50

CLEAN N13 - AIR TERMINAL SCHEDULE

REFERENCE	TYPE	SPIGOT	QTY
HDF1	NEW AIR-TERMINAL TO MATCH EXISTING C/W PLENUM BOX	250	02

CLEAN N13 - HEPA FILTER SCHEDULE

REFERENCE	MODEL	TYPE	PHYSICAL SIZE	QTY
HDF1	HTH-H14-AL-610x610-FC1/19M	GRILLE C/W HEPA FILTER AND PLENUM BOX	610x610	4

CLEAN N13 - DUCT ACCESSORIES SCHEDULE

REFERENCE	TYPE	SIZE	QTY
D4	DAMPER ROUND	Ø250	3

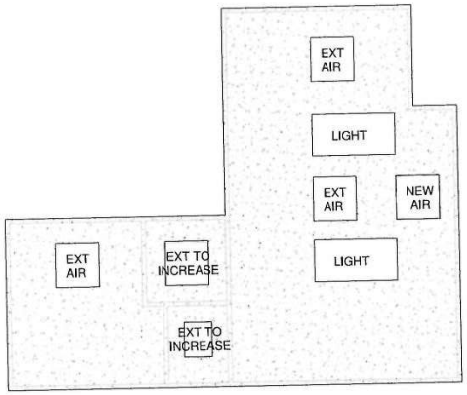
CLEAN N13 - DUCT FITTINGS SCHEDULE

TYPE	SIZE	ANGLE	QTY
END CAP RETANGULAR	300x250		1
SPIGOT ROUND	250ø-250ø		4
SPIGOT ROUND	350ø-350ø		1
BEND RETANGULAR	350x450-350x450	90.00°	1
TRANSFORMATION RETANGULAR TO RETANGULAR	450x250-300x250		1
TRANSFORMATION RETANGULAR TO RETANGULAR	450x350-450x250		1
END CAP ROUND	350ø		1

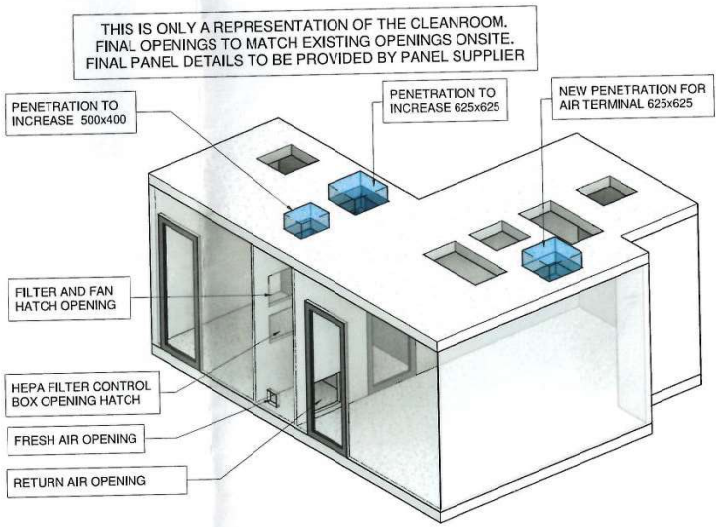
CLEAN N13 - DUCT SCHEDULE

TYPE	SIZE	Area	LENGHT
RETANGULAR FLAVGED DUCTING	300x250	0.94 m²	0.65 m
RETANGULAR FLAVGED DUCTING	450x250	1.19 m²	0.85 m
RETANGULAR FLAVGED DUCTING	450x350	1.60 m²	1.00 m
ROUND SPIRAL DUCTING	250ø	0.92 m²	1.18 m
ROUND SPIRAL DUCTING	350ø	1.04 m²	0.95 m

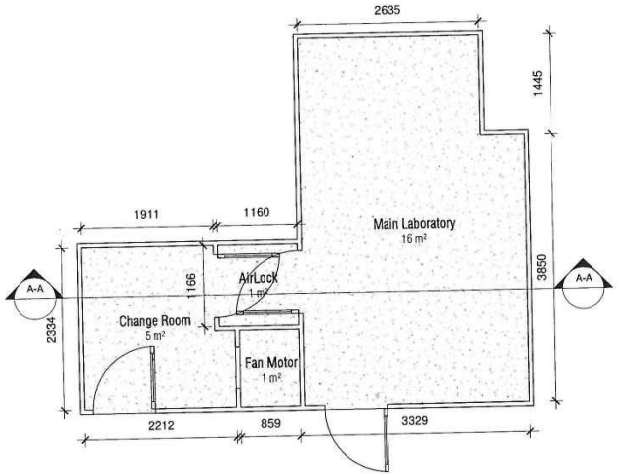
ISSUED FOR CONSTRUCTION



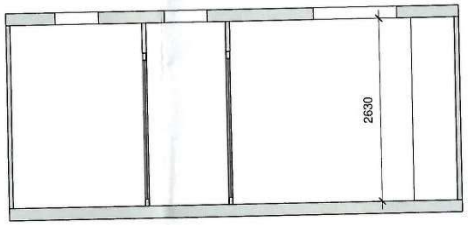
2 **Ceiling Layouts**
1 : 50



3 **3D VIEW - CLEANROOM N15**



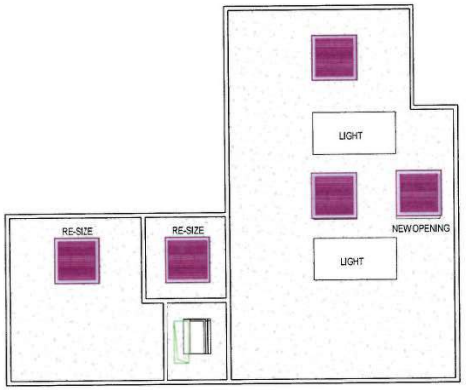
1 **Ground Floor FFL**
1 : 50



A-A **SECTION A-A**
1 : 50

ISSUED FOR INFORMATION

HVAC LEGEND	
	EXTRACTION AIR DUCT
	RETURN AIR DUCT
	SUPPLY AIR DUCT
	FRESH AIR DUCT



2 **CLEANROOM N15 - CEILING LAYOUT**
1 : 50

CLEAN N15 - AIR TERMINAL SCHEDULE

REFERENCE	TYPE	SPIGOT	QTY
HDF1	NEW AIR-TERMINAL TO MATCH EXISTING C/W PLENUM BOX	250	03

CLEAN N15 - HEPA FILTER SCHEDULE

REFERENCE	MODEL	TYPE	PHYSICAL SIZE	QTY
HDF1	HTI-H14-AL-610x610-FC1/10M	GRILLE C/W HEPA FILTER AND PLENUM BOX	610x610	5

CLEAN N15 - DUCT ACCESSORIES SCHEDULE

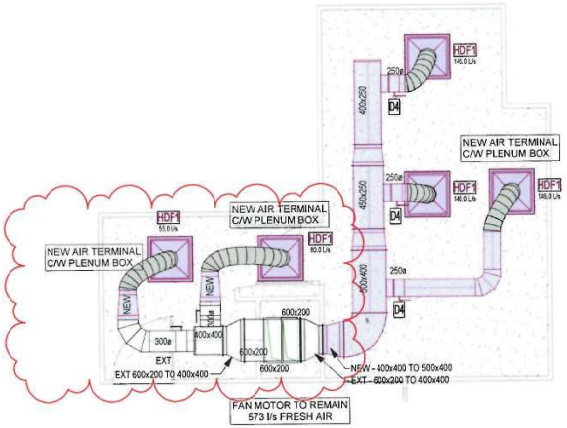
REFERENCE	TYPE	SIZE	QTY
D4	DAMPER ROUND	Ø250	3

CLEAN N15 - DUCT FITTINGS SCHEDULE

TYPE	SIZE	ANGLE	QTY
END CAP RETANGULAR	400x250		1
SPIGO" ROUND	250ø-250ø		3
	250ø-250ø	90.00°	1
	300ø-250ø		2
TRANSFORMATION RETANGULAR TO RETANGULAR	450x250-400x250		1
TRANSFORMATION RETANGULAR TO RETANGULAR	500x400-450x250		1

CLEAN N15 - DUCT SCHEDULE

TYPE	SIZE	Area	LENGHT
RETANGULAR FLANGED DUCTING	400x250	1.56 m²	1.20 m
RETANGULAR FLANGED DUCTING	450x250	1.26 m²	0.90 m
RETANGULAR FLANGED DUCTING	500x400	1.62 m²	0.90 m
RETANGULAR FLANGED DUCTING	600x200	1.41 m²	0.88 m
ROUND SPIRAL DUCTING	250ø	1.39 m²	1.78 m



1 **HVAC - CLEANROOM N15 UPGRADE LAYOUT**
1 : 50

ISSUED FOR CONSTRUCTION

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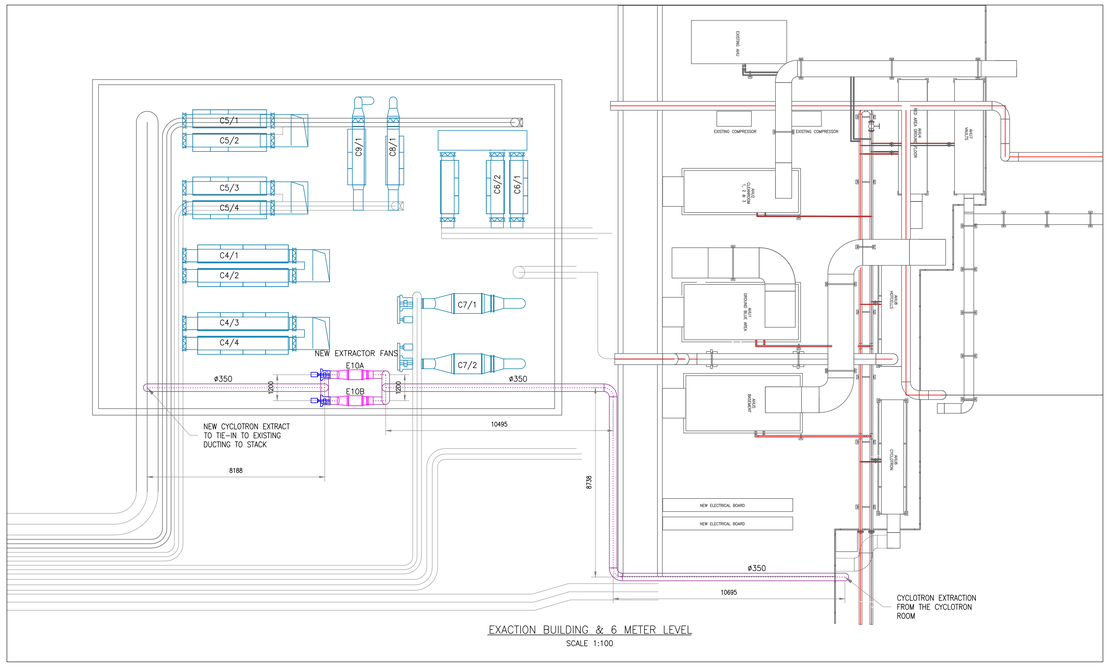
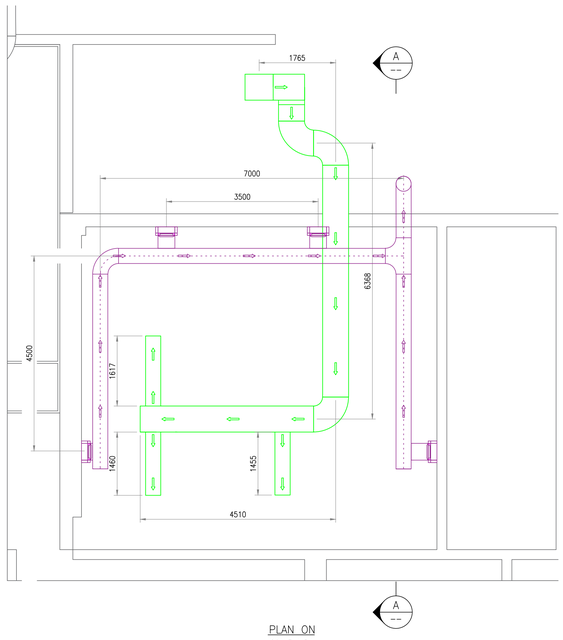
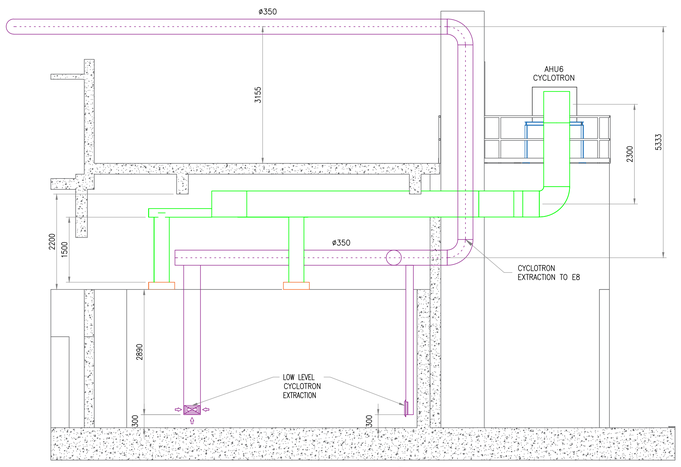


EXACTION BUILDING & 6 METER LEVEL
SCALE 1:100



PLAN ON
SCALE 1:50



SECTION A
SCALE 1:50

KEYPLAN

NOTES

1. –

HOLDS

1. –

FOR TENDER
22.11.2024

LEGEND

- AIR SUPPLY TO AHU
- EXTRACT FROM CYCLOTRON TO EXTRACT E10A/B
- NEW CLEANROOM SUPPLY DUCTING
- EXISTING CLEANROOM EXTRACT DUCTING
- NEW CLEANROOM EXTRACT DUCTING

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	SCOPE UPDATED	MNR	09.09.24	GC	GC	20.06.24	–
0	FIRST ISSUE	MNR	20.06.24	GC	GC	20.06.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA
CYCLOTRON EXTRACT
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
AS–SHOWN	20.06.2024	MNR	GC

DRG. No.	REV.	SHEET SIZE
W1986–55002	1	A1

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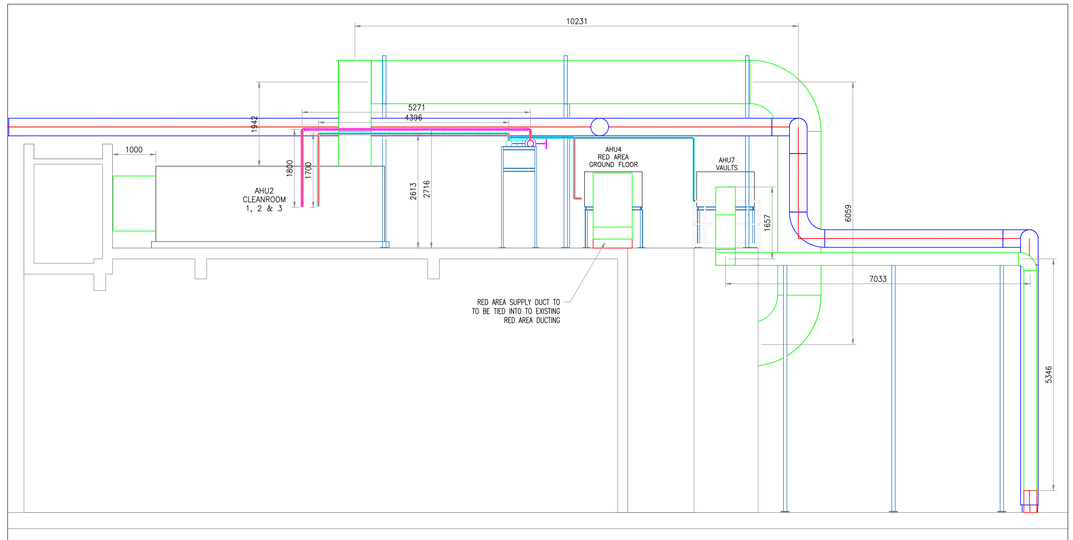
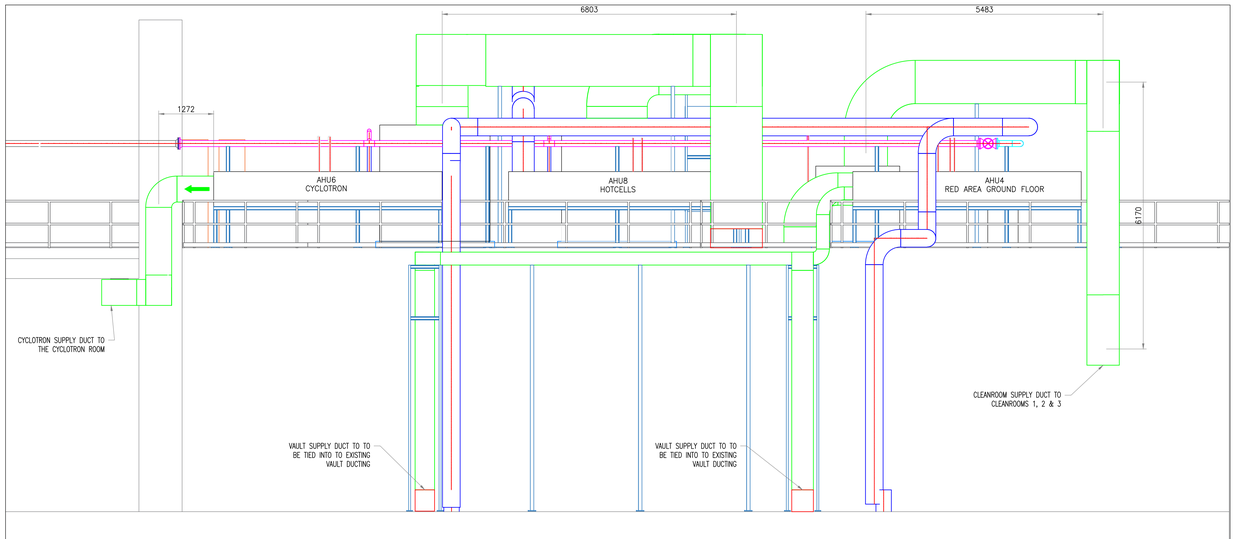
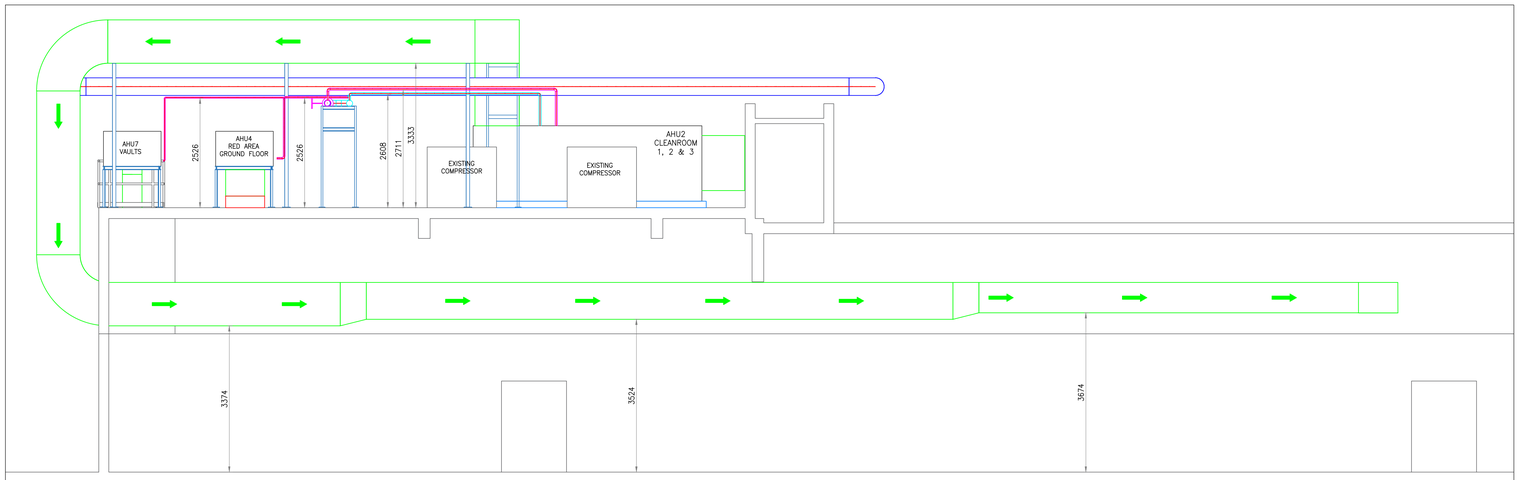


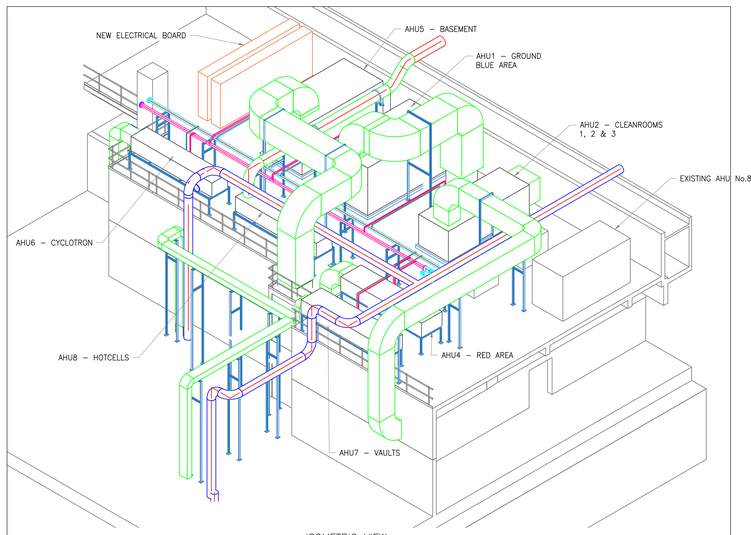
SECTION C
SCALE 1:50 SHT1



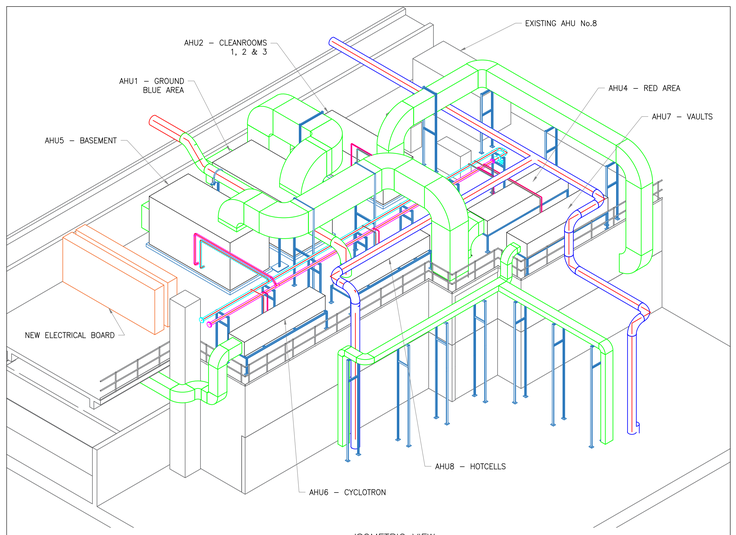
SECTION D
SCALE 1:50 SHT1



SECTION E
SCALE 1:50 SHT1



ISOMETRIC VIEW
SCALE 1:100



ISOMETRIC VIEW
SCALE 1:100

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

→ AIR SUPPLY FROM AHU

FOR TENDER
22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
3	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
2	SCOPE UPDATED	MNR	22.10.24	GvdH	SA	–	–
1	SCOPE UPDATED	MNR	28.08.24	GC	GC	–	–
0	FIRST ISSUE	MNR	08.05.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA IADS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA IADS HVAC UPGRADE
PROPOSED 7 AHU ON THE 6 METER LEVEL
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	08.05.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-55001 SHT2	3	A0

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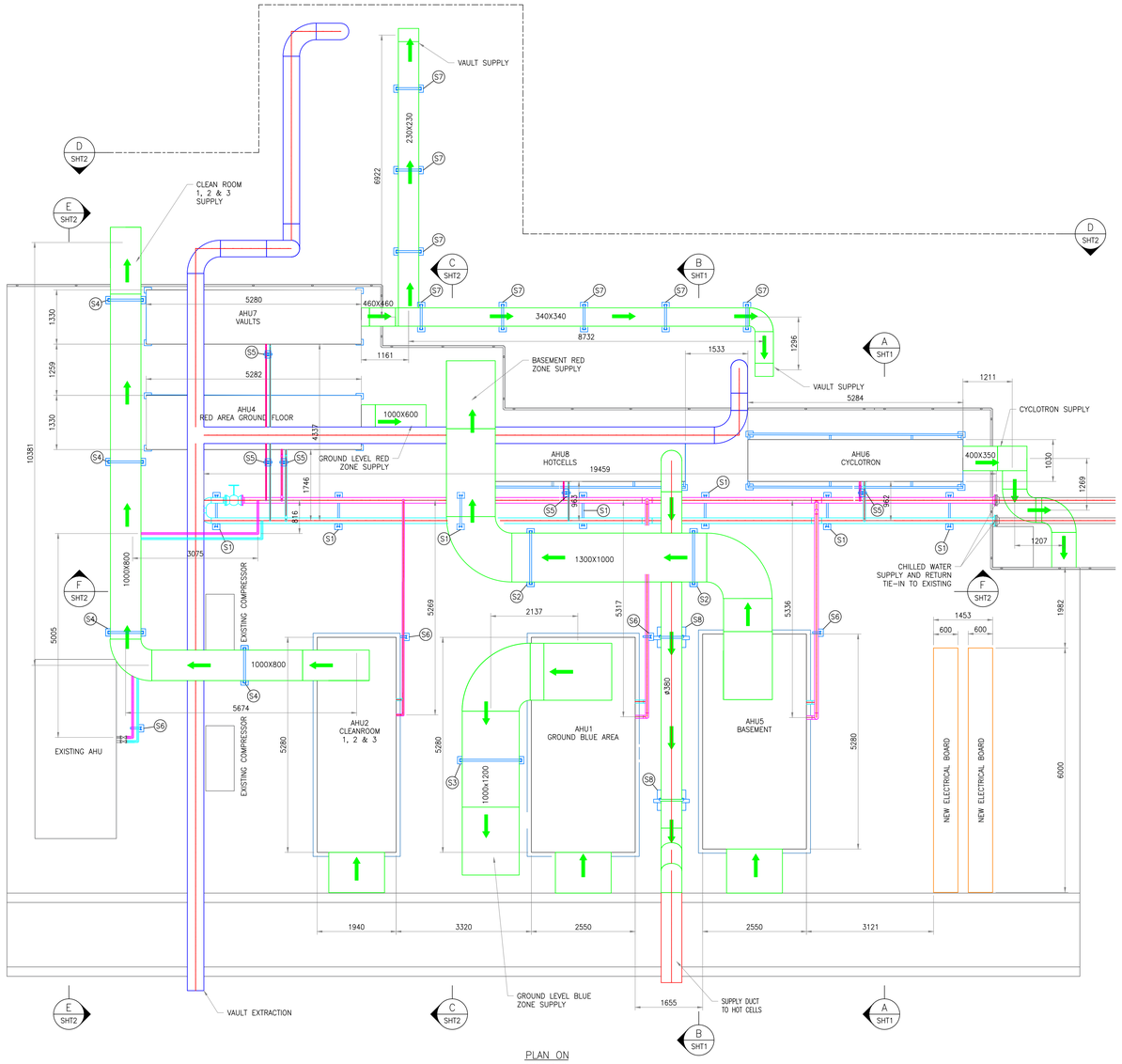
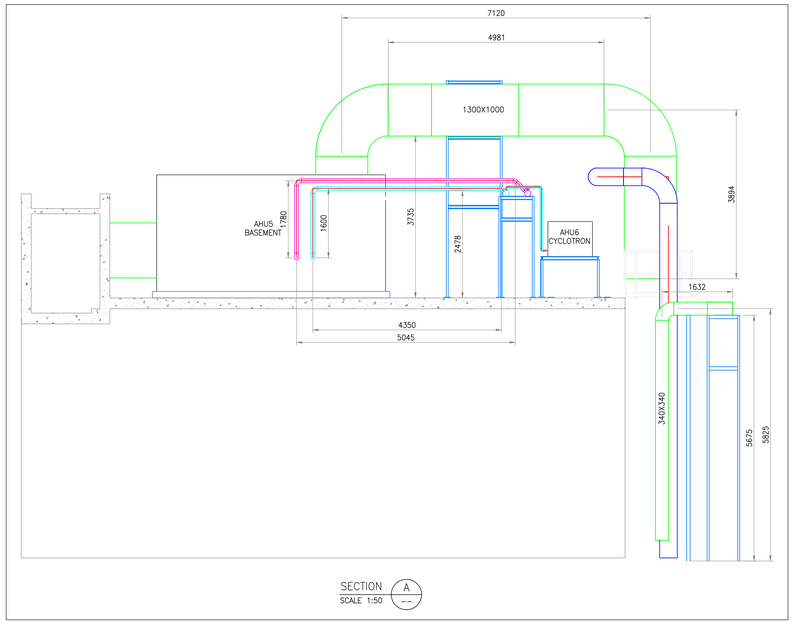
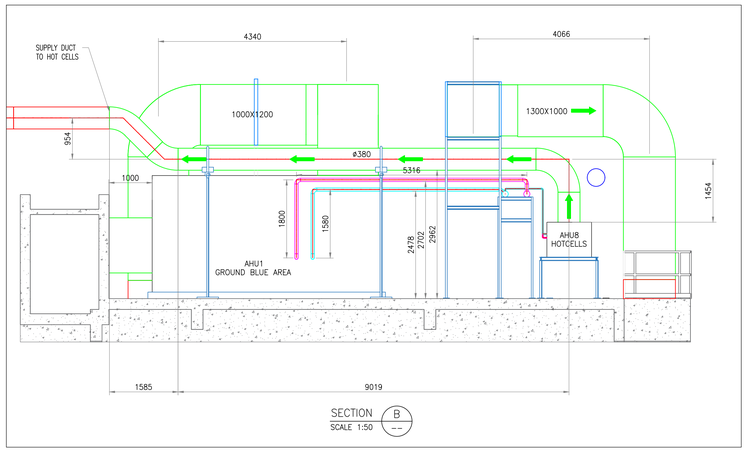


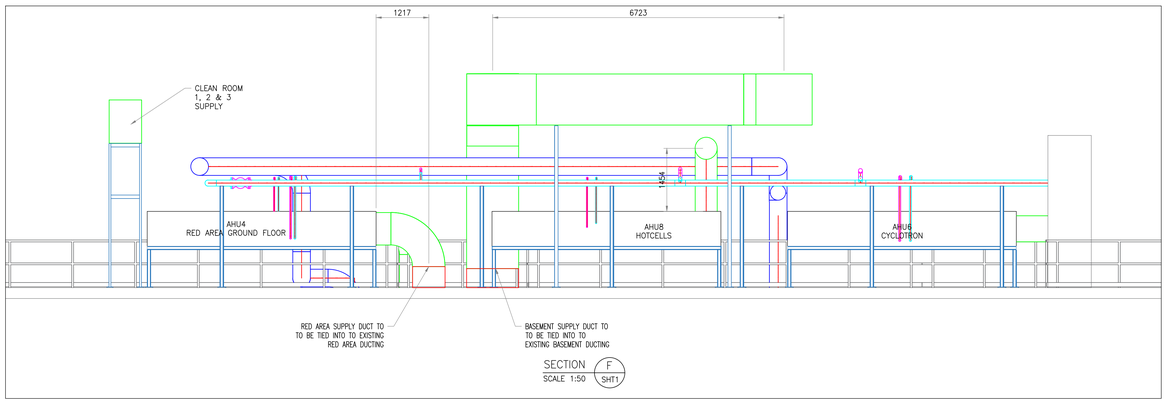
PLAN ON
SCALE 1:50



SECTION A
SCALE 1:50



SECTION B
SCALE 1:50



SECTION F
SCALE 1:50

KEYPLAN

NOTES

1. ALL AHU STEEL PLATFORMS TO BE SUPPLIED BY AHU SUPPLIER, WITH APPROPRIATE VIBRATORS DAMPING.

HOLDS

1. –

LEGEND

AIR SUPPLY FROM AHU

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
3	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
2	SCOPE UPDATED	MNR	22.10.24	GvdH	SA	–	–
1	SCOPE UPDATED	MNR	28.08.24	GC	GC	–	–
0	FIRST ISSUE	MNR	08.05.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA IADS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: iTHEMBA IADS HVAC UPGRADE
PROPOSED 7 AHU ON THE 6 METER LEVEL
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	08.05.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-55001 SHT1	3	A0

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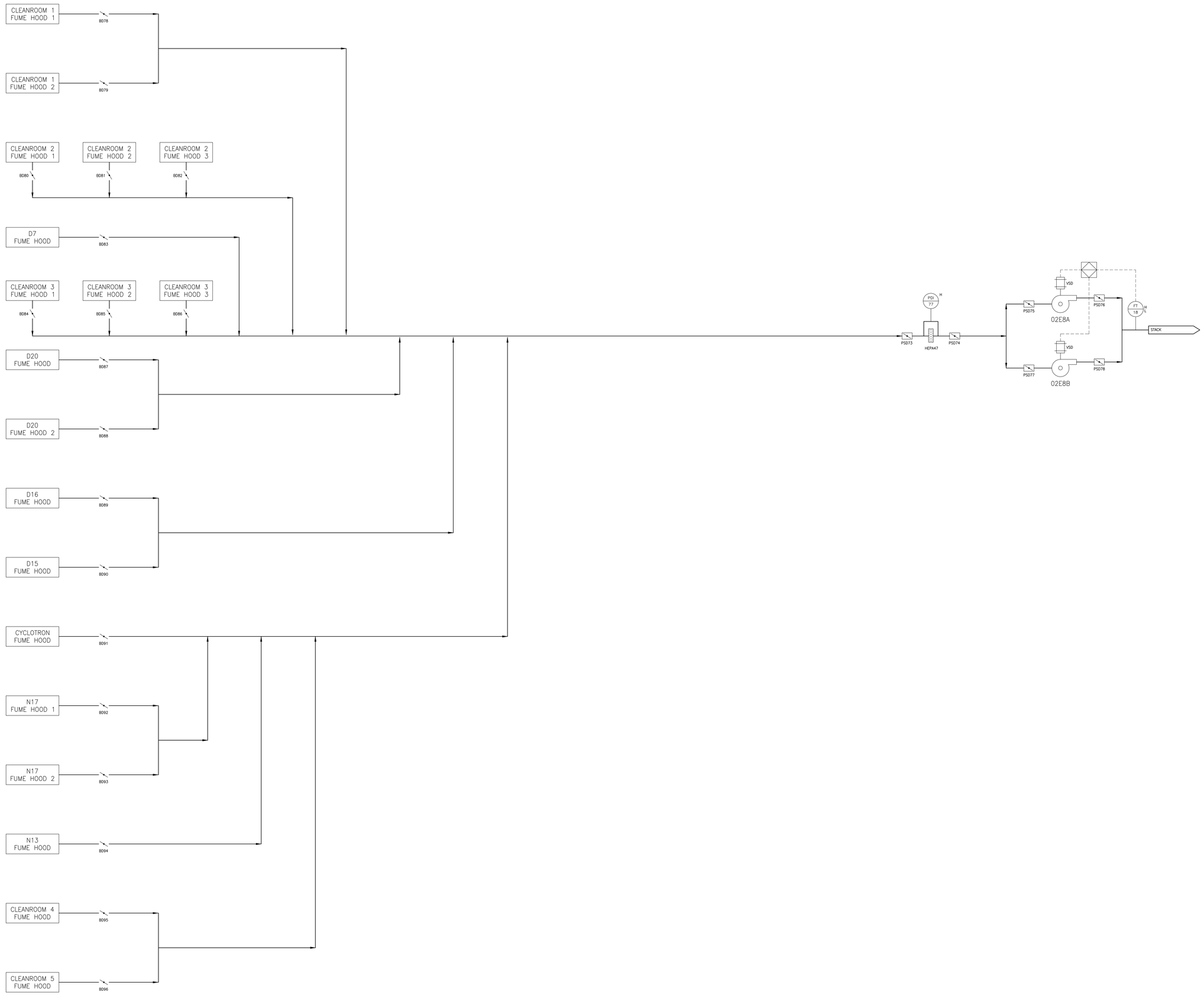

KEYPLAN

NOTES

1.

HOLDS

1. –

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	CONTROLS UPDATED & ISSUE FOR TENDER	MNR	26.11.24	BM	SA	27.11.24	–
0	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	20.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
PIPING & INSTRUMENTATION DIAGRAM
iTHEMBA LABS HVAC UPGRADE
FUME HOODS EXTRACTION

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	14.11.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–45012	1	A0

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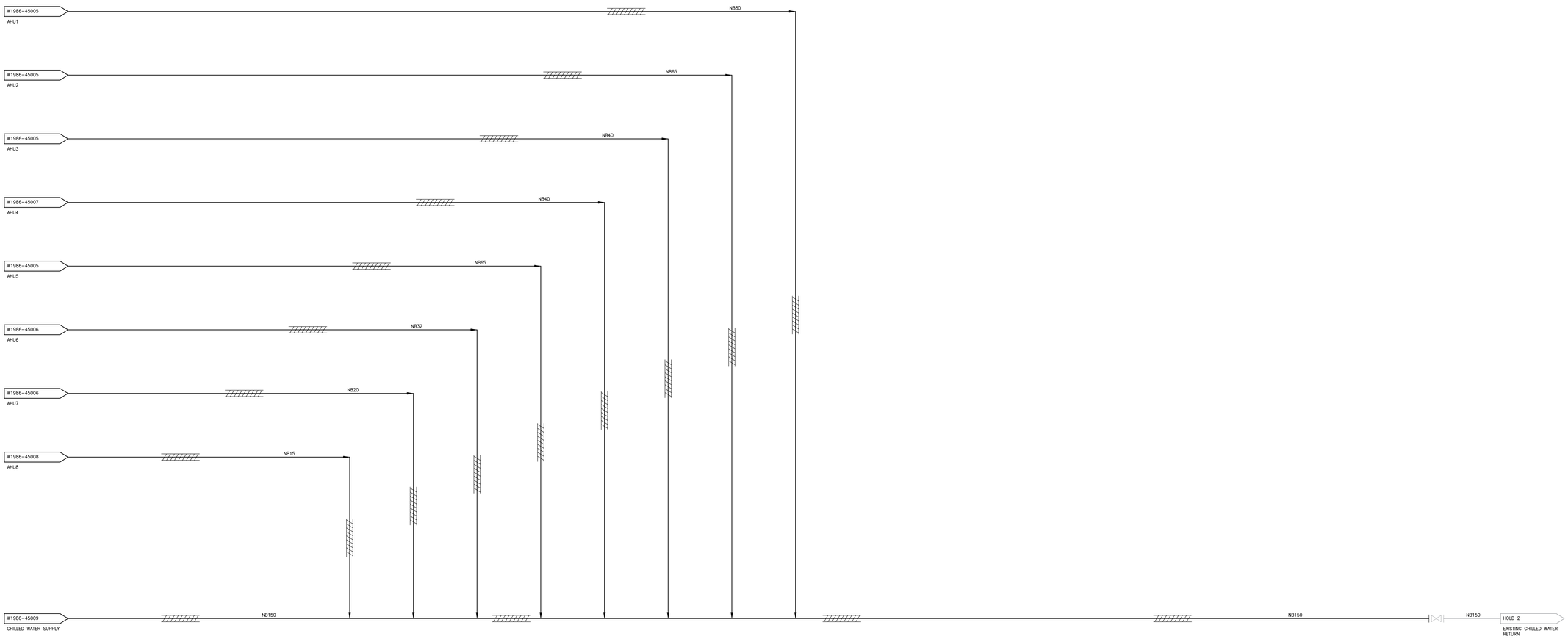

KEYPLAN

NOTES

1.

HOLDS

1. –

LEGEND

FOR TENDER 26.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	UPDATED LINE SIZES & ISSUE FOR TENDER	MNR	26.11.24	BM	SA	27.11.24	–
0	FIRST ISSUE	MNR	10.09.24	BM	SA	20.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
PIPING & INSTRUMENTATION DIAGRAM
iTHEMBA LABS
CHILLED WATER RETURN

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	10.09.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-45010	1	A0

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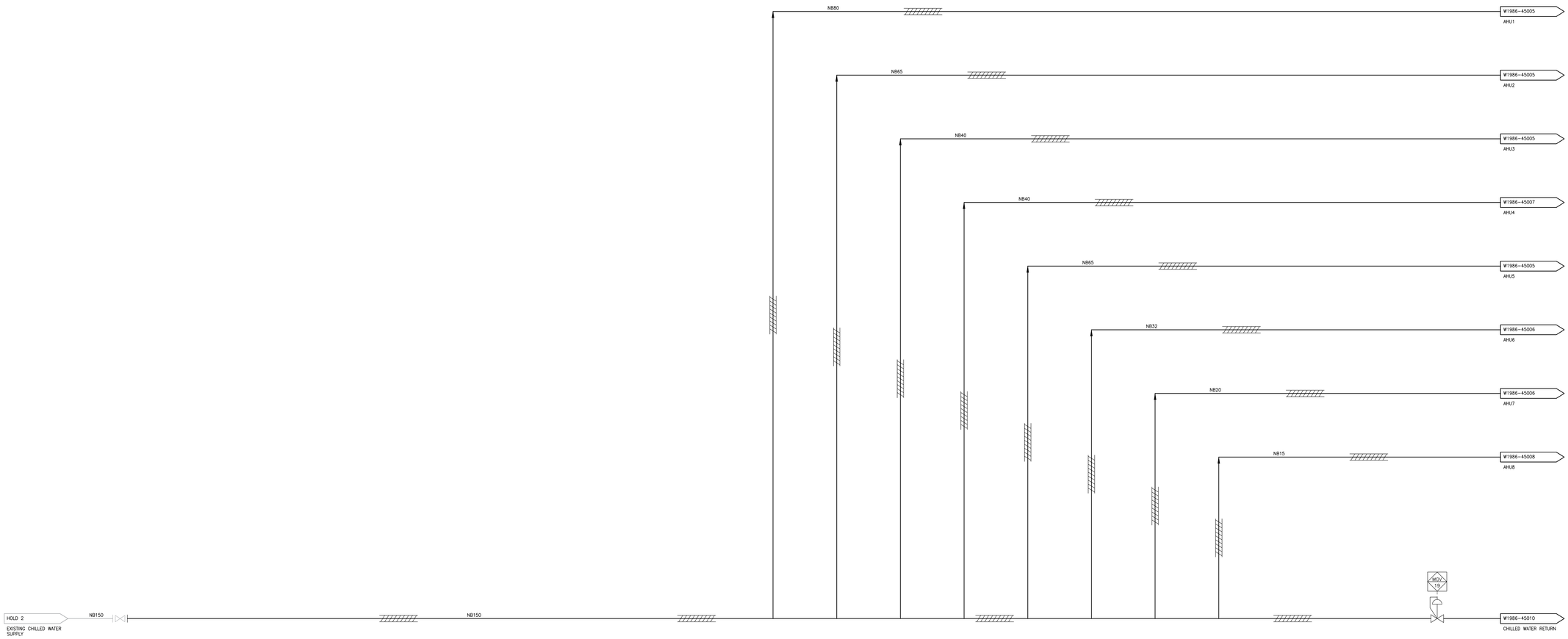

KEYPLAN

NOTES

1.

HOLDS

1. –

LEGEND

FOR TENDER
27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	UPDATED LINE SIZES & ISSUE FOR TENDER	MNR	26.11.24	BM	SA	27.11.24	–
0	FIRST ISSUE	MNR	10.09.24	BM	SA	29.11.24	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT:

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:

PIPING & INSTRUMENTATION DIAGRAM
iTHEMBA LABS
CHILLED WATER SUPPLY

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	10.09.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986-45009	1	A0

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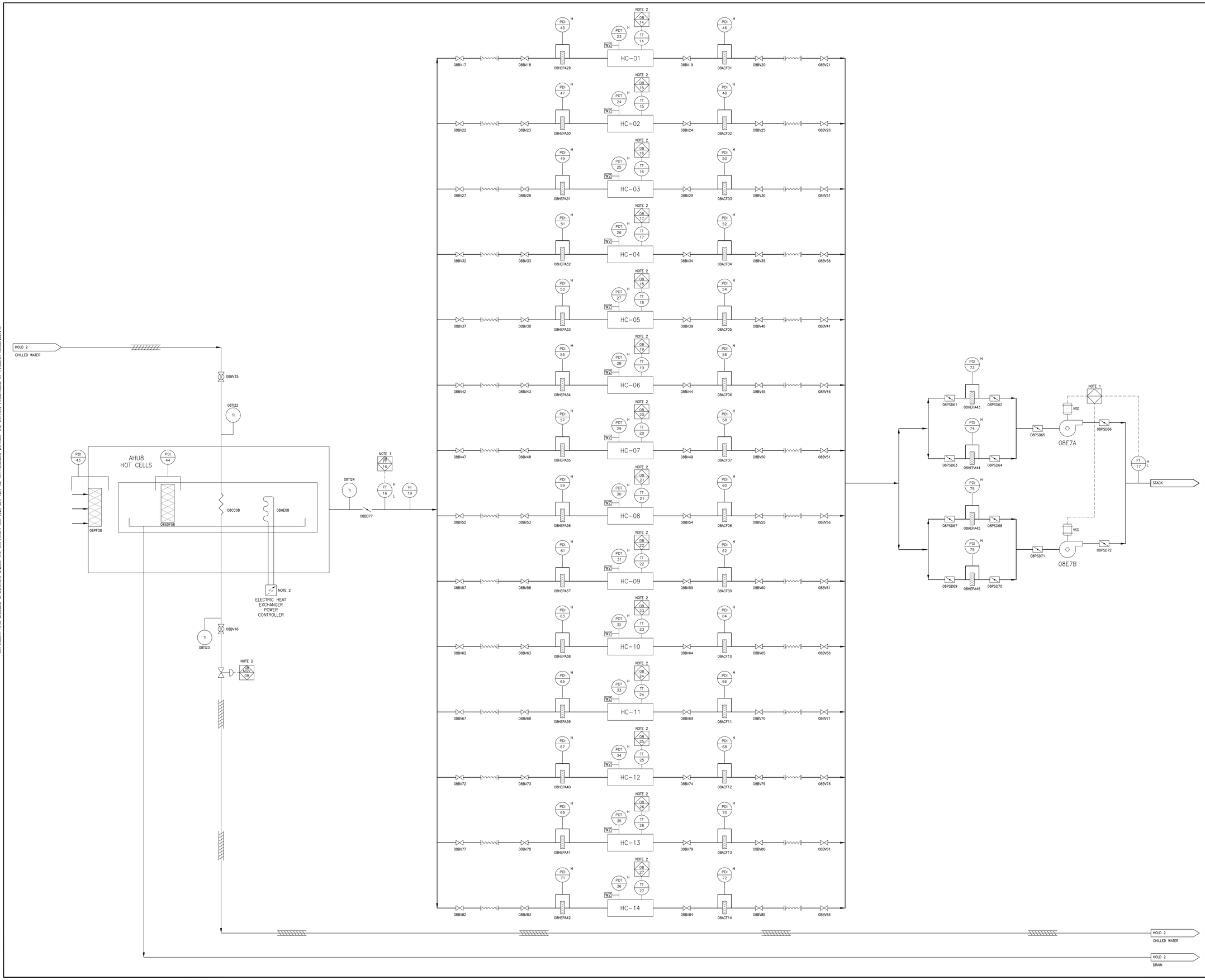

KEYPLAN

NOTES

1. FFT16 CONTROLS FANS E7A–B.
2. TT14–27 CONTROLS (AVERAGE OF) THE HEATING ELEMENT & COOLING COIL CONTROLS VALVE IN AHU8.

HOLDS

1. –

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
4	UPDATED CONTROLS & ISSUE FOR TENDER	MNR	26.11.24	BM	SA	27.11.24	–
3	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
2	SCOPE UPDATED	MNR	22.10.24	BM	SA	23.10.24	–
1	EQUIPMENT NUMBERS ADDED	MNR	27.08.24	BM	GC	–	–
0	FIRST ISSUE	MNR	06.08.24	BM	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
PIPING & INSTRUMENTATION DIAGRAM
iTHEMBA LABS HVAC DOUBLE FAN AHU8
HOT CELLS

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	06.08.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–45008	4	A0

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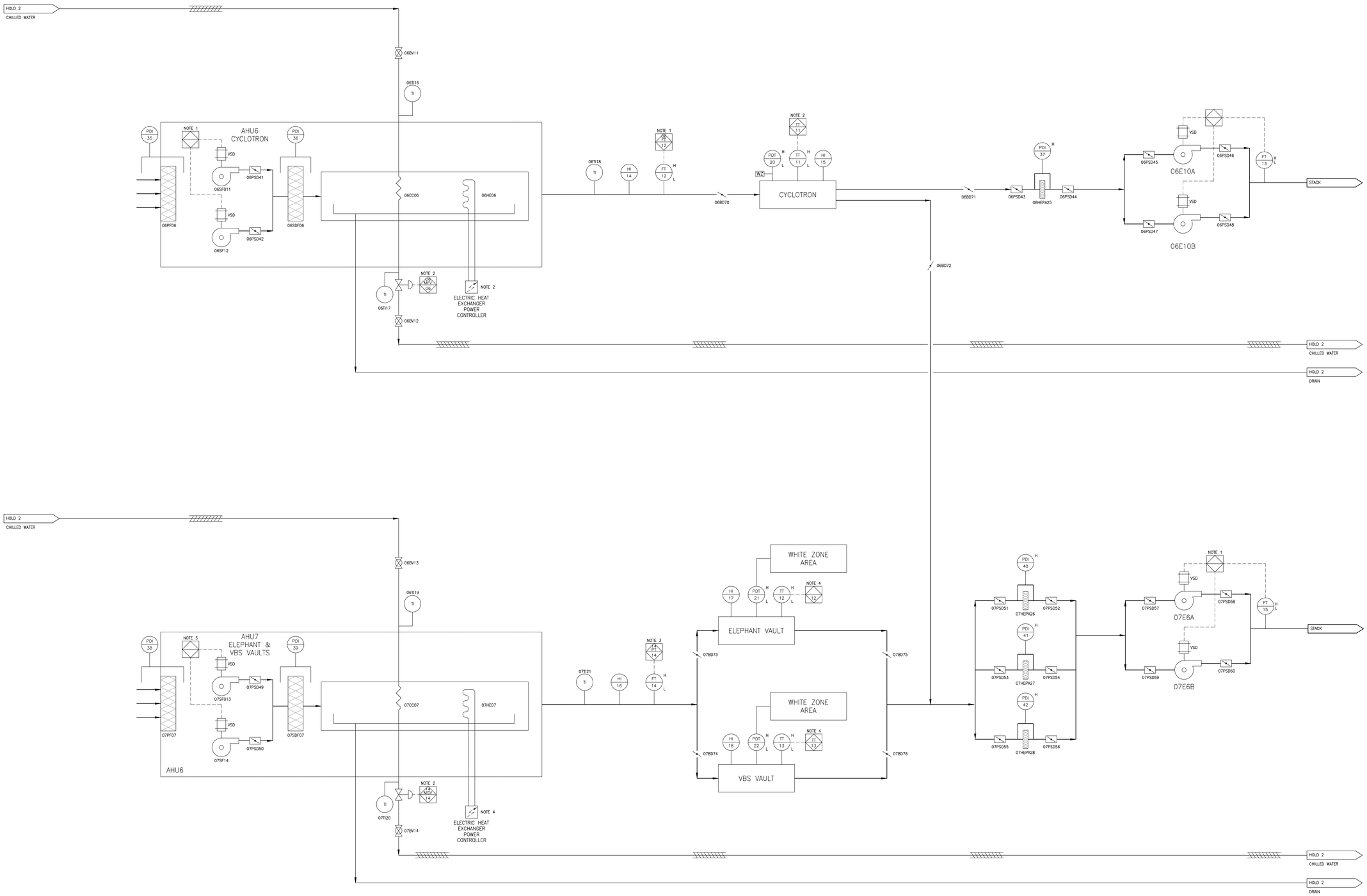


KEYPLAN

NOTES

1. FT12 CONTROLS FANS SF11–12.
2. TT11 CONTROLS THE HEATING ELEMENT & COOLING COIL CONTROL VALUE IN AHU6.
3. FT14 CONTROLS FANS SF13–14.
4. TT12 & TT13 CONTROLS THE HEATING ELEMENT & COOLING COIL CONTROL VALUE IN AHU7.
5. CYCLOTRON SUPPLY FEATURES 4 OBD'S:
   - 060BD150
   - 060BD151
   - 060BD152
   - 060BD153
6. CYCLOTRON EXTRACTION HAS 2 OBD'S:
   - 060BD154
   - 060BD155
7. VAULT SUPPLY & EXTRACTION FEATURES 12 OBD'S:
   - 070BD156
   - 070BD157
   - 070BD158
   - 070BD159
   - 070BD160
   - 070BD161
   - 070BD162
   - 070BD163
   - 070BD164
   - 070BD165
   - 070BD166
   - 070BD167

HOLDS

1. –

LEGEND

FOR TENDER
27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG.	ISSUED	CLIENT
6	UPDATED CONTROL & ISSUE FOR TENDER	MNR	26.11.24	BM	SA	27.11.24	–
5	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
4	SCOPE UPDATED	MNR	22.10.24	BM	SA	23.10.24	–
3	EQUIPMENT NUMBERS ADDED	MNR	27.08.24	BM	GC	–	–
2	SCOPE UPDATED AFTER HAZOP	MNR	06.08.24	BM	GC	–	–
1	DESIGN UPDATE	MNR	10.07.24	BM	GC	–	–
0	CONCEPT ISSUE	MNR	16.05.24	BM	GC	–	–

REVISIONS

–	–

DRG No	TITLE

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

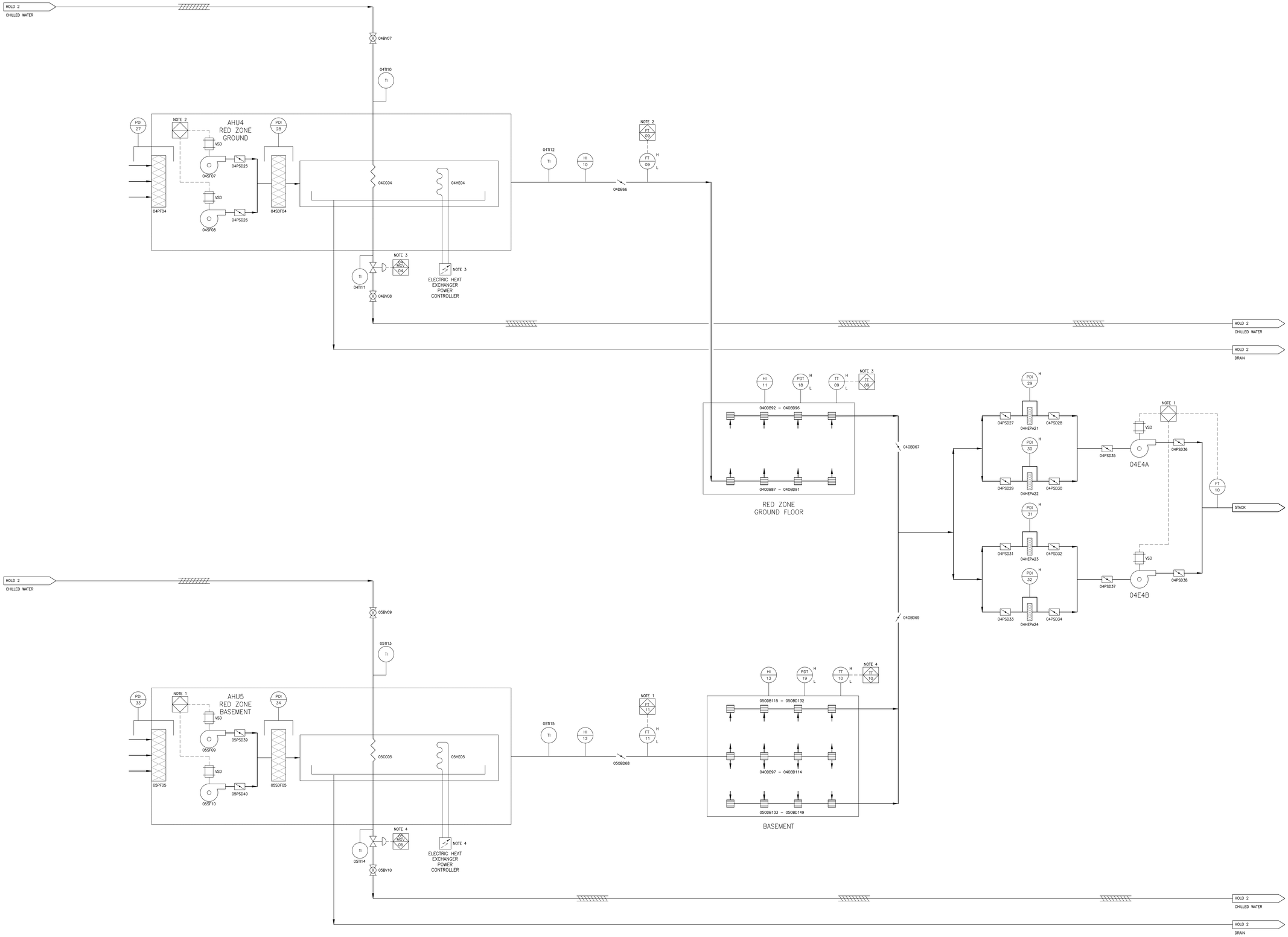
PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
PIPING & INSTRUMENTATION DIAGRAM
iTHEMBA LABS HVAC DOUBLE FAN AHU6 & 7
– CYCLOTRON & VAULTS

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	16.05.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–45007	6	A0



KEYPLAN

NOTES

1. FT11 CONTROLS FANS SF09–10.
2. FLOW TRANSMITTER FT09 CONTROLS FANS SF07–08.
3. TT09 CONTROLS HEATING ELEMENT & COOLING COIL CONTROL VALVE IN AHU4.
4. TT10 CONTROLS FANS THE HEATING ELEMENT & COOLING COIL CONTROL VALVE IN AHU5.

HOLDS

1. –

LEGEND

FOR TENDER
27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
6	UPDATED CONTROLS & ISSUE FOR TENDER	MNR	24.11.24	BM	SA	27.11.24	–
5	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
4	SCOPE UPDATED	MNR	22.10.24	BM	SA	23.10.24	–
3	EQUIPMENT NUMBERS ADDED	MNR	27.08.24	BM	GC	–	–
2	SCOPE UPDATED AFTER HAZOP	MNR	06.08.24	BM	GC	–	–
1	DESIGN UPDATE	MNR	10.07.24	BM	GC	–	–
0	CONCEPT ISSUE	MNR	16.05.24	BM	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: PIPING & INSTRUMENTATION DIAGRAM
iTHEMBA LABS HVAC DOUBLE FAN AHU4 & 5
– RED ZONE GROUND FLOOR & BASEMENT

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	16.05.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–45006	6	A0

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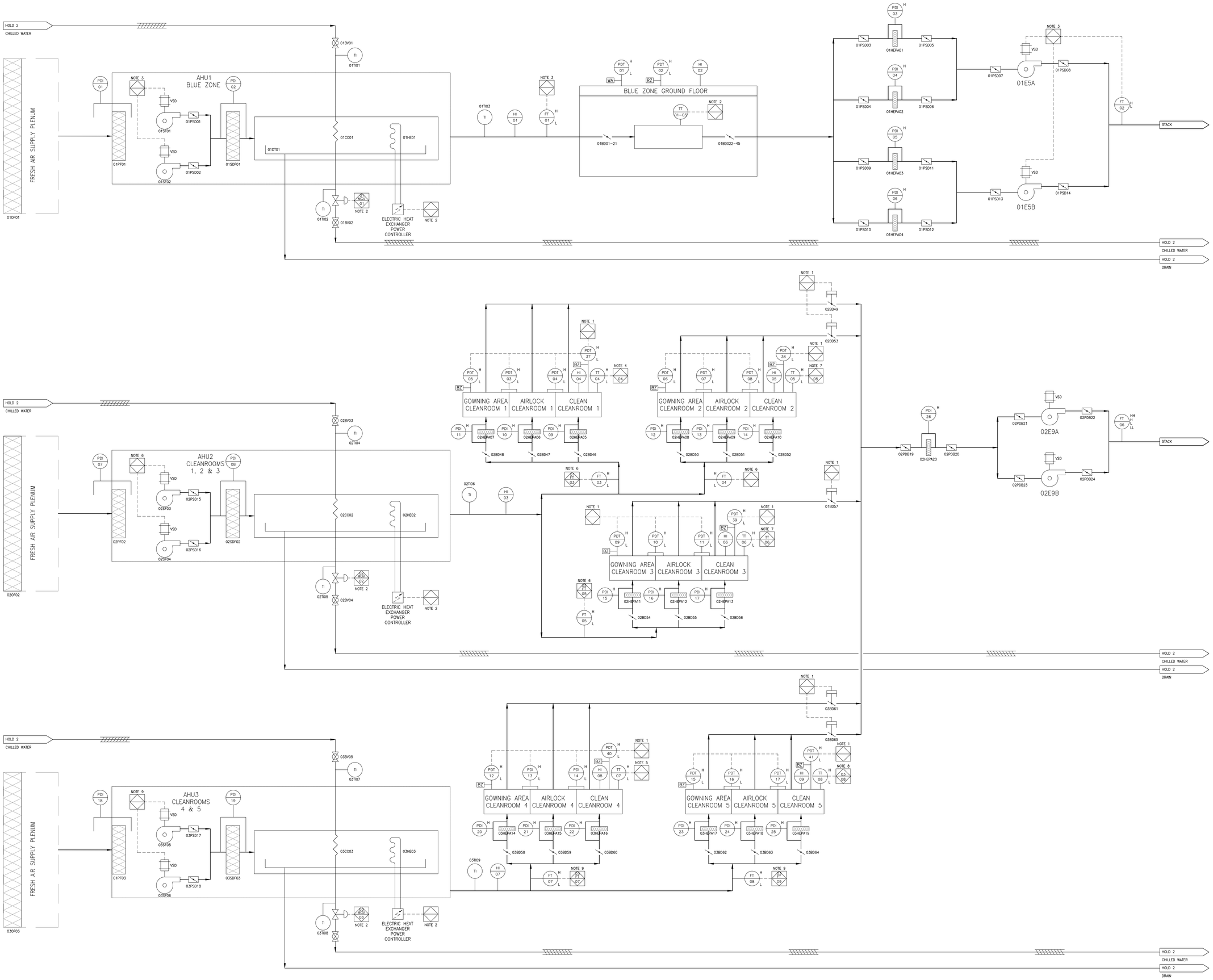

KEYPLAN

NOTES

1. PRESSURE DIFFERENTIAL TRANSMITTERS (PDT) CONTROL PNEUMATIC BALANCING DAMPERS.
2. TEMPERATURE TRANSMITTERS (TT) IN THE BLUE ZONE CONTROL (AVERAGE OF THE 3 SENSOR) THE HEATING ELEMENT & COOLING COIL CONTROL VALVE.
3. FLOW TRANSMITTER (FT01) CONTROLS FANS (SF01–02), & FLOW TRANSMITTER (SF01–02) CONTROL FANS (E5A–B)
4. BLUE ZONE SUPPLY FEATURES 44 OPPOSED BLADE DAMPER (OBD) ON THE SUPPLY GRILLES:
   - 010BD01 – 010BD44
5. BLUE ZONE EXTRACTION FEATURES 42 OBD'S ON THE EXTRACTION:
   - 010BD45 – 010BD86
6. FLOW TRANSMITTER (FT03–05) CONTROL (SUM OF) FANS SF03–04.
7. TEMPERATURE TRANSMITTERS TT04–06 CONTROL (AVERAGE OF) THE HEATING ELEMENT & COOLING COIL CONTROL VALVE IN AHU2.
8. TEMPERATURE TRANSMITTER TT07–08 CONTROL (AVERAGE OF) THE HEATING ELEMENT & COOLING COIL CONTROL VALVE IN AHU3.
9. FLOW TRANSMITTER FT07–08 CONTROL (SUM OF) FANS SF05–06.

HOLDS

1. –

LEGEND

FOR TENDER 27.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
6	UPDATED CONTROLS & ISSUE FOR TENDER	MNR	26.11.24	BM	SA	27.11.24	–
5	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
4	SCOPE UPDATED	MNR	22.10.24	BM	SA	23.10.24	–
3	EQUIPMENT NUMBERS ADDED	MNR	27.08.24	BM	GC	–	–
2	SCOPE UPDATED AFTER HAZOP	MNR	06.10.24	BM	GC	–	–
1	DESIGN UPDATED	MNR	10.07.24	BM	GC	–	–
0	CONCEPT ISSUE	MNR	16.05.24	BM	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: PIPING & INSTRUMENTATION DIAGRAM iTHEMBA LABS HVAC DOUBLE FAN AHU1, 2 & 3 – BLUE AREA & CLEANROOMS

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	16.05.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–45006	6	A0

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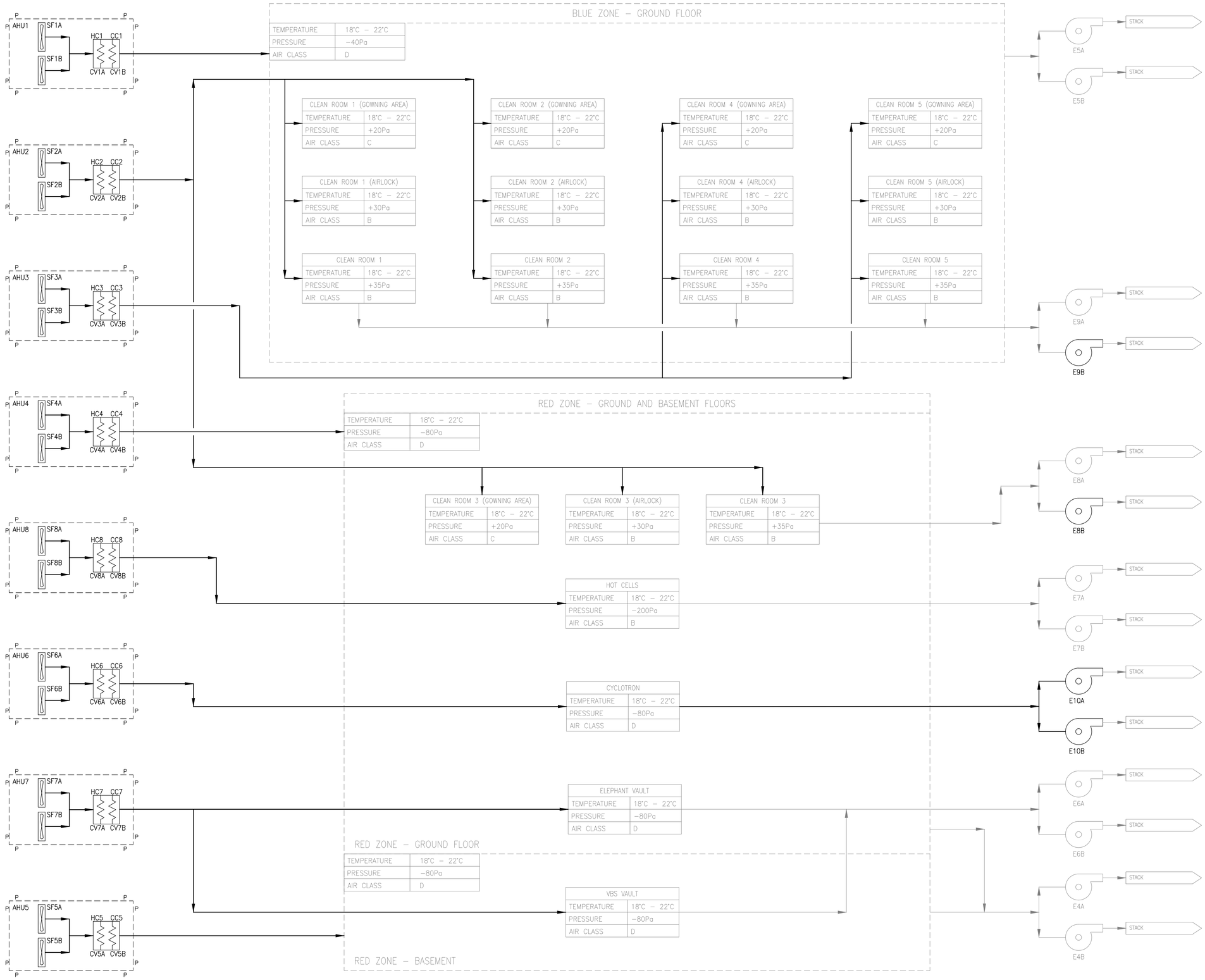


KEYPLAN

NOTES

1. ALL CLEAN ROOMS FITTED WITH PRIMARY & SECONDARY AIR–LOCKS:
   - PRIMARY – CLASS B
   - SECONDARY – CLASS C
2. TWO FANS, ISOLATED FROM EACH OTHER SHARE COMMON HEATING/COOLING COIL.
3. CLEAN ROOMS HAVE DEDICATED EXTERNAL SUPPLY.
4. THE HEATING/COOLING COIL SHALL EACH HAVE BY–PASS DUCTING IN THE EVENT OF MAINTENANCE.

FOR TENDER 15.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
2	ISSUE FOR TENDER	MNR	14.11.24	BM	SA	15.11.24	–
1	SCOPE UPDATED	MNR	23.10.24	BM	SA	–	–
0	CONCEPT ISSUE	MNR	26.02.24	BM	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No. X

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

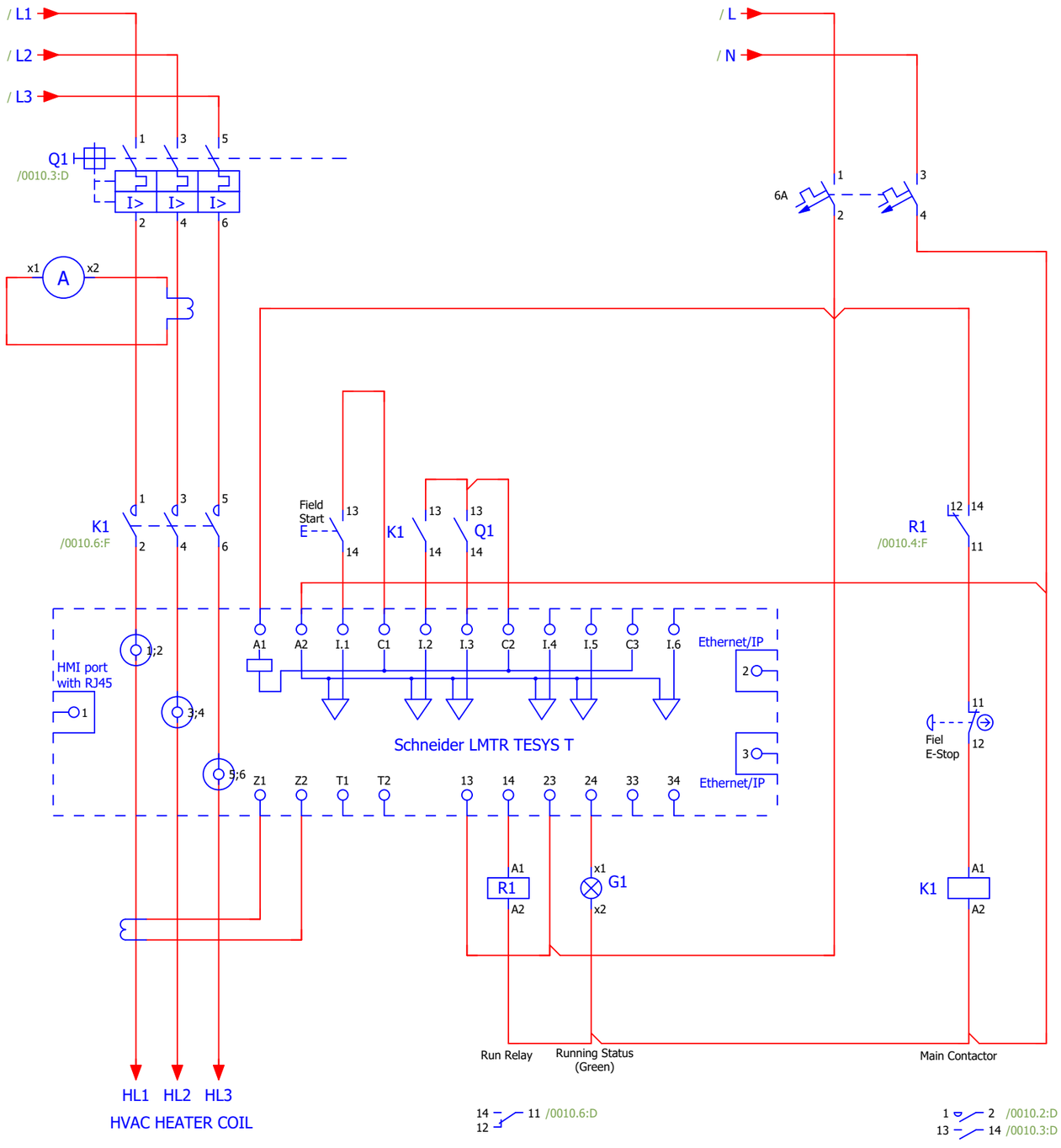
PROJECT: W1986 – iTHEMBA LABS HVAC UPDATE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
PROCESS FLOW DIAGRAM
iTHEMBA LABS HVAC
DOUBLE FASN AHU

SCALE	DATE	DRAWN BY	PROJECT ENG.
NTS	26.02.2024	MNR	BM

DRG. No.	REV.	SHEET SIZE
W1986–41002	2	A2



REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		

BCE BÜHRMANN CONSULTING ENGINEERS
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CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

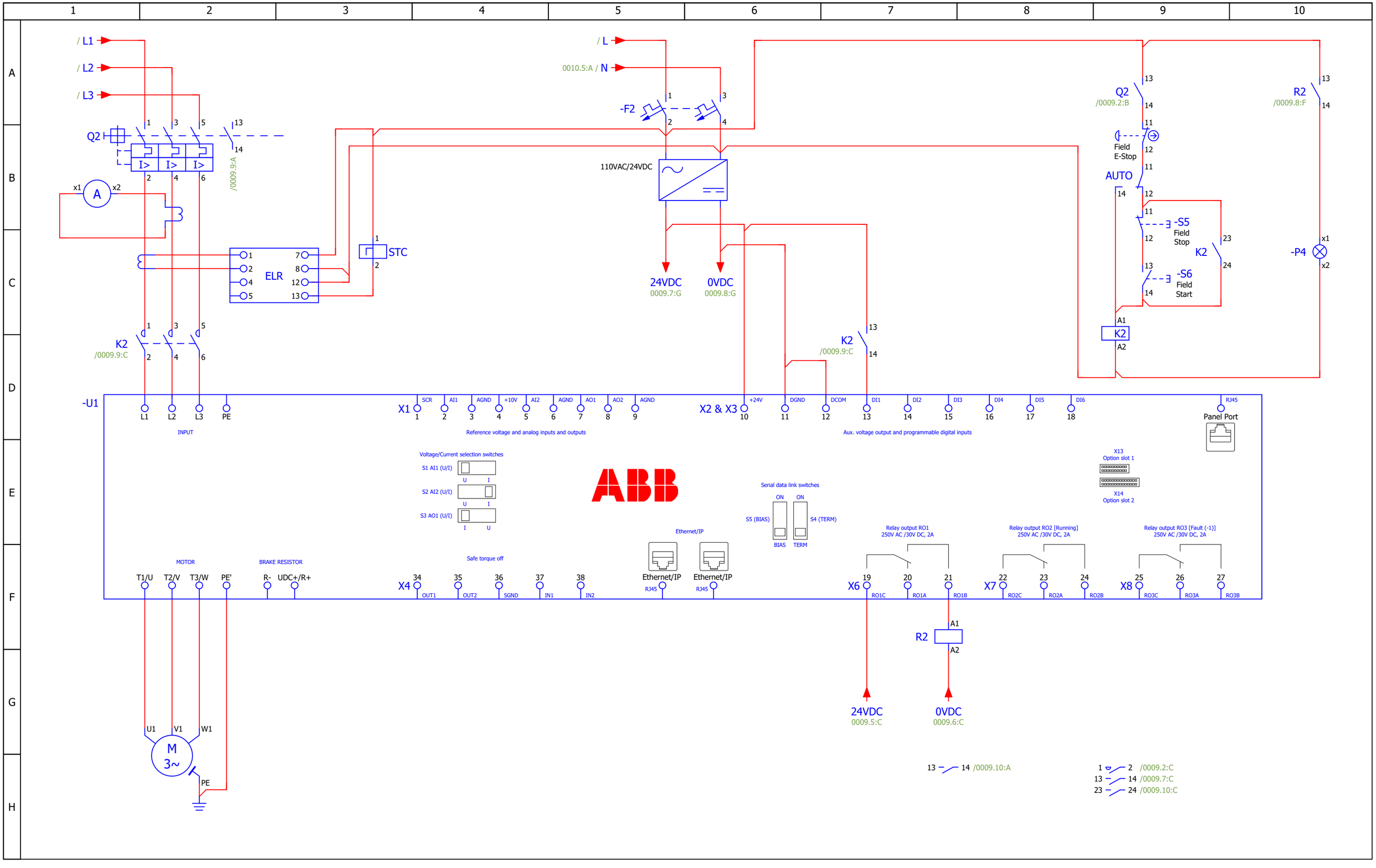
PROJECT: iThemba HVAC

TITLE: Typical HVAC Heater

FOR TENDER

DESIGNED:	BH	CHECKED:	JHvW
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0340-EL-SLD-2000** REV: **0**



REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		

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Unit 25 Muirfield House, Midpark Business Village
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info@buhrmannce.co.za I www.buhrmannce.co.za

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

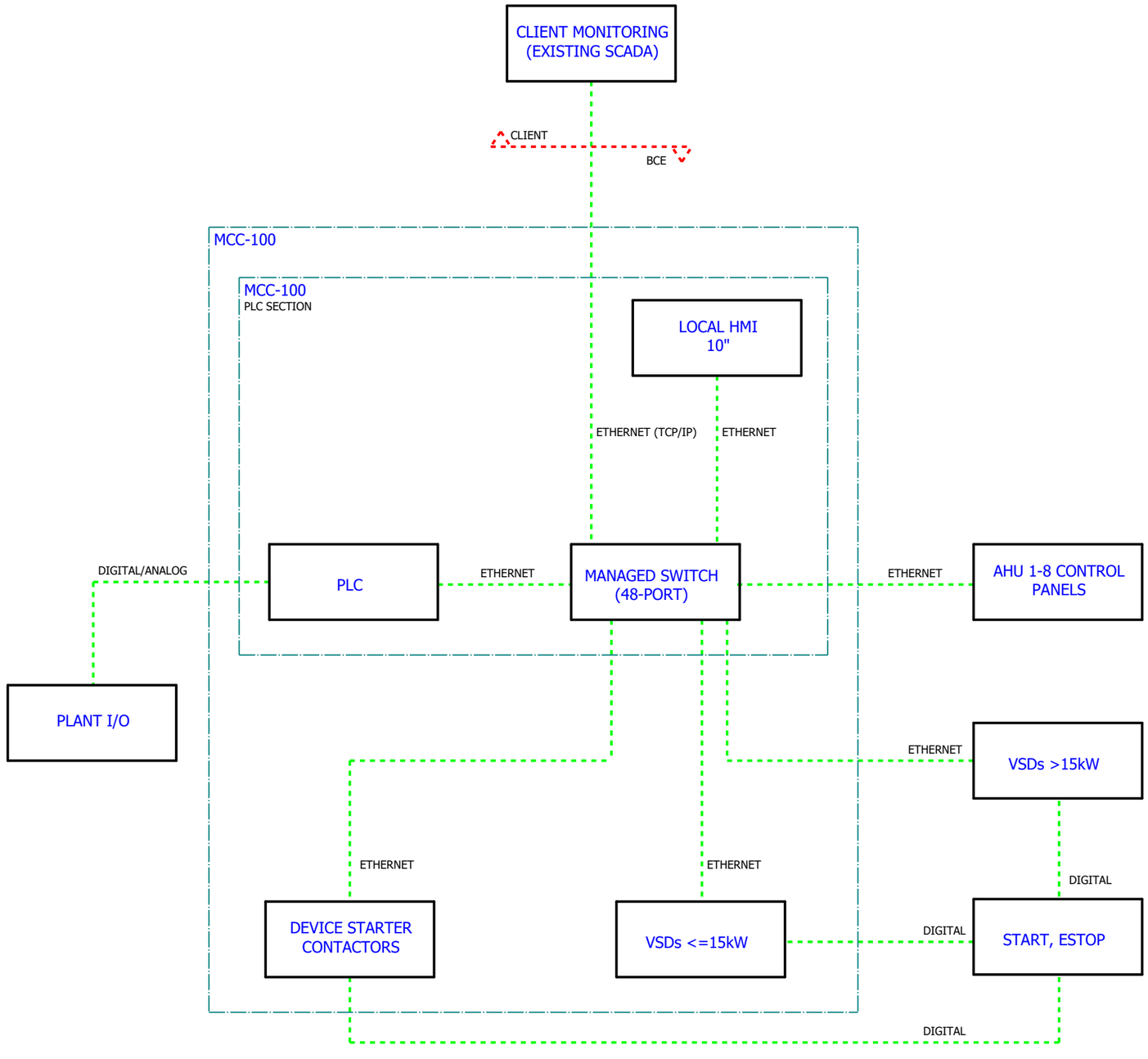
PROJECT: iThemba HVAC

TITLE: Typical VSD

FOR TENDER

DESIGNED:	BH	CHECKED:	JHvW
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0340-EL-SLD-1000** REV: **0**



REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		
B	06 JUN 24	DETAIL DESIGN		
A	07 JUN 24	ISSUED FOR INFORMATION		

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CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

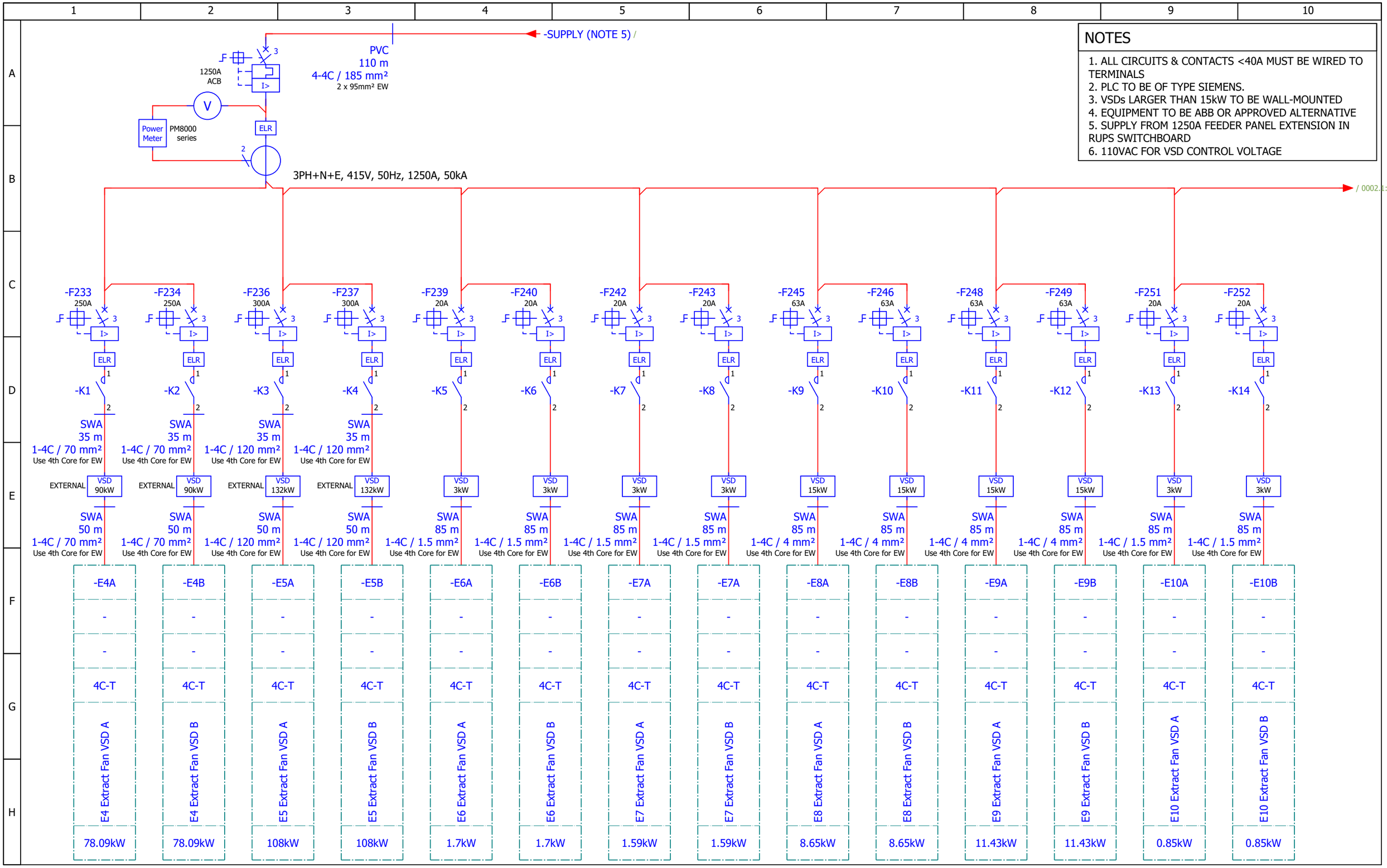
PROJECT: iThemba HVAC

TITLE: AUTOMATION ARCHITECTURE

FOR TENDER

DESIGNED:	BH	CHECKED:	HB
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0350-EL-SLD-0200** REV: **0**



NOTES

1. ALL CIRCUITS & CONTACTS <40A MUST BE WIRED TO TERMINALS
2. PLC TO BE OF TYPE SIEMENS.
3. VSDs LARGER THAN 15kW TO BE WALL-MOUNTED
4. EQUIPMENT TO BE ABB OR APPROVED ALTERNATIVE
5. SUPPLY FROM 1250A FEEDER PANEL EXTENSION IN RUPS SWITCHBOARD
6. 110VAC FOR VSD CONTROL VOLTAGE

REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		
C	02 SEP 24	UPDATED FOR DETAILED DESIGN		
B	07 JUN 24	UPDATED FOR PRELIM DESIGN		
A	15 MAY 24	ISSUED FOR INFORMATION		

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CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

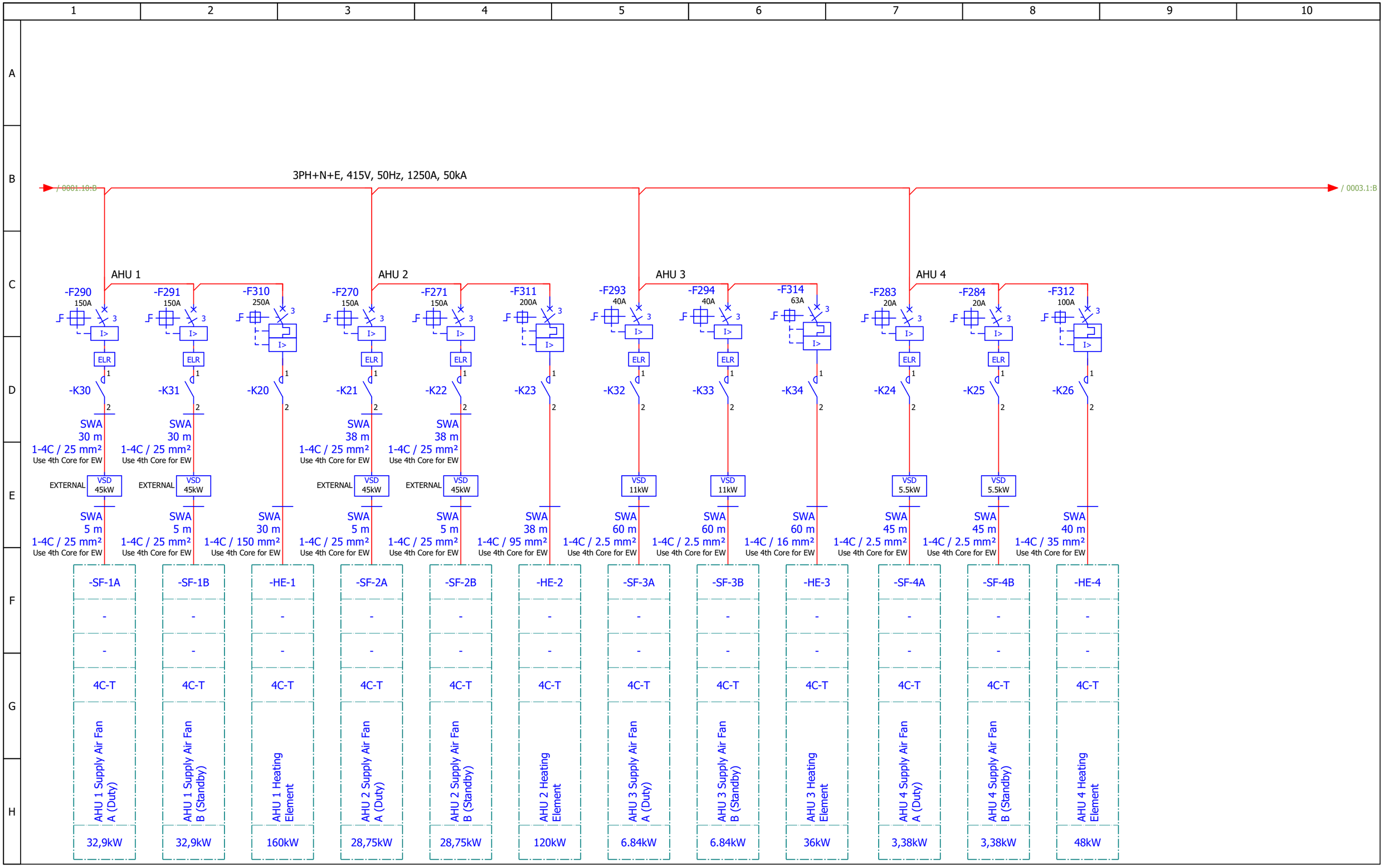
PROJECT: iThemba HVAC

TITLE: MCC-100 SLD
PAGE 1 OF 4

FOR TENDER

DESIGNED:	BH	CHECKED:	JHvW
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0340-EL-SLD-0100** REV: **0**



REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		
C	02 SEP 24	UPDATED FOR DETAILED DESIGN		
B	07 JUN 24	UPDATED FOR PRELIM DESIGN		
A	15 MAY 24	ISSUED FOR INFORMATION		

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CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

PROJECT: iThemba HVAC

TITLE: MCC-100 SLD PAGE 2 OF 4

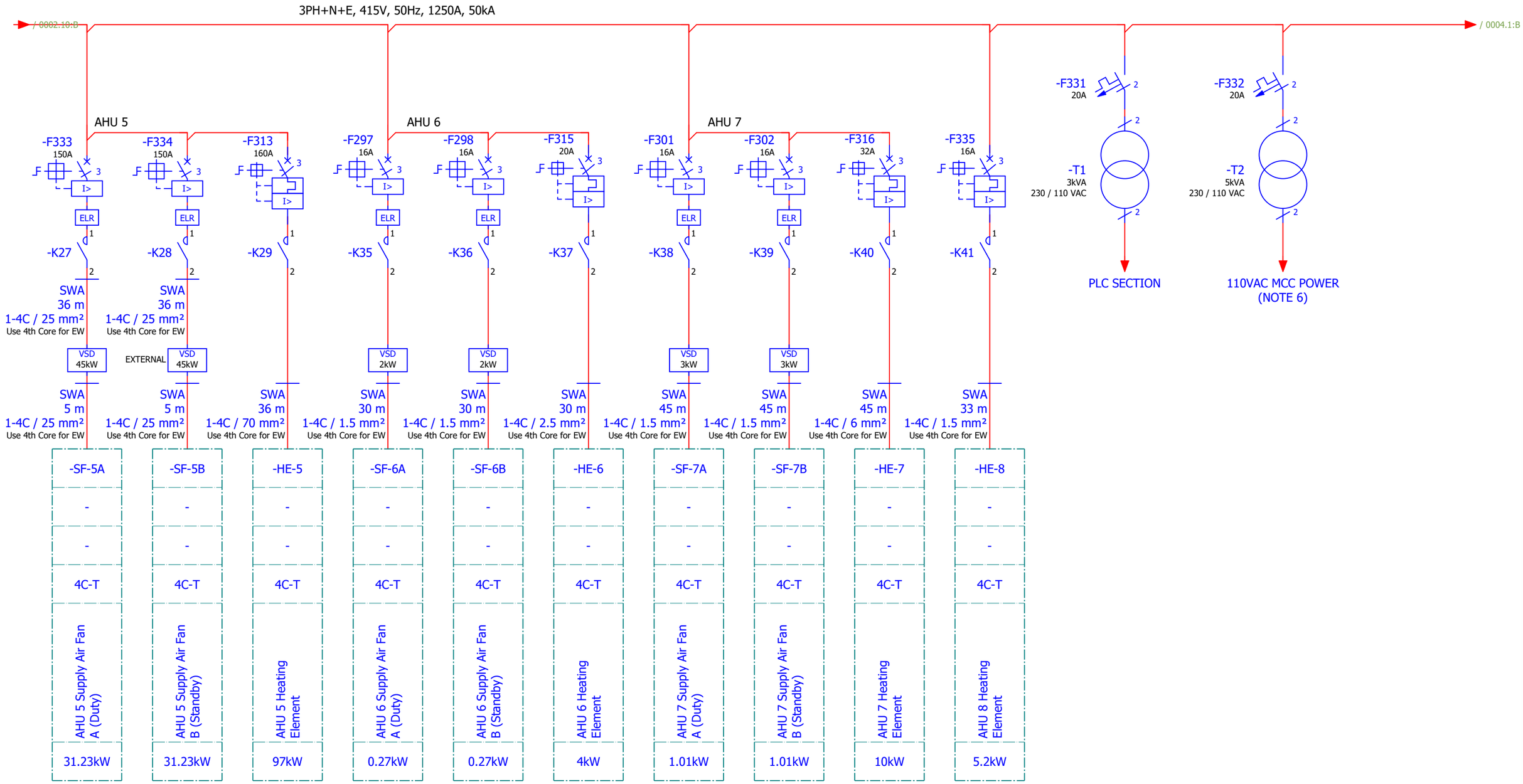
FOR TENDER

DESIGNED:	BH	CHECKED:	JHvW
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0340-EL-SLD-0100** REV: **0**

NOTES

1. ALL CIRCUITS & CONTACTS <40A MUST BE WIRED TO TERMINALS
2. PLC TO BE OF TYPE SIEMENS.
3. VSDs LARGER THAN 15kW TO BE WALL-MOUNTED
4. EQUIPMENT TO BE ABB OR APPROVED ALTERNATIVE
5. SUPPLY FROM 1250A FEEDER PANEL EXTENSION IN RUPS SWITCHBOARD
6. 110VAC FOR VSD CONTROL VOLTAGE



REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		
C	02 SEP 24	UPDATED FOR DETAILED DESIGN		
B	07 JUN 24	UPDATED FOR PRELIM DESIGN		
A	15 MAY 24	ISSUED FOR INFORMATION		

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PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

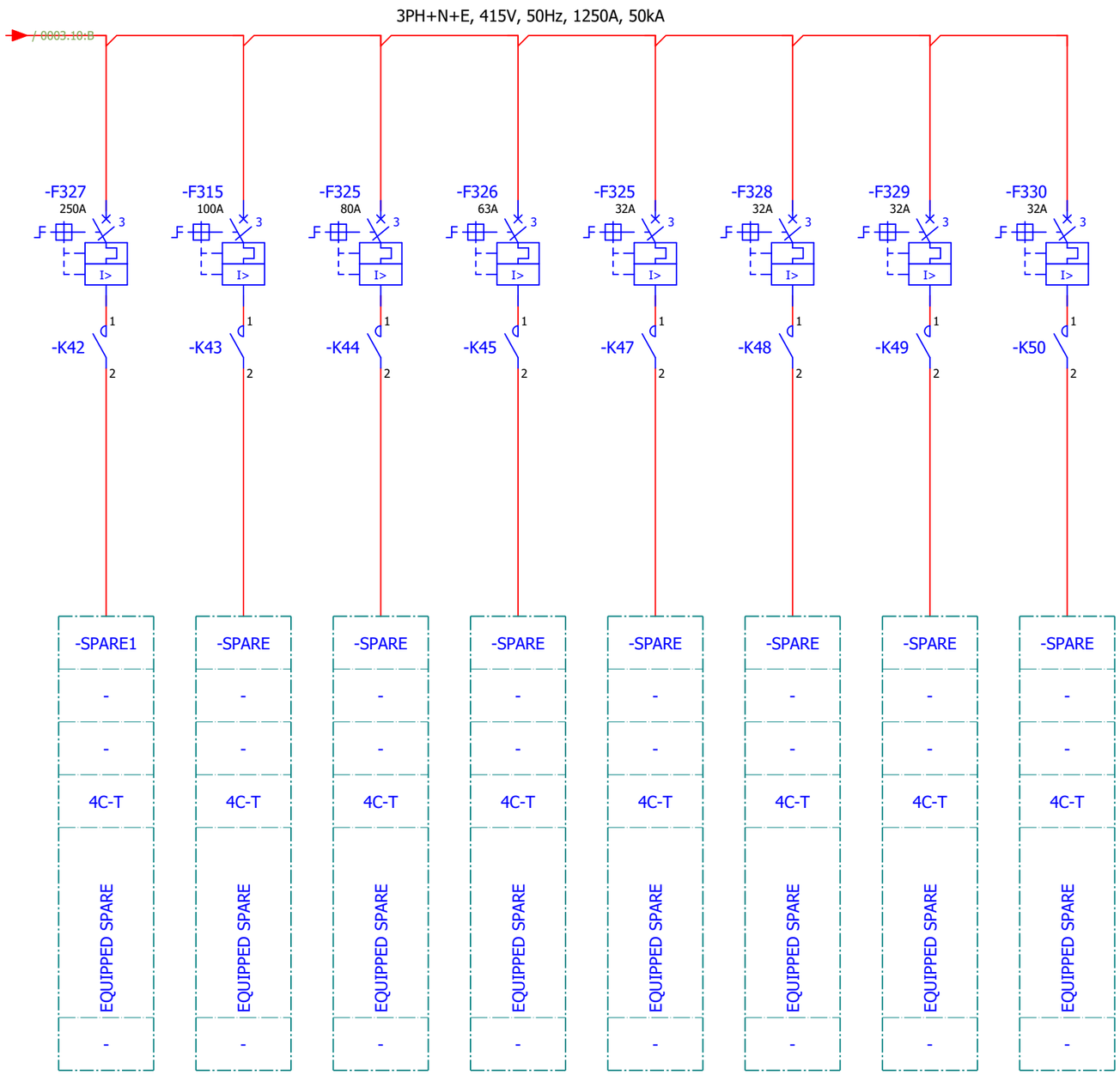
PROJECT: iThemba HVAC

TITLE: MCC-100 SLD PAGE 3 OF 4

FOR TENDER

DESIGNED:	BH	CHECKED:	JHvW
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0340-EL-SLD-0100** REV: **0**



REV	DATE	DESCRIPTION	REFERENCE DRAWING No.	REFERENCE DRAWING DESCRIPTION
0	05 NOV 24	ISSUED FOR TENDER		
C	02 SEP 24	UPDATED FOR DETAILED DESIGN		
B	07 JUN 24	UPDATED FOR PRELIM DESIGN		
A	15 MAY 24	ISSUED FOR INFORMATION		

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CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPLE AGENT: PROJECT ASSIGNMENTS Process & Project Engineers

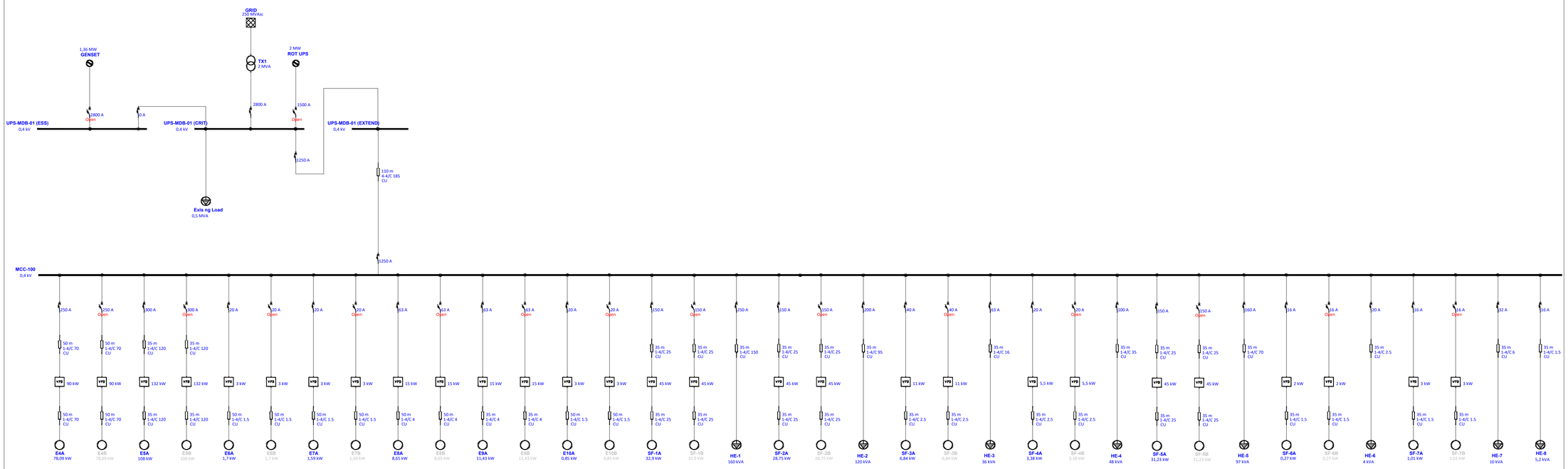
PROJECT: iThemba HVAC

TITLE: MCC-100 SLD
PAGE 4 OF 4

FOR TENDER

DESIGNED:	BH	CHECKED:	JHvW
DRAWN:	BH	SHEET:	

DRAWING NO: **CT0340-EL-SLD-0100** REV: **0**



GENERAL NOTES

REV	DATE	DESCRIPTION	BY
0	13 NOV 24	ISSUED FOR TENDER	BH
A	30 AUG 24	ORIGINAL	MVB

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CLIENT:

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPAL AGENT:

PROJECT ASSIGNMENTS Process & Project Engineers

PROJECT:

iTHEMBA HVAC

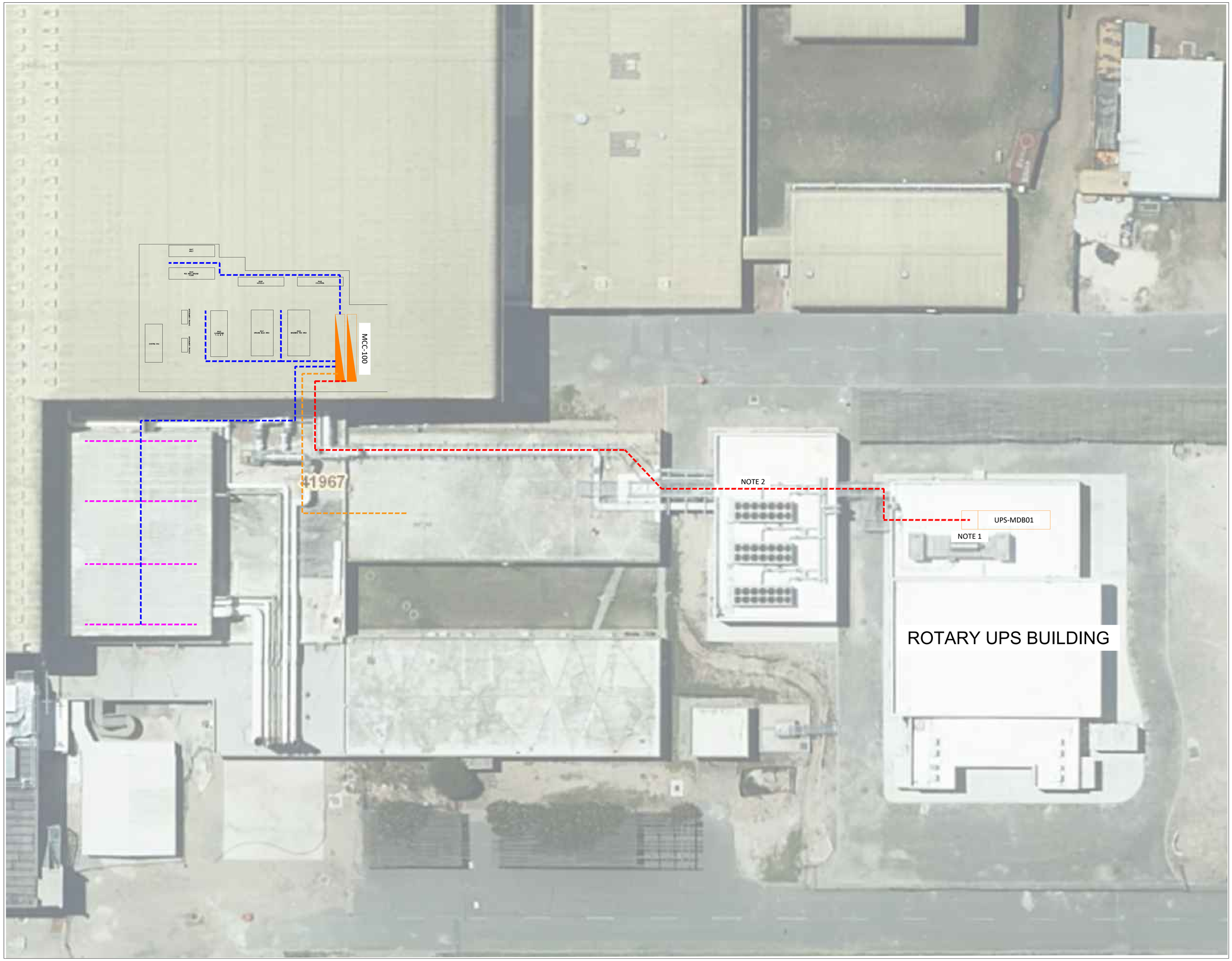
TITLE:

OVERALL SLD

FOR TENDER

DESIGNED:	B HUMAN	CHECKED:	JH VAN WIJK
DRAWN:	B HUMAN	SCALE:	N/A (A0)

DRAWING NO: **CT0340-EL-SLD-0001** REV: **0**



LEGEND

- DISTRIBUTION BOARD
- 400mm HD CABLE LADDER
- EXISTING CABLE LADDER
- 150x75mm HD CABLE LADDER
- 600x75mm HD CABLE LADDER

NOTES

1. UPS-MDB01 EXTENDED TO ACCOMMODATE HVAC MCC-100 FEEDER.
2. USE EXISTING SPARE CABLE LADDER.

REV	DATE	DESCRIPTION	BY
0	05 NOV 24	ISSUED FOR TENDER	BH
A	02 SEP 24	ORIGINAL	BH

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info@buhrmannce.co.za I www.buhrmannce.co.za

CLIENT:
NRF National Research Foundation
iThemba LABS Laboratory for Accelerator Based Sciences

PRINCIPAL AGENT:
PROJECT ASSIGNMENTS Process & Project Engineers

PROJECT:
iTHEMBA HVAC

TITLE:
SITE POWER LAYOUT

FOR TENDER

DESIGNED:	B HUMAN	CHECKED:	JH van Wijk
DRAWN:	B HUMAN	SCALE:	1:200 (A1)

DRAWING NO: **CT0340-EL-LAY-0100**
REV: **0**

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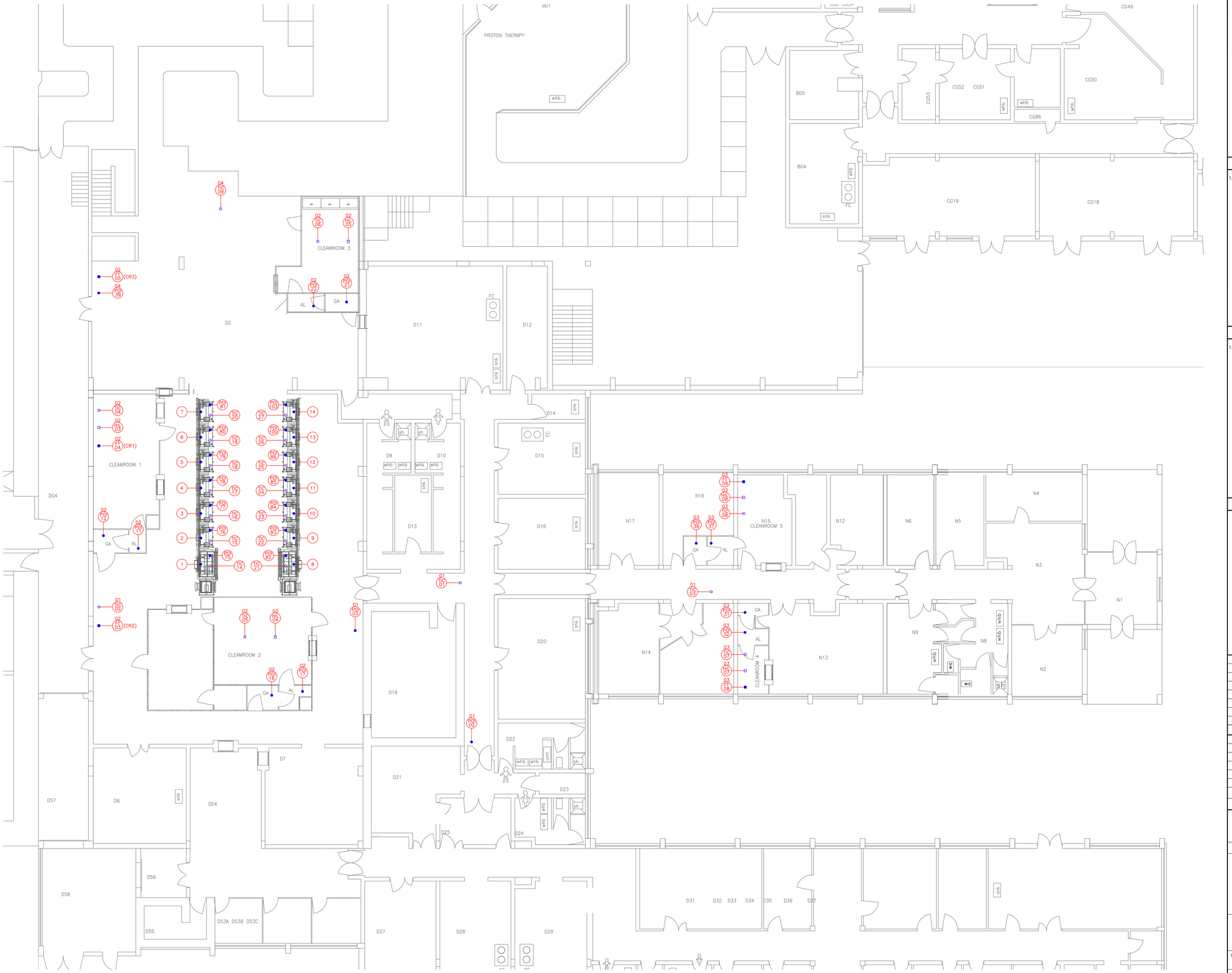

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
1	ISSUE FOR TENDER	MNR	14.11.24	GvdH	SA	22.11.24	–
0	FIRST ISSUE	MNR	02.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: W1986–iTHEMBA LABS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE:
iTHEMBA
GROUND FLOOR EQUIPMENT
LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:75	02.09.2024	MNR	SA

DRG. No.	REV.	SHEET SIZE
W1986–99002	1	A1

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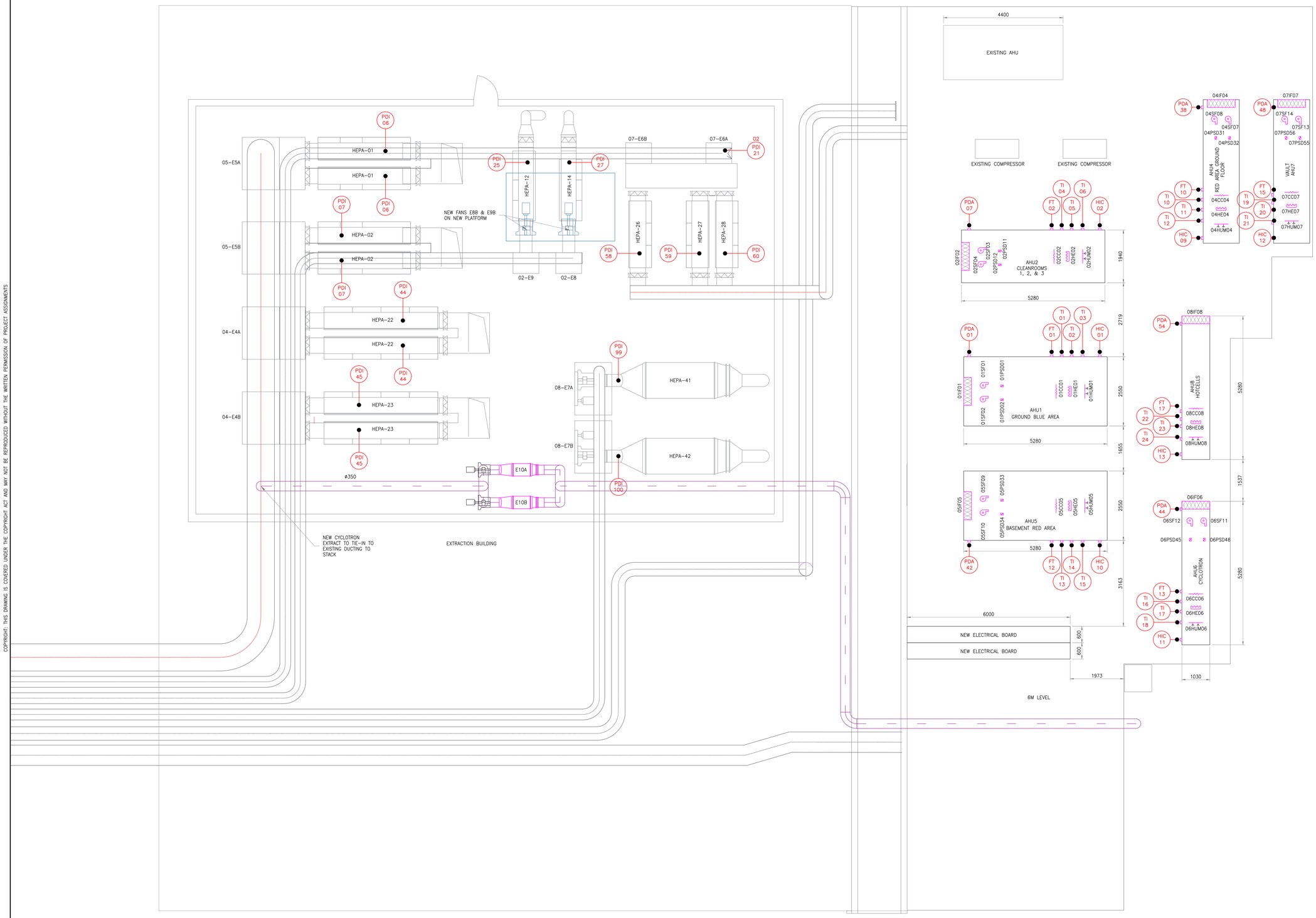

KEYPLAN

NOTES

1. –

HOLDS

1. –

LEGEND

FOR TENDER 22.11.2024

REV	DESCRIPTION	DRAWN	DATE	CHKD	ENG	ISSUED	CLIENT
2	ISSUE FIR TENDER	MNR	14.11.24	BM	SA	22.11.24	–
1	SCOPE UPDATED	MNR	22.10.24	BM	SA	–	–
0	FIRST ISSUE	MNR	09.09.24	GC	GC	–	–

REVISIONS

DRG No	TITLE
–	–

REFERENCE DRAWINGS

AUTOCAD FILE No.

PROJECT ASSIGNMENTS
Process & Project Engineers
Tel: +27 21 511 1325 P.O. Box 78, Howard Place 7450

PROJECT: iTHEMBA IADS HVAC UPGRADE

CLIENT: NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

TITLE: iTHEMBA IADS HVAC UPGRADE 6 METER LEVEL EQUIPMENT LAYOUT

SCALE	DATE	DRAWN BY	PROJECT ENG.
1:50	02.09.2024	MNR	GC

DRG. No.	REV.	SHEET SIZE
W1986-99001	2	A1

Annexure F – Health & Safety Specification

HEALTH AND SAFETY SPECIFICATION

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

FOREWORD

This Health and Safety specification has been compiled under the guidelines of the Occupational Health & Safety Act no.85 of 1993 and amended Construction Regulations.

Huge emphasis is placed on the requirements of Construction Regulation 2014, the Occupational Health and Safety Act and the Baseline Risk Assessment that form the basis of this specification.

Contractors are encouraged to not only read these two documents in isolation but must consider the By-Laws Relating to Community Fire Safety, the relevant National Building Regulations SANS Codes 10400 and the Disaster Management Act 57/2002.

Should there be any contradiction between the document and the Act; the Act shall take preference except where explicitly stated.

Similarly, where this document is silent on a specific Health & Safety requirement, the Act and all relevant legislation shall be used as the minimum requirement.

1. INTRODUCTION AND BACKGROUND

1.1 Background to The Health and Safety Specification

Construction Regulations (February 2014) place the onus on the Client to prepare a preconstruction Health and Safety specification, highlighting all risks not successfully eliminated during design setting standards for Health and Safety during construction phase. The Health and Safety Specification will be based on the findings of the Baseline Risk Assessment.

1.2 Purpose of The Health and Safety Specification

To assist in achieving compliance with the Occupational Health and Safety Act 85/1993 and the promulgated Construction Regulations (February 2014) to reduce incidents and injuries. This specification shall act as the basis for the drafting of the construction phase Health and Safety plan by the Principal Contractor.

The specification sets out the requirements to be followed by the Principal Contractor and their Contractors so that the Health and Safety of all persons potentially at risk may receive the same priority as other facets of the project e.g. Cost, programme, environment, quality etc.

2. HEALTH AND SAFETY SPECIFICATION

2.1 Scope

This specification covers the requirements for eliminating and mitigating incidents and injuries at the **iThemba LABS: HVAC Upgrade to D-Block and N-Block**

Scope of works

iThemba LABS is in the process of upgrading its facility for the production of medical radioisotopes and radiopharmaceutical products under Good Manufacturing Practise (GMP) quality requirements.
The radiological controlled general areas and hotcells are supplied with air from an air handling unit (AHU) which filters and cools fresh air with assistance from an existing chiller plant. Air is exhausted from the radiological controlled general areas via extraction fans through separate HEPA filters and discharged to atmosphere via high-velocity exhaust stacks.
Operations inside the radiological controlled areas and cleanrooms involve the handling and chemical processing of radioactive substances. Differential air pressures inside the cleanrooms and radiological controlled areas, fume cupboards and hotcells must therefore manage by a system designed to maintain negative pressures inside the controlled areas relative to atmosphere, in order to minimise the potential escape of airborne radioactive contamination, whilst maintaining positive pressures inside the cleanrooms relative to the controlled area in order to avoid the ingress of airborne contaminants into the cleanroom.
The 5 cleanrooms are located inside radiological controlled areas, where each cleanroom draws supply air from the general area through high-efficiency particulate air (HEPA) filters. Air is then exhausted via biohazard cabinets with integral filtration systems back to the general areas and eventually to atmosphere via the general area extraction system through a HEPA filter bank and an exhaust stack. Some cleanrooms are equipped with biohazard isolators that are exhausted directly to the exhaust stacks of the general plant through the HEPA filter bank.
The existing heating, ventilation and air conditioning (HVAC) system requires upgrading and/or replacement in order to maintain the required air flow, air temperature and relative humidity in all the radiological controlled areas in accordance with modern GMP requirements as well as the air quality requirements of the cleanrooms to Grade B standard.

Additional Activities but not limited to,

- Site Establishment
- Site clearance (If Applicable)
- Electrical Installations
- Installation of new mechanical plant
- Demolition (Hard & Soft)
- Wet Trades
- Temporary Works
- Working at Heights
- Core Drilling
- Waterproofing
- Ceiling & Partitioning
- Public Safety- Relevant precautions to be taken (Hoarding/Physical Barriers, signage etc.)
- Steel fixing
- Use of Temporary Access
- Balustrades
- **Unforeseen activities**

The Principal Contractor must provide adequate control measures.
The scope also addresses legal compliance, hazard identification and risk assessment, risk control and promoting a Health and Safety culture amongst those working on the project.
The specification also makes provision for the protection of those persons other than employees.

2.2 Provision for Health & Safety Cost

The Principal Contractor and their contractors shall make adequate provision for the cost of Health & Safety Measures during the construction process as required by the Construction Regulation 5(1)(g) and must allow for (but not limited to) adequate funds for at least one **Full-time Senior Safety Officer** until all activities have been completed. Equipment, Signage, Training for all relevant personnel, PPE, Edge Protection, Safe Access, Emergency/Rescue and Equipment, on site monitoring, adequate supervision, safe removal of rubble, adequate welfare facilities, Medicals

3. INTERPRETATIONS

3.1 Application

This specification is a compliance document drawn up in terms of the South African legislation including all relevant South African Standards and where applicable, International Standards and is therefore binding. It must be read in conjunction with all relevant legislation, regulations and by-laws.

3.2 Definitions

The definitions as listed in the Occupational Health and Safety Act 85/1993 and Construction Regulations (February 2014) shall apply.

4. MINIMUM ADMINISTRATIVE REQUIREMENTS

4.1 Notification of Intention to Commence Construction Work

The appointed CHSA shall inform the Provincial Director of the Department of Labour in writing as per the Annexure 1 in terms of CR 3. **The appointed Principal Contractor shall ensure that the Construction Work Permit is conspicuously displayed at the Site Entrance**

Should Direct Contractors be appointed (All Principal Contractors) they shall notify the Provincial Director of the Department of Labour in writing that construction work commences as per the Annexure 2 in terms of CR 4. A copy of the Notification must be placed in the Principal Contractor Health and Safety File on site and one copy shall be sent to the Client.

4.2 Assignment of Contractor's Responsible Persons to Manage and Supervise Health and Safety on Site.

The Principal Contractor shall submit management and supervisory appointments as well as any relevant Appointments in writing (as stipulated by the OHSA and Construction Regulations), prior to commencement of work. Proof of competency must be included.

Note: All appointments shall be done by the Chief Executive Officer/Managing Director or his/her assistant in terms of Section 16 of the OHS Act 85/1993 with exception to the Construction Manager in terms of Construction Regulation 8. The Construction Manager shall be full-time on site unless an Alternate Competent Construction Manager has been appointed in writing. The Principal Contractor shall inform the appointed Health and Safety Agent of any change in appointments

The Principal Contractor shall ensure that competent Construction Supervisors and where applicable that assistant construction supervisors are appointed in writing. Note: This shall apply to all contractors.

Section 8 (OHS Act 85/1993) General duties of employers to their employees
"ensuring that work is performed, and that plant or machinery is used under the general supervision of a person trained to understand the hazards associated with it and who have the authority to ensure that precautionary measures taken by the employer are implemented; and"

Management and supervision of construction work

1. (7) "A construction manager must in writing appoint construction supervisors responsible for construction activities and ensuring occupational health and safety compliance on the construction site".

(8) "A contractor must, upon having considered the size of the project, in writing appoint one or more competent employees for different sections thereof to assist the construction supervisor contemplated in sub regulation (7), and every such employee has, to the extent clearly defined by the contractor in the letter of appointment, the same duties as the construction supervisor: Provided that the designation of any such employee does not relieve the construction supervisor of any personal accountability for failing in his or her supervisory duties in terms of this regulation".

4.3 Competency of Principal Contractor Responsible Persons

The Principal Contractor' competent persons for the various risk management portfolios shall fulfil the criteria as stipulated under the Definition of Competent in accordance with the Construction Regulations (February 2014). Proof of competence for the various appointments must be included prior to start of work.

The Principal Contractor shall ensure that all his/her employees including their contractors have the relevant competency and training for them to perform their duties and or carry out construction activities.

4.4 Compensation for Occupational Injuries and Diseases Act (COIDA) 130 Of 1993

The Principal Contractor and their contractors shall submit a valid Letter of Good Standing from their Compensation Insurer-FEM or Compensation Commissioner to the Client's Representative as proof of registration before they commence work on site. Note: Contractors shall submit proof of registration to the Principal Contractor before they commence work on site. This requirement also applies for all Contractors.

Note:

A client must ensure before any work commences on a site that every Principal Contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993 (Act No. 130 of 1993);

A Principal Contractor must ensure prior to work commencing on the site that every contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993;

4.5 Occupational Health and Safety Policy

The Contractor and their Contractors shall submit a Health and Safety Policy signed by their Chief Executive Officer. The Policy must outline objectives and how they will be achieved and implemented by the Company / Contractor.

4.6 Health and Safety Organogram

The Principal Contractor and their Contractors shall submit an organogram with contact numbers, outlining the Health and Safety Site Management Structure including the relevant appointments / competent persons. In cases where appointments have not been made, the organogram shall reflect the intended positions. The organogram shall be updated when there are any changes in the site Management Structure and must be site specific. **This requirement applies to all Contractors**

4.7 Preliminary Hazard Identification and Risk Assessment

The Principal Contractor and their contractors shall develop Risk Assessments and Method Statements by a competent person for the risk that they foresee during construction.

Safe Work Procedures shall form of hazard identification during the construction phase with control measures. Proof of communication must be provided. A Baseline Risk Assessment has been compiled and forms part of the Health and Specification, the appointed Contractor shall consider these risk assessments when compiling their own risk assessments.

The Principal Contractor must also consult the health and safety committee regarding the monitoring and reviewing of risk assessments on the relevant site

All Risk Assessments shall be conducted by the appointed Risk Assessor/Team PRIOR to start of any work. Note: This shall apply for all contractors.

The Principal Contractor shall ensure that a competent Risk Assessor is appointed in writing and shall be Full-Time on site for the duration of the project.
The Risk Assessor shall have additional training and shall prove competence in line with the SAQA Unit Standard 120330

Principal Contractor to provide a 14-day Look Ahead Hazard Identification Risk Assessment (HIRA) for upcoming activities before they are encountered on a bi-weekly basis and forward an electronic copy to the appointed Health and Safety Agent.

Furthermore, the Principal Contractor and their contractors shall ensure that Daily Safe Task Instructions are conducted prior to any activity with proof placed on file.

Note: The DSTI's shall consist of Hazard Identification with control measures and must be task specific. This applies to all contractors and must be readily available upon request.

Planned Tasked Observations shall be conducted as often as possible but at least monthly to ensure the effectiveness of their existing and current control measures. Contractors may use their own Formats/Templates

The following is a site-specific source of risks that have been identified but is not limited to and must as a minimum, be appropriately addressed by the Principal Contractor in their Health & Safety Plan with Control Measures but is not limited to:

Site Establishment

- Site needs to be adequately Secured as per Client requirements, Hoarding Specification or Drawings
- Offloading of containers/site office
- Secure / Safe Storage of Material, Plant & Equipment
- Ablution Facilities
- Adequate Eating & changing facilities
- Vehicle Access to Site
- Location of existing Services
- Hoarding Permits (If Applicable)
- Dealing with existing structures and Traffic
- Provision for drinking water for all staff
- CoC for temporary electrical supply

- Safe Access i.e. Entry and Exit Points for all Deliveries with adequate control measures is required,
- Public Safety

Hoarding & Access Control

- Public Liability / Access Control / Compliance to Section 9
- Site needs to be Adequately Secured
- Relevant Construction Warning Signage
- Daily inspections with proof placed on file
- Security to be placed on site as needed
- All employees shall have ID copies readily available

The Principal Contractor shall provide adequate site hoarding (Physical Barriers), ensure that the hoarding is Fixed and are at least 1.8m in height or as per the Architects/Clients requirements.

The Principal Contractor shall liaise with the Client/Client Representative regarding safe vehicle and pedestrian access to the site.

Note, "All contractor vehicles will be subjected to a search before entry and when leaving the premises." by iThemba Labs

Public Liability

- Contractor to ensure all safety measures and material storage are stacked safely during the installation period
- Effect of Construction Work on members of the public and existing property e.g. Neighboring Property and roads
- Noise Control
- Dust Control
- Temporary lighting
- Relevant signage
- Hazardous Chemical Substances

Protecting of Persons Affected by Construction (Section 9 of the OHS Act 85/1993)

- Demolition/Removal of material while working above/close to persons neighboring property/persons
- Risk Assessments and Method Statement to be provided and communicated to relevant parties.
- Construction Activities
- Crash Decks or any other suitable means of protection (If Applicable)

Principal Contractor and their Contractors to provide adequate control measures due to adjacent property, roads and walkways

Crane Management System (i.e. All Cranes)

- Competency and Medical Certificates of Operators
- Load Test Certificates
- Emergency Procedures Rescue Plan
- Crane Management Plan/System to be provided
- Emergency/Rescue Procedures
- CR 23 and Driven Machinery Regulations (2015) must be adhered to
- Relevant Inspections conducted by an LME/LMI as per DMR 18(2015)

- Cranes shall be fitted with wind meters/anemometers and must be in line with section 10 and 44 of the OH'S Act 85/1993 and all relevant SANS codes
- Adequate means of communication

Should the crane be found not to be fitted with a gauge/anemometer due to its Design, then the Principal Contractor must provide alternative control measures e.g. the use of a handheld wind gauge/anemometers

Note, The Principal Contractor, their contractors and service providers shall ensure that all vehicles and plant are adequately earthed especially when in close proximity of electrical cables

Lifting and Installation Procedures

- Principal Contractor to submit Full Method Statements of their lifting and installation procedures e.g. manually or mechanically.
- All lifting equipment to comply with Driven Machinery Regulation (2015)
- Guide Ropes shall be used as far as reasonably practicable when busy with all lifting Operations to assist with possible uncontrolled loads especially during inclement weather and restricted areas.
- All work areas shall be adequately demarcated with spotters' present
- Competent Banksman/Riggers shall assist with lifting operations
- Public Safety to be taken into consideration at all times

Procedure for Over Under Head Work

- The appointed contractor shall provide adequate procedures and control measures to avoid any over/under head work activities

Working near existing services

- Principal Contractor to provide control measures to protect the existing services
- Contractor to liaise with Client Representative /Electrical Consultant prior to any electrical activities.
- Contractor to compile method statement and risk assessment when working on live electrical Cables.
- Must be communicated to all staff prior to the activity.
- Identification and protection of existing services i.e. Electrical Cables, Telkom, Data etc. Principal Contractor to provide adequate control measures including cable detection for unknown services
- The Principal Contractor shall apply for and obtain the following permits but is not limited to, Civils Work Permit, Wayleaves
- Principal Contractor to work according to all approved drawings
- Lock-out/Tag-out Procedures

Note, The Principal Contractor shall tie into the existing services with minimal disruption as far possible. Principal Contractor and their contractors to provide adequate control measures when working close to overhead lines including relevant permits/wayleaves. Adequate Earthing required for plant and material when close to High Voltage
Cables

Procedure to identify HV/Electrical Cables (Cable Detection)

- The Principal Contractor shall apply for and obtain the following permits but is not limited to, Civils Work Permit, Wayleaves
- The appointed contractors shall provide procedures for the identification of all HV/Electrical Cables

Electrical Installations

- A competent contractor must be appointed to install all specialized cables such as low/high/mega voltage cables in and around the site.
- Must be carried out under supervision.
- Excavations
- Cable laying/Stringing
- Lock out/Tag out procedures
- Working with live cables/live installations
- Working in existing/new substations
- Tying in of new electrical lines onto existing lines
- Working on control and switch gears
- Switching process and Isolation operations
- Working with & in close proximity of live apparatus
- Compliance with SANS 10142
- Relevant Permits to be obtained
- Diverting of existing cables
- Protecting of existing cables

The Principal Contractor must communicate with the appropriate Consultant and Client when/if they need any amendments to the design relating to improve safety

Civils Work

- Excavation & Compliance to Construction Regulation 12, 13 and 10, 23
- Compliance with the South African Road Traffic Signs Manuel (SARTSM) Chapter 13 (If Applicable)
- Persons/Equipment falling into Excavations- Control measures required
- Edge Protection
- Asphalt Surfacing
- Traffic and Pedestrian Accommodation
- Heavy Construction Vehicles/Mobile Plant
- Road Cleaning to be maintained daily
- **Procedure to identify underground HV/Electrical Cables including unknown services**

Note, the Principal Contractor shall use Cable Detectors or any other suitable methods to identify unknown services. The Principal Contractor shall tie into the existing services with minimal disruption as far possible

The Use of Troxler's: Contractors to ensure compliance

- License for use of Troxler and density material and equipment
- Leak Test Certificates
- Calibration Certificate
- Procedure when transporting with relevant signage displayed
- Risk Assessments
- Proof of Competency for operators

Plant & Machinery

- Principal Contractor to provide designated area should any plant and machinery be parked at night. Plant to be fully secured to avoid possible unauthorized access. Adequate lighting required as and when needed
- Safe Access required for all operations including deliveries

All operators shall be in possession of a valid Drivers' License

Traffic Management Plan to include but is not limited to,

- Traffic Plan and Layout to be approved and signed by Engineer/Client Representative and relevant local authorities
- Delivering of Material and Equipment
- Advance construction Signage, Competent Flagmen and Compliance with all relevant regulation and legislation including the South African Road Traffic Signs Manuel (SARTSM) Chapter 13. (If Applicable)
- Plan to be Monitored and Reviewed at least monthly (Every 30 Days) or as the building programme/activities changes
- Adequate barriers and delineators to be provided and placed strategically as needed
- Procedure for maintaining road signage
- All employees working in or close to the road to wear Hi-Viz vests at all times
- Flagmen shall be provided and readily available to assist with all Deliveries
- Flagmen shall not be on duty for a period longer than 8 (eight) hours per day. Flagmen to be rotated as needed (If Applicable)
- **Heat and Inclement weather to be considered for all Flagmen. Adequate control measures required**

Principal Contractor and their contractors shall provide adequate control measures when working close to public roads. Note, the Principal Contractor to consider safe drop off zones if and when needed

No road may be closed without the engineer's approval and traffic shall be accommodated as per the approved drawings/layout. Pedestrian and vehicle access are of paramount importance with relevant signage displayed

Note, the Principal Contractor shall provide adequate control measures for both internal and external roads

Working at Heights

- Principal Contractor and their contractors to compile a Site-Specific Fall Protection Plan in Line with CR 10.

Scaffolding and Working at Heights

- Principal Contractor and their contractors to compile a Site-Specific Fall Protection Plan in Line with CR 10.
- The Scaffolding must comply with CR 16 and SANS 10085:1-2004
- Process to Remove Equipment, Tools Scrap, Material etc. to and from Elevated Positions.
- System to Protect Persons / items or material falling from any elevated positions/areas.
- Design Drawings to be provided by a competent person
- Daily inspections to be conducted or prior to use and recorded at least weekly or as per SANS 10085

Note: No Trestle or Walkthrough Scaffolds may be used on site **Temporary**

Works (Including possible bracing and shoring of excavations)

- The Principal Contractor shall comply with CR 11, CR 12, CR10 and CR 13
- Competent persons to be appointed in writing **(Proof of competency to be provided for all relevant appointments and shall include competency for all employees erecting temporary works)**
- Erecting and Stripping of Temporary Works to be done by competent persons
- Approved Design Drawings issued by a competent person to be done by competent persons
- Casting of Concrete

- Daily Inspections to be conducted by competent person
- Control measures should Drilling/ Cutting into Slab be required (If Applicable)
- Adequate Edge Protection- **No Danger Tape or shade cloth**
- Authorization to be provided in writing by a competent person **(Before Concrete Pour)** and
- Handover Certificates/Signed off by a Competent Person **before Stripping any temporary works structures**
- Authorization to be provided in writing by a competent person (Before Concrete Pour) and Handover Certificates/ Signed off by a Competent Person before Stripping any temporary works structures

The appointed contractor shall closely monitor and control all construction loads when busy with temporary works. The contractor shall consult the appointed Structural Engineer and verify any specific requirements

Note, the Principal Contractor and their appointed contractor/temporary works team shall provide a procedure to ensure that edge protection is provided at all times especially when erecting or removing/stripping temporary works structures

Unplanned collapse of Material or Structures- Contractor to provide control measures

- Contractor to provide adequate protection to avoid falling objects e.g. Crash Decks or any other suitable protection as and where needed
- Principal Contractor to assess all work areas prior to start of work.
- Structures to be inspected by competent persons to render the structure safe.
- Principal Contractor to provide full method statement and risk assessment
- The structure to be maintained in such a manner so that it remains safe for continuous use.
- Records of inspections and maintenance are to be kept on file and must be made available on request to an inspector.

Note: Principal Contractor and all contractors must comply with Construction Regulations (CR) 11

Structural Steel

- Principal Contractor to submit Task Specific Method Statements and Task Specific Risk Assessments of their lifting and installation procedures e.g. Manually or Mechanically.
- Full compliance with CR 9, 10, CR 23 and DMR 18 (2015)
- Guide Ropes shall be used as far as reasonably practicable when busy with all lifting operations to assist with possible uncontrolled loads especially during inclement weather and restricted areas.
- Only competent persons to conduct operations
- Task Specific Fall Protection & Rescue Plan
- All work areas shall be adequately demarcated with spotters' present
- Safe Access required at all times

Hot Works

- Principal Contractor and their contractors to ensure that Fire Equipment and adequate precaution measures are in place when grinding, welding / hot works etc. including PPE and demarcation
- Hot work permits to be issued once the area has been inspected by a competent person and declared safe with proof placed on file. **(Note- All permits should not exceed one (1) working day)**
- Compliance with CR 25 & 29

Temporary Flammable Liquid/Material Storage

- Principal Contractor to compile a risk assessment
- Flammable to Store be provided
- Ensure that adequate ventilation with Relevant Signage and Fire Precautions are provided.
- Adequate Fire Equipment to be readily available.
- Comply with all relevant legislation and regulations including the Community Fire Safety
- By-law Compliance and CR 25 & 29
- Control measures to avoid possible spillage or contamination
- Drip Trays shall be provided and be used as and when needed

Working near Electrical Cables

- Contractor to provide full method statement and risk assessment when working on live electrical Cables. Must be communicated to all staff prior to the activity.
- All Staff must be provided with the relevant Personal Protective Equipment (PPE)
- Lock out procedures

- **Procedure to identify HV/Electrical Cables** (Cable Detection)
- The Principal Contractor shall apply for and obtain the following permits but is not limited to, Civils Work Permit, Wayleaves

Safe Use of Portable Electrical Equipment

- Electrical Drilling Machine
- Angle Grinder
- Kango / Jack Hammer
- High Pressure Equipment
- Any Other Equipment used by Principal Contractor
- All portable electrical tools shall comply with all relevant legislation, regulations, standards and best practices

Emergency Preparedness

- **Principal Contractor to liaise with iThemba Labs regarding their emergency procedures**
- Emergency Evacuation Plan with Relevant Emergency Numbers
- Revision of Emergency Plan
- Principal Contractor to monitor site conditions and conduct Evacuation Drills as and when needed with proof placed on file (Roll call, report to be placed on file etc.)
- Sufficient workers are Trained (Competent) in the use of Fire Extinguishing Equipment
- Emergency assembly point to be established with the relevant signage displayed.
- Air horn/alarm/siren to be provided on site
- The Principal Contractor shall make provision and have procedures in place for possible sewer spillage

Dust Control

- Principal Contractor to provide a procedure to control dust and ensure that this is maintained daily
- Contractors shall use Dustless Grinders when working in restricted areas

Noise Control

- Principal Contractor to provide a procedure to control noise and shall comply with CR 9, Section 8 of the OH'S Act 85/1993 and the Noise-induced Hearing Loss Regulation
- Hearing protection to be used where noise levels cannot be reduced below 85dBA and comply with the OH'S Act 85/1993

Manual and Mechanical Handling

- Principal Contractor to provide control measures
- **Ergonomics related hazards must be analysed, evaluated and addressed in a risk assessment.**

Mechanical Installations

- Principal Contractor to provide control measures

Protection of Storm Water System

- Method to Prevent Run Off into Storm Water System
- Principal Contractor to provide control measures

Demolition during construction phase

- Adequate measures to ensure the safety of public
- Identifying services of live services
- PPE
- Relevant signage to be displayed
- Noise- Procedure to control noise to be in place.
- Use of Portable Power Tools
- Combustibles
- Debris
- Housekeeping
- Demolition method statements & Risk Assessments
- Dust inhalation

Note, The Principal Contractor shall liaise with the Structural Engineer and consider all engineers reports

Working Close to other Contractors

iThemba Labs may use their own contractors and may be required to work simultaneously at the facility. The Principal Contractor and their contractors shall provide adequate control measures and ensure good communication between all interested parties.

Lift installation – repair and maintenance

- The Competent Lift Contractor must comply to SANS 50081-1;1545-1; 1545-2; 1545-3 and the Lift, Escalator and Passenger Conveyor Regulations.

Possible Working Close to Water (if applicable)

- The Principal Contractor shall comply with CR 26, CR 9 and Section 8 and 9 of the OH'S Act 85/1993
- Emergency Procedures with Rescue Plan
- Contractor to specify Safe Means of Access
- Contractor to provide what control measures will be provided for employees

Health Hazards

- Possible Existing hazardous materials
- Contaminated land
- Polluted drinking water
- Working with cementitious material
- Dust
- Noise
- Vibration

- Inhaling of Bituminous material (if applicable)
- Working with fuel, lubrications and other chemicals
- Vermin
- Possible Radiation Exposure (Block A, N & D)

Any work that must be performed in any Radiation Protection Controlled Area requires the RSHEQ Department: Radiation Protection Manager to be notified before such work is commenced.
Contractors will adhere to all iThemba LABS Radiation Protection Protocols. Failure to do so shall result in termination of all contracts and removal from the premises.

In addition All material removed to be screened for radiation contamination before discarded with normal building waste.

Contact Person
Mr. Philip Beukes
Manager: RSHEQ
Radiation Safety Health Environment & Quality
T: 021 843 1211
E: philip@tlabs.ac.za

Environmental Management
- Contaminated Land/Water
- Air and Dust Pollution;
- Noise Pollution;
- Water Pollution;
- Possible Soil Pollution;
- Normal and abnormal operations;
- Waste Management practices;

Principal Contractor shall consult the Client/ Professional Team of any discovery work of Change in Design

Principal Contractor and their contractors to ensure that the risk assessments, as well as other risks identified by them, are updated and reviewed at least every 30 days, as the risk changes and after any incident and must be recorded and communicated to all relevant parties with proof placed on file- CR 9. Note: All reviews must be signed off by the appointed Risk Assessor. All identified risks and hazards must be based on a documented method (method statements). Furthermore, the Principal Contractor and their contractors shall provide a Monitoring and a Review Plan including a Risk Register indicating all activities.

The Principal Contractor shall comply with the Occupational Health and Safety Act (OH'S Act) 85/1993, Construction Regulations and all relevant Legislation.

Note: Principal Contractor must ensure as far as is reasonably practicable, ergonomic related hazards are analysed, evaluated and addressed in a risk assessment.

The Principal Contractor shall comply with all relevant Environmental Requirements as and when needed

4.8 Fall Protection Plan:

Working at heights includes any work that takes place from an elevated position.
The Principal Contractor and their contractors must submit a risk/task-specific Fall Protection Plan in accordance with Construction Regulations 10. The Fall Protection Plan must be task specific, be reviewed at least every 30 Days, as the risk changes and after any incident. Contractors to ensure that medicals are provided for all persons exposed to elevated positions.

All employees working on heights must have a Medical Certificate issued by an Occupational Health Practitioner (OHP) in the form of an Annexure 3

A fall protection plan must include

(a) a risk assessment of all work carried out from a fall risk position and the procedures and methods used to address all the risks identified per location;
(b) the processes for the evaluation of the employees' medical fitness necessary to work at a fall risk position and the records thereof;
(c) a programme for the training of employees working from a fall risk position and records thereof;
(d) the procedure addressing the inspection, testing and maintenance of all fall protection equipment; and
(e) a rescue plan detailing the necessary procedure, personnel and suitable equipment required to affect a rescue of a person in the event of a fall incident to ensure that the rescue procedure is implemented immediately following the incident.

4.9 Health and Safety Officer 8(5) (Full-time)

The Principal Contractor shall appoint at least one **Full-time Senior** Safety Officer on site until all activities has been completed. Proof of competency to be attached to each appointment.

The Safety Officer shall be registered with the South African Council for the Project and Construction Management Professions (SACPCMP)

The appointed Principal Contractor and their contractors may determine and agree on the frequency of their contractors' safety officers' visits to site

The following health & safety officer related duties will be required and must be carried out but is not limited to.

a) Health & safety audits and inspections including administrative and physical audits of all Contractors' health & safety plans, files and activities, and record findings in the form of audit reports to be kept in the health & safety file;
b) Weekly inspection reports – site hazard survey findings recorded, and actions taken recorded;
c) Assess, and finally approving Contractor H&S plans;
d) Maintain and co-ordinate the Principal Contractor health & safety management plan and file;
e) Investigate near misses, incidents and injuries;
f) Co-ordinate the function of reviewing the hazard identifications and risk assessments;
g) Assist with method statements and safe work procedures and checking whether the responsible persons follow these safe work procedures;
h) Enforcing discipline on the site and checking on compliance with safety procedures, standards and rules;
i) Implement and enforce the site hot work permit system;
j) Ensure that public protection protocols are adequate and well maintained;

k) Conduct planned job observations to check whether workers are carrying out activities in accordance with the safe work procedures;
l) Fire risk assessments and enforcement;

Note: "No contractor may appoint a construction health and safety officer to assist in the control of health and safety related aspects on the site unless he or she is reasonably satisfied that the construction health and safety officer that he or she intends to appoint is registered with a statutory body approved by the Chief Inspector and has necessary competencies and resources to assist the contractor",

4.10 Medicals

The Principal Contractor to ensure that all his or her employees including all appointed contractors have a valid medical certificate of fitness specific to the construction work to be performed and issued by an Occupational Health Practitioner in the form of an Annexure 3.

Failing to comply may result in the relevant employees being stopped without compensation to protect the Client in terms of CR 5

Furthermore, the Principal Contractor and their contractors must provide a tracking register clearly indicating the full names, surnames and ID numbers of employees with the expiry dates of all medical certificates Note: Expiry Dates of all medicals shall be clearly displayed on all induction cards

4.11 Health and Safety File (HSF)

The Principal Contractor and their contractors shall, in terms of CR 7(1), maintain the HSF on site always. The HSF is a file with permanent records containing information on aspects of the construction project - which will be necessary to ensure the health and safety of any persons who may be affected by the construction work. The HSF must include all documentation required in terms of the OH'S Act and Regulations and must also include a list of all Contractors on site that are accountable to the Principal Contractor and the agreements between the parties and details of work being done.
The Principal Contractor shall appoint a suitably qualified person to prepare the HSF and to keep it up to date for the duration of the contract

4.12 The HSF Shall Include At Least The Following Information but is not limited to,

a) Notification of Construction Work (CR 3 & 4)
b) Copy of OHSA (updated) (GAR 4.)
c) Proof of Registration and good standing with a COIDA Insurer (CR 5(1)(j) (The Principal Contractor shall submit a letter of good standing with the compensation Insurer, at the tender stage).
d) OHSP agreed with client including the underpinning Risk Assessment/s & Method Statements CR 9(1)
e) Designs/drawings including scaffolding and Temporary works (form work)
f) A list of Contractors including copies of the agreements between the parties and the type of work being done by each Contractor (CR 7)
g) Appointment/Designation forms h) Registers
h) Inductions

Method Statements must be provided for all High-Risk activities and must be approved and signed by the Construction Manager. All high-risk method statement must be made available to the relevant Engineers for comment. All documentation must be readily available to the Client/Client Representatives for perusal or comment

The HSF/CD shall be handed over to the Client on completion of the contract. It must contain all the documentation as set out above, or as instructed, as well as any handed to the Principal Contractor by any subcontractors together with a record of all drawings, designs, materials used and other similar information concerning the completed project.

4.13 Health and Safety Representative(s)

The Principal Contractor and their Contractors shall ensure that competent Health and Safety Representative(s) are appointed under consultation and trained to carry out their functions as soon as the total workforce has reached a number of 20 employees or more. **Should the Principal Contractor and their contractors have less than 20 employees, then the accumulative number of employees working on site shall apply.** The appointments must be in writing. The Health and Safety Representative shall carry out regular inspections at least monthly, keep records and report all findings to the Responsible Person forthwith and at Health and Safety meetings.

Note: The Principal Contractor and their contractors shall ensure that all certificates provided are issued by an accredited service provider as required by the National Qualification Framework Act 67/2000 and SAQA

The number of representatives for each contractor shall be as per Section 17 of the OHS Act 85/1993, but as a minimum, The Principal Contractor shall appoint at least one competent Health and Safety Representative on the project.

4.14 Health and Safety Committees

Principal Contractor shall organize **at least monthly** Health & Safety meetings. Minutes and records shall be kept. Principal Contractor Health & Safety representative and responsible person shall attend this meeting. Principal Contractor to ensure that all Contractor Representatives attend these meetings.
Note, The Principal Contractor and their contractors site management must form part of these meetings. It is recommended that the Construction Manager or his assistant act as chairperson. These meetings shall be conducted regardless how many contractors are appointed or as soon as there are 20 or more employees on site

The Principal Contractor must consult the health and safety committee regarding the monitoring and reviewing of risk assessments on the relevant site

4.15 Health and Safety Training

4.15.1 Induction

Principal Contractor shall ensure that all (including site visitors etc.) undergo site- specific induction presented by a competent person and proof placed in the Safety File prior to start of work. Employees to carry proof of inductions. **Note: Induction cards shall clearly indicate the full names, surnames (No Nick Names), ID numbers, picture of employees, including the expiry dates of all medical certificates of the relevant employee. Visitors shall also have induction cards**
The Principal Contractor shall ensure that the following documentation is communicated to all employees working on site prior to induction and shall include but is not limited to, Task Specific Risk Assessments, Method Statements, Safe Work Procedures, Fall protection Plan.
It is recommended that all inductions take place in a safe space/zone thus ensuring employees and visitors are not exposed to any immediate construction activities/hazards.

Note, Additional Inductions may be required by iThemba Labs

4.15.2 Awareness

The Principal Contractor shall ensure that, on site, toolbox talks take place at least weekly. These talks should deal with risks relevant to the construction work at hand. A record of attendance shall be kept in the Health and Safety file. All Principal Contractor have to comply with this minimum requirement. Contractors to ensure that the discussion is recorded on file (Topics with notes)

4.15.3 Health and Safety Site Rules

The Principal Contractor must develop a Set of Site-Specific Health and Safety Rules that will be applied to regulate the Health and Safety aspects on Site. Security and Access control must be included in the rules and those non-employees or visitors will not be allowed on site unaccompanied.

Note, the Principal Contractor shall consult the Client/Client Representative for any additional requirements

The Principal Contractor and their contractors shall comply with all rules as required by iThemba Labs

4.15.4 Competence

In accordance with the Construction Regulation the Principal Contractor shall appoint, in writing, competent persons (in addition to the Construction Managers – CR 8 (1)(2) & Construction Supervisor/s-8(7)(8) responsible for supervising construction work for the following work situations that may be expected on the site of the works, as applicable to the project.

The Principal Contractor shall ensure that all his/her employees including their contractors have the relevant competency and training for them to perform their duties and or to carry out construction activities.

A competent person may be appointed for more than one part of the construction work with the understanding that the person must be suitably qualified and able to manage and supervise at the same time the construction work on all the work situations for which he/she has been appointed.

The appointment of competent persons to supervise parts of the construction work does not relieve the Principal Contractor from any of his responsibilities to comply with all requirements of the Construction Regulations.

Note: The Principal Contractor and their contractors shall ensure that all Site Management and Site Supervision have at least training in Legal Liability

Note: The Principal Contractor and their contractors shall ensure that all certificates provided are issued by an accredited service provider as required by the National Qualification Framework Act 67/2000 and the South African Qualifications Authority (SAQA)

The Principal Contractor shall assess all work areas on a regular basis and ensure that sufficient and competent Supervision is present at all wok areas

4.16 Environmental

The Contractor must ensure that all its Contractors, employees and all persons entering the site during construction are fully aware of the environmental issues and all relevant regulations

It is the Contractor's responsibility to stay within the parameters of his/her activities and to execute said tasks within the applicable regulated Norms and Standards.

It is the responsibility of the Contractor to:

- Report to the Client/Client Representative any environmental incidents, e.g. hazardous substances spillage, damage to vegetation, public complaints, etc.

5. GENERAL RECORD KEEPING

The Principal Contractor and their Contractors shall keep and maintain Health and Safety records to demonstrate compliance with this Specification, with the OHS Act 85/1993, and with the Construction Regulations (February 2014).

The Principal Contractor and their contractors shall ensure that all records of incidents / accidents, emergency procedures training, inspections, audits, etc. are kept in a Health and Safety file held in the site office. The Principal Contractor must ensure that every contractor keeps and maintains its own Health and Safety file and must be readily available at all times. (The file must include the Contractor's health and safety plan). These records are crucial for inclusion in the Principal Contractor consolidated health and safety file for handover to the Client on completion of construction work.

6. HEALTH AND SAFETY AUDITS, MONITORING AND REPORTING

The Client's Health & Safety Agent shall conduct Health and Safety audits/inspections as and when needed. Operations including a full audit of physical site activities as well as an audit of the administration Health and Safety. The Health and Safety Agent may conduct unannounced visits/inspections and audits as and when needed.

The Principal Contractor shall provide a Corrective Action Plan within 3 days for all non-compliances noted in the Audits conducted by the Client's Health and Safety Agent.

This Plan shall include proof that all non-compliances have been rectified and an electronic copy shall be sent to the Client Representative including the appointed Health and Safety Agent as proof of items closed out

The Principal Contractor and their contractors are obligated to conduct similar audits on their Contractors. Detailed reports of the audit findings and results shall be reported on at all levels of project management meetings. Copies of the reports shall be kept on file and must be readily available for inspection. The Principal Contractor must audit their Contractors and keep records of these audits in their Health and Safety files and must be available on request.
The Principal Contractor shall ensure that all contractors documentation is assessed and approved prior to start of work with proof placed on file.

The Principal Contractor shall conduct continuous audits where contractors fail to comply and not only every 30 days including a procedure for continuous monitoring of all contractors. Note: The Principal Contractor shall provide at least one Consolidated/Comprehensive Contractor Audit every 30 days with proof placed on file

6.1 Internal Audits/Inspections

The Principal Contractor safety manager/safety officer must conduct weekly inspections/audits with a detailed report. A copy of these inspections/audits must be placed on file for perusal by the Health and Safety Agent. **These reports shall include photographic evidence and must be closed out ASAP.**

Urgent/High Risk items to be rectified immediately or where there is an immediate threat to the health and safety of persons.

7. EMERGENCY PROCEDURES

The Principal Contractor/s shall submit a detailed Emergency Procedure and Evacuation Plan with assembly point and contact details in the case of any emergency.

The procedure shall detail the response plan including the following key elements:

- List of key competent personnel;
- Details of emergency services;
- Actions or steps to be taken in the event of the specific types of emergencies;
- Information on hazardous material/situations.
- Emergency procedure(s) shall include, but shall not be limited to, fire, spills, accidents to employees, use of hazardous substances, bomb threats, major incidents/accidents, etc.
- Possible Fires
- Adequate Signage to be displayed for easy evacuation
- Clear and obstruction free access routes
- Emergency Contact numbers to be clearly displayed at all times
- Community/Civil Unrest
- Detailed drawings/ layout plans of evacuation routes and must be updated and be in line with all construction activities

Principal Contractor to provide a procedure to ensure that no access routes are closed without employees being aware of the new access routes. All access and emergency access routes must be safe and obstruction free at all times. Relevant signage shall be provided and displayed clearly indicating the escape routes

It is recommended that all escape routes and signage be discussed with the Employer/ Fire Consultant

The Principal Contractor shall inform and notify the Client, Client Representative and all relevant authorities forthwith, of any emergencies, together with a record of action taken. This shall be confirmed in writing as soon as possible after the incident.

A contact list of all service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc.) must be maintained and available to site personnel. These procedures shall form part of the OHSF.

The Principal Contractor to ensure that the relevant staff is trained to perform such duties as required by the OHS Act. All emergency procedures must be monitored on a regular basis and must be in line with the building program.

The Emergency/Evacuation plan and routes must be revised on a regular basis for all employees and contractor (including staff) should any unforeseen event take place during the implementation phase/s of the project.
Evacuation Drills must be conducted as and when needed. Contractor to assess all activities to ensure this is implemented with proof placed on file.

Note, All planned evacuation drills must be communicated to iThemba LABS RSHEQ Department with written approval prior to any drills. Contractor to assess all activities to ensure this is implemented with proof placed on file.

Emergency Preparedness and Response plan shall include but is not limited to, First Aid, Fire and Explosions, Hazardous Chemical Substance and Flammable Substances spillage, Civil unrest and violence etc.

Principal Contractor to Liaise with the Client Representative/Client Representative for any additional procedures

8. FIRST AID BOXES AND FIRST AID EQUIPMENT

The Principal Contractor and their Contractors shall appoint in writing First Aider(s).
The appointed First Aider(s) are to be sent for accredited first aid training. Valid certificates are to be kept on site. All Contractors with more than 5 employees shall supply their own first aid box. Principal Contractor with more than 10 employees shall have trained, certified first aider on site at all times & First aid Box stocked always.

9. ACCIDENT / INCIDENT REPORTING AND INVESTIGATION

Injuries are to be categorized into first aid, medical, disabling and fatal. The Principal Contractor and their contractors must stipulate in its construction phase Health and Safety plan how it will handle each of these categories. When reporting injuries to the Client, these categories shall be used. All contractors must investigate and report on the 4 categories of injuries to the Principal Contractor at least monthly.
Contractors must investigate injuries and accidents involving their employees within seven days of the incident in the form on Annexure 1 (General Administrative Regulations) and forward a copy on the investigation report to the Principal Contractor forthwith.

The Principal Contractor shall conduct their own detailed investigation where their contractors/visitors are involved in any incident. These reports must be readily available for any duly authorised person and must include but not limited to, the Client, Client Representative, H&S Agent, Department of Labour.

All incidents reportable in terms of the provision of Section 24 of the OHS Act 1993 must be reported to the local Dept. of Labour in the prescribed manner.
Should construction work be finished/completed within 3 days after any occurrence, the investigation shall be conducted before such construction work is completed.

The Principal Contractor and their contractors must report all injuries to the Client in the form of a spreadsheet, which includes all contractor injuries/incidents including near misses, property damage and man-hours worked for the month as well as the cumulative total.
This report must be done on a monthly basis and must form part of the Principal Contractor' progress report.
Note: Principal Contractor must provide an Incident Register and must record all incidents when applicable

The Principal Contractor shall immediately notify the Client and Client's Health & Safety Agent of any hazardous or potentially hazardous situations that may arise during the performance of construction activities immediately or before end of shift by means of a flash report.

Furthermore, the contractor shall liaise with the Client prior to any communication with any Media source

10. HAZARDS AND POTENTIAL SITUATIONS

The Principal Contractor shall immediately notify the Client and Client's Health & Safety Agent of any hazardous or potentially hazardous situations that may arise during the performance of construction activities.

11. PERSONAL PROTECTIVE EQUIPMENT (PPE) AND CLOTHING

The Principal Contractor shall ensure that all workers are issued and wear but is not limited to i.e. hard hats, protective footwear, Hi-Viz vests and overalls. The Principal Contractor and their Contractors shall make provision and keep adequate quantities of SANS approved PPE on site at all times.

Contractors to provide control measures should employees continuously fail to use the prescribed PPE. Worn or tattered personal protective clothing will not be permitted on site

Note: The Principal Contractor and their contractors shall ensure that All Safety harnesses/Fall Protection Equipment are inspected by the user on a daily basis and kept on record. The fall protection plan developer / competent person is responsible to ensure that at least monthly inspections are undertaken with proof placed on file.

The Principal Contractor and their contractors shall ensure that Double Lanyard Safety Harnesses with Scaffold/Pylon Hooks are used as a minimum requirement

12. OCCUPATIONAL HEALTH AND SAFETY SIGNAGE

The Principal Contractor shall provide adequate on-site OHS signage. Including but not limited to: "no unauthorized entry", "report to site office", "site office", and "hard hat area". Signage shall be posted up at all entrances to site as well as on site in strategic locations e.g. Access routes, entrances to structures and buildings, scaffolding and other potential risk areas / operations. All Contractors to adhere.

Signage may not be erected in such a manner that it interferes with sight lines or pedestrian movement.

Note, adequate signage required for e.g. Drinking/Not Drinking Water/Effluent Water etc.

13. CONTRACTORS

The Principal Contractor shall ensure that all Contractors appointed by them comply with this Specification, the OHS Act 85/1993, and Construction Regulation (February 2014).
The Principal Contractor may only appoint a contractor after approving the contractor's health & safety plan with proof placed on file. The Principal Contractor must audit each of its Contractors at least monthly, with audit reports filed in the health & safety file on site.

The audit must include an administrative assessment as well as a physical inspection of the contractor's health & safety system.

The Principal Contractor must stop any Contractor from carrying out construction work that is not in accordance with the Principal Contractor or Contractor's Health & Safety Plan or if there is an immediate threat to the health and safety of persons.

Note- Failing to comply may result in the relevant employees and activities being stopped without compensation to protect the Client in terms of CR 5

- The Principal Contractor shall take all reasonable steps necessary to ensure co-operation between all Contractors to enable each of those Contractors to comply with the provisions of these regulations;

- The Principal Contractor must ensure that their Contractors are registered and in good standing with a recognized compensation fund or with a licensed compensation insurer prior to work commencing on site;

- The Principal Contractor must ensure that potential Contractors submitting tenders have made provision for the cost of health and safety measures during the construction process; The Principal Contractor shall discuss and negotiate with their Contractor the contents of the health and safety Plan and shall finally approve that plan for implementation;

14. NO-GO AREAS

Principal Contractor and their contractors to avoid all no-go areas and ensure that all relevant parties/employees and visitors are informed.

Note: The facility is operative, no employees of any contractors are allowed to enter any part of the Building user's environment unless permission is given in writing from the End User Department or Client Representative

Additional areas may be identified by the Client if applicable

15. PHYSICAL REQUIREMENTS

15.1 Existing Structures/Roads/Walkways

Any adjacent structures/roads/walkways that may be affected by work must be considered in the planning process. Precautionary measures must be detailed and applied to prevent damage, uncontrolled collapse of existing structures and/or loss to property and persons during the entire construction phase.

Note: Adequate Hoarding and Control Measures are required due to adjacent buildings, roads, pedestrians and walkways

15.2 Edge Protection and Penetrations

The Principal Contractor and their contractors must ensure that all exposed edges and openings are guarded at all times until permanent protection has been erected.
The Principal Contractor has the following options when contemplating the protection of openings, slabs and edges:

- A physical barrier at the edge of the opening, which must be strong enough to carry the weight of **any** person in the process of falling.
- External façade scaffold with fully boarded platform with a handrail.
- Any other suitable means of protection may be used that will prevent a fall.
- Timber to be nailed on all penetrations, alternatively any other means of protection may be used that will prevent a fall.
- Any person working on an unprotected slab/deck to wear fall arrest and prevention equipment devices, like safety harness, lifelines etc.

The Principal Contractor risk assessment must include these items. E.g. all other openings and areas where a person may fall.

All Lifelines shall be certified as per the relevant standards and Anchorage points shall be load/pull tested by a competent person

Note: Danger Tape and shade cloth shall not serve as edge protection.
Furthermore, the Principal Contractor shall provide adequate control measures to avoid Falling Objects especially at all walkways

15.3 Roof Work

All roof work must be conducted in accordance with Construction Regulation 10. A fall protection plan must be prepared by a competent person who should evaluate, revise and amend the plan at least monthly (30 Days) or after any change in activity or incident.
Rescue Plan to be provided including methodology and key personnel to perform such rescue.

All employees shall be in possession of Working at Heights Training issued by a competent person who has at least proof of training as an Assessor/Facilitator

The plan must also include the following but is not limited to,

- How the roof work was planned/Method Statements
- That the roof workers are competent (trained, experienced, knowledgeable)
- Lifelines (Proof of Certification) and anchor points (Load/Pull Tested) are provided and installed by a competent person and with proof placed on file
- That no Roof work is carried during inclement weather or where conditions are hazardous to workers.
- That fragile material/areas are demarcated, and signs posted;
- That suitable platforms are provided where fragile materials exist;
- That there are suitable and sufficient guardrails or barriers and toe boards or other similar means of protection to prevent the fall of any person, material or equipment.
- Rescue Plan
- All employees exposed to heights must be declared medically fit by an Occupational Health Practitioner. (Annexure 3)

Note: The Principal Contractor and their contractors shall ensure that all lifelines are certified, and all Safety Harnesses shall be inspected daily by a competent person and recorded at least monthly with proof of inspections placed on file

Furthermore, The Principal Contractor and their contractors shall ensure that Double Lanyard with Scaffold/Pylon Hooks are used as a minimum requirement and shall assess the fall risk at all times.

All Safety Harnesses shall be inspected on a Daily basis by a competent person and recorded at least monthly with proof of inspections placed on file

15.4 Working at Heights Including Rescue Plan (This Includes Excavations)

Scaffolds

Scaffolding must comply with the requirements of SANS 10085-1:2004. Scaffolds are used extensively by Contractors and strict control measures must be in place to prevent Unauthorised alterations to scaffolding such as removing ties and scaffold boards.

Competent persons to be appointed in writing to:

- erect scaffolding (Scaffold Erector/s)
- act as Scaffold Team Leaders
- inspect Scaffolding daily, alterations, and after inclement weather (Scaffold Inspector/s).
- **Written Proof of Competency of above appointees to be available on Site**

Note: No Trestle or Walkthrough Scaffolds may be used on site.
Furthermore, the Contractor shall provide a site-specific Risk Assessment based on their Fall Risk.

Where scaffolding or work from scaffolding may negatively affect the public, it must include adequate control measures to protect employees and members of the Public.
Should the scaffolding be adjacent to an existing pavement of similar public walkway, a pavement **gantry and crash deck** will be required or any other suitable control measures.

All employees working on heights must have a Medical Certificate issued by an Occupational Health Practitioner (OHP).

A safe working platform is required at all times when performing any scaffold activities including erecting and or dismantling. Where this is not possible then adequate control measures must be provided

Safe Work Loads must be clearly indicated on all Loading bays

Note, The Principal Contractor shall provide a programme for the training of employees working from a fall risk position and the records thereof;

Loading Platforms (If Applicable)

The Principal Contractor shall ensure the following control measures are provided but is not limited to,

- All loading platforms shall have a sold barrier including toe/kick boards to avoid falling objects- Note, no chains
- Design Drawings
- Risk Assessments and Fall Protection Plan
- Handover Certificates
- Method Statement
- Safe Workload to be displayed
- Daily Inspections

15.5 Cranes (All) including a Crane Management Plan, Rescue Plan & (Emergency Procedures)

The Principal Contractor and all other Contractors shall ensure that lifting machinery and tackle is inspected before use and thereafter in accordance with the Amended Driven Machinery Regulations (2015) and 23. There must be competent lifting machinery and lifting tackle inspectors who must inspect the equipment daily or before use, taking into account that:

- Contractors to plan carefully when crane work is required.
- All lifting machinery and tackle must carry a load test certificate and must have an inspector register.
- All lifting machinery and tackle have a safe working load clearly indicated,
- Regular inspections and servicing are carried out

- There is proper supervision in terms of guiding the loads that includes a trained banksman/rigger to direct lifting operations and check lifting tackle,
- Rescue Plan to be provided
- Adequate control measures and procedures are required to determine the relevant loads when busy with lifting operations

The Principal Contractor to provide an updated Lifting Inventory and must include all lifting equipment and machinery with proof placed on file clearly indicating the inspection dates

Note: Records are kept of inspections and of service certificates conducted by an approved LMI/LME. The operators are competent as well as physically and psychologically fit to work and in possession of a medical certificate of fitness to be available on site

Note:
Sugar/sand/grit bags may not be used as lifting equipment and may only be used for its intended purpose or as per the manufacturer's specifications

15.6 Confined Space Entry

"confined space" means an enclosed, restricted, or limited space in which, because of its construction, location or contents, or any work activity carried on therein, a hazardous substance may accumulate or an oxygen-deficient atmosphere may occur, and includes any chamber, tunnel, pipe, pit, sewer, container, valve, pump, sump, or similar construction, equipment, machinery or object in which a dangerous liquid or dangerous concentration of gas, vapour, dust or fumes may be present;

The Principal Contractor to prepare a confined space procedure in line with General Safety Regulation (GSR) 5 OHS Act including the following but is not limited to,

- **Confined Space Training**
- The areas have been declared safe to use by a competent person in writing
- Task Specific Risk Assessments,
- Method Statements
- Emergency Procedures
- Adequate Supervision
- Permit to work in confine space (Including entry and exit)
- Adequate Lighting
- Safe Access
- Adequate Ventilation and with breathing apparatus available
- Buddy System with ropes to be implemented
- Proof that continuous Gas assessments are being conducted
- Duration of working hours when working inside confined spaces
- Competent person/s and equipment to be readily available to assist with resuscitation
- Two Way Radios
- Tank Guards
- Gas/Oxygen Detectors
- Gas Free Certificates

No breaks shall be taken in any confined spaces or when working in any ducting

15.7 Construction Vehicles

Construction Vehicles and Mobile Plant shall be inspected by the Principal Contractor prior to being allowed on a project site and suppliers of hired vehicles, plant and equipment will be required to comply with this specification as well as the OHS Act and Regulations.
The Principal Contractor shall ensure that all such plant complies with the requirements of the OHS Act 85/1993 and Construction Regulations (February 2014).

Construction Vehicles and Mobile Plant (Construction Vehicles & MP) to be:

- of acceptable design and construction
- maintained in good working order
- used in accordance with their design and intention for which they were designed
- operated/driven by trained, licensed competent and authorised operators/drivers. no unauthorised persons to be allowed to drive or operate construction vehicles & mp
- operators and drivers of construction vehicles must be in possession of a valid medical certificate declaring the operator/driver physically and psychologically fit to operate or drive construction vehicles
- fitted with adequate signalling devices to make movement safe including reversing
- excavations and other openings must be provided with sufficient barriers to prevent construction vehicles from falling into same
- provided with roll-over protection, appropriate seat fitted which shall be used during construction vehicle operations.
- inspected daily before start-up by the driver/operator/user and the findings recorded in a register/log book
- construction vehicles to be fitted with two head and two taillights or as per the manufacturers design whilst operating under poor visibility conditions, in addition they shall be equipped with 'hazard warning' lights, which must be used whenever the construction vehicles is on site or as per the manufacturers specifications
- construction vehicles used for transporting persons must have seats firmly secured and sufficient for the number of persons being transported **(PDP required when transporting employees)**
- operators to be issued with personal protective equipment as required and identified by the risk assessments
- only licensed and road worthy vehicles will be allowed onto public roads
- Principal Contractor to provide designated area should any plant and machinery be parked at night. plant to be fully secured to avoid possible unauthorized access.
- adequate lighting required as and when needed

"CR 23. (2) A contractor must ensure that—
(c) the traffic routes are suitable for the persons, construction vehicles or mobile plant using them, are sufficient in number, in suitable positions and of sufficient size;
(d) every traffic route is, where necessary, indicated by suitable signs

Note, all plant operators shall have at least a code 10 Drivers licence. No person may ride on a CV except in a safe place provided by the manufacturer for this purpose

The construction site must be organized to facilitate the movement of Construction Vehicles so that pedestrians and other vehicles are not endangered. Traffic routes are to be suitable, sufficient in number and adequately demarcated. Construction Vehicles left unattended after hours adjacent to roads and areas where there is traffic movement must be fitted with lights reflectors or barricades to prevent moving traffic encountering the parked Construction Vehicles.
In addition, Construction Vehicles left unattended after hours must be parked with all buckets, booms etc. fully lowered, the emergency brakes engaged and, where necessary, the wheels chocked, the transmission in neutral and the motor switched off and the ignition key removed and stored safely. Workers employed adjacent to, or on public roads must wear reflective safety vests. All Construction Vehicles inspection records must be kept in the OH&S File.

Note, The Principal Contractor and their contractors shall ensure that adequate control measures are provided should they Refuel Mobile plant on Site
Furthermore, the Principal Contractor and their contractors shall provide task specific risk assessment for each individual plant

Transporting of Employees
The Principal Contractor and their contractors shall ensure that all vehicles are roadworthy and that all Drivers have the relevant licenses and permits E.g.
Professional Driving Permit (PrDP) previously known as Public Drivers Permit (PDP) as and when needed

15.8 Deliveries

Delivery of materials and the safe movement of construction vehicles must be controlled by the Contractor to alleviate any congestion or interference in the roads leading to the construction site.
Principal Contractor shall ensure vehicle management procedures are in place by way of flagmen control during contractor deliveries.

- No contractor vehicles are to be left unattended during deliveries.
- Adequate control measures are required for all Service Providers
- Avoid stacking of Delivery Vehicles
- All vehicles and plant shall comply with the speed limits

The Principal Contractor shall ensure that designated routes with adequate control measures are provided for all deliveries to allow for easy entry and exiting of the site
Furthermore, the Principal Contractor shall provide adequate control measures for both internal and external roads

15.9 Hazardous Chemical Substances (HCS)

The Principal Contractor and their contractors working with Hazardous chemical substances shall copies of all the (MSDS) Material Safety Data Sheets and this to be kept on site in the Health and Safety File. Risk Assessments to be compiled. First Aider to have copies of MSDS.

All hazardous waste shall be disposed of at an authorised landfill site and proof of disposal shall be provided upon request. Employees shall be provided with suitable PPE including Respirators as and when needed. Adequate control measures shall be taken to avoid exposure to employees and members of the Public.

15.10 Housekeeping & Stacking of Materials

Housekeeping
Housekeeping shall be maintained on a daily basis and all walkways and access routes shall be kept clear and obstruction free. The Principal Contractor shall comply with CR 27.

External and internal roads shall be kept clean at all times and there shall be safe walkways at all times. Demarcated rubble areas, etc.

Stacking & Storage
The Principal Contractor shall ensure that there are sufficient appointed stacking supervisors and all materials and equipment are stacked and stored safely. Double handling of material should be avoided and for this purpose, pallets and other stacking options should be used.

No stacking outside site hoarding area, blocking of entrance/ exists to site, walkways on site, etc. Stacking of materials shall be clearly demarcated.

15.11 Civils Work

Principal Contractor to ensure that they comply with Construction regulation 13 and 23 and that the following is undertaken during civil work:

- A competent site supervisor to be on site always.
- Plant and equipment inspected daily, and registers kept.
- All operators of plant and vehicles trained, competent and physically and psychologically fit. Certificates to be put in Health & Safety File.
- Workers that are working close to the traffic to be visible and wear reflective vests.
- Adequate safety signage to be posted ahead of any work area in the road.
- All signage, including delineators to be maintained and kept clean at all times.
- The required PPE must be worn always (Hard hats, safety shoes, overalls, etc.)
- Risk assessments to be conducted on all activities.
- Road Cleaning to be maintained daily

Laying of Pipes / Backfilling
- A competent site person to supervise lifting operations always.
- No employee to stand under any suspended load.
- Loads must not be slewed over personnel, plant, site huts or property.
- All lifting equipment and accessories must be marked with the Safe Working Load.
- Slings must not be placed on sharp edges.
- Work to be stopped when weather conditions prevent safe operations during trenching work or laying of pipes.
- Everyone to stand clear of area being backfilled by mobile plant.
- Method statement to be developed for connection to main sewer line and to water mains.

The Principal Contractor must ensure that the correct Lifting Machinery is used and must be used for its intended purpose as required by Section 10 and 44 of the OHS Act 85/1993 and Driven Machinery Regulation (DMR) 18(2015)

Note, Excavators and Digger Loaders may not be used as lifting machinery, for lifting pipes or any slewing of material. All machinery shall be used for its intended purpose

15.12 Excavations, Shoring, Dewatering/ Drainage

The Principal Contractor and any relevant Contractor shall make provision in their **tender (for bracing, shoring, dewatering and or drainage if applicable)** of any excavations as per this specification.

Principal Contractor to obtain a Civil Works Permit from the local authorities should any works be required close to any electrical kiosks

The Principal Contractor shall ensure the following but is not limited to,

- Wayleaves and all relevant permits to be obtained
- Excavations/trenches are inspected before every shift, after blasting, after unexpected fall of ground, after substantial damage of supports, and after rain.
- A record of these inspections must be kept;
- The location and nature of all existing services must be established before trenching operation is undertaken.
- Safe work procedures have been communicated to the workers;
- The safe work procedures are enforced and maintained by the Principal Contractor and Contractors' Responsible Persons always;
- Safe access/egress is provided to all levels;
- No load, material, plant or equipment is placed or moved near the edge of any excavation or trench which may undermine the stability of the same unless adequate steps are taken to prevent the sides from collapsing;
- All excavations and trenches that are adjacent to public access routes must be barricaded and illuminated.
- All excavations next to any building to be carefully monitored during such an operation.
- The contractor shall comply with all the requirements as set out by legislation and shall include but is not limited to CR 10, CR 13, Section 8 and 9 of the OHS Act 85/1993
- **Permit/Authorisation in writing to be provided by competent person prior to any person entering the Excavation**

The Principal Contractor shall provide Emergency/Rescue Procedures and must include but is not limited to,

- Possible collapse of Excavation
- Persons Falling into Excavations
- Mobile Plant falling into Excavations

Should an HV cable be discovered, the Principal Contractor and their contractors shall cease all current works and activities, make the area safe and then immediately contact the Electrical Consultant/Client Representative to provide a method statement prior to re-commencement. Proof of Communication shall be provided.

Furthermore, the Principal Contractor and their contractors shall ensure that the excavated sides are battered and include considering dewatering/creating site run offs during winter. All deep excavations and high cut slopes should be battered back to a safe and stable angle during construction and as per the Client/Engineers requirements

15.13 Erosion and Sedimentation Control

The Contractor shall take all reasonable measures to limit erosion and sedimentation due to the construction activities and shall, in addition, comply with such detailed measures as may be required by the Scope of Work. Where erosion and/or sedimentation, whether on or off the Site, occurs, rectification shall be carried out in accordance with details specified by the Engineer.

Where erosion and/or sedimentation occur due to the fault of the Contractor, rectification shall be carried out to the reasonable requirements of the Engineer, at the Contractor's cost.
The Contractor shall ensure that the Municipality storm water system is kept free from sediment arising from the Works.

Any runnels/channels or erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored to a proper condition. Stabilisation of cleared areas to prevent and control erosion shall be pro-actively managed by the Contractor.

15.14 Temporary Works and Support Work

The Principal Contractor shall ensure that the provisions of Section 12 of Construction Regulations (February 2014) are adhered to.

These provisions must include but not be limited to ensuring that all equipment used is examined for suitability before use, that all Temporary Works and support work is inspected by a competent person immediately before, during and after placement of concrete or any other imposed load and thereafter daily until the Temporary Works and support work has been removed. Records of all inspections must be kept in a register on site. Temporary Works Design Drawings shall be provided by a competent person for all Temporary Works Structures

Note: Authorisation shall be provided in writing by a competent person before concrete is poured and before any temporary works structure is removed with proof placed on file. The Principal Contractor shall ensure that all employees erecting temporary works (False Work, Formwork, Support Work) are competent to perform such work, including the Temporary Works Designer, Temporary Works Supervisor and Temporary Works Inspector

15.15 High & Low Voltage Electrical Installations

Should high voltage electrical lines/fencing be present on the site perimeter or in close proximity to any works, the Contractor shall take extra caution and demarcate as far as reasonably practicable. These demarcations must be maintained for the duration of the construction work. The minimum safety clearances as per Electrical Machinery Regulations must be adhered to.

The Principal Contractor must ensure that a lock-out/tag-out procedure is provided and must be adhered to by his/her employees as required.

The Principal Contractor must ensure that safety measures stipulated in the Electrical Installation Regulations, Machinery Regulations, General Machinery Regulations and Construction Regulations are adhered to at all times. All installations must comply with SANS 10142 & the regulations of the OHS Act 85/1993 and Construction Regulation 24.

The Principal Contractor and their contractors must ensure that prior notice is given to Local Authority Electrical Department of any work involving electrical installation. A lock-out certificate must be issued to the relevant Contractor.
The Principal Contractor must ensure that safety measures stipulated in the Electrical Installation Regulations, Machinery Regulations, General Machinery Regulations and Construction Regulations are adhered to at all times. All installations must comply with SANS 10142 & the regulations of the OHS Act 85/1993 and Construction Regulation 24.
All temporary electrical installations including **Ready Boards** must be inspected at least weekly with proof placed on file. A diagram to be provided for all DBs'

The Principal Contractor shall ensure that they tie / connect into existing electrical systems without interruption as far as reasonably practicable
All temporary electrical installations must be inspected at least weekly with proof placed on file

15.16 Installation and commissioning of mechanical equipment

A contractor must, in addition to compliance with the Electrical Installation Regulations and the Electrical Machinery Regulations, ensure that –

- before construction commences and during the progress thereof, adequate steps are taken to ascertain the presence of and guard against danger to workers from any electrical cable or apparatus which is under, over or on the site;
- all parts of electrical installations and machinery are of adequate strength to withstand the working conditions on construction sites;
- the control of all temporary electrical installations on the construction site is designated to a competent person who has been appointed in writing for that purpose;
- all temporary electrical installations used by the contractor are inspected at least once a week by a competent person and the inspection findings are recorded in a register kept on the construction site; and
- all electrical machinery is inspected by the authorized operator or user on a daily basis using a relevant checklist prior to use and the inspection findings are recorded in a register kept on the construction site.

15.17 Demolition During Construction Process- (Method Statement/Procedure)

The Principal Contractor and their contractors shall appoint a competent person in writing to supervise and control all Demolition work on site at all times.
Prior to any demolition work being carried out, the Principal Contractor shall submit a method statement and a detailed engineering survey for perusal/approval by the Client/Engineer. Acceptance will then be issued to the Principal Contractor to proceed with the demolition work.

The Principal Contractor shall ensure that demolition work complies with the Construction Regulations section 9 and 14 (February 2014). Principal Contractor to ensure that:

All Demolition work to comply with the Engineers methodology, procedures, requirements and drawings.

- Work should be carried out by competent operatives experienced in demolition work under the control of an experienced, competent supervisor.
- Restricted areas and safe distances should be established.
- Underground services to be considered, including electrical cables, water mains, etc.
- All services should be disconnected prior to demolition.

- Adequate precautions against accidental collapse of the structure or adjacent structures should be in place.
- Pre-stressed reinforced concrete should be demolished under supervision of a suitability qualified and experienced engineer. (If Applicable)
- Measures should be taken to protect the public, e.g. 2m high fence, debris fans, etc.
- Floors/work areas should not be overloaded. **Principal Contractor must liaise with the Engineer regarding loading requirements**
- All plant and equipment should be suitable for the task, well maintained, and inspected and tested in accordance with legislation.
- Work at heights should be minimized.
- Measures should be taken to protect persons working at height, e.g. working platforms, harness, nets, etc.
- Appropriate personal protective equipment (PPE) should be worn.
- Adequate Dust Control

15.18 Removal of Rubble & Debris

The Principal Contractor must ensure the safe removal of debris and rubble to comply with CR 27. A safe work procedure or method statement detailing the removal process and steps to be taken to contain the debris and rubble must be drafted and placed on File. Safe removal of rubble especially from elevated areas (e.g. Chutes, loading platforms etc.)

15.19 Permits

All relevant permits must be obtained from Local Authority (where needed) before any construction work commences. (Way leaves, Civils Work Permit, etc.) **All Hoarding shall be as per the approved Drawings or as agreed with the Client/Client Representative**

Note

"The iThemba LABS Project Manager, RSHEQ Department and other affected Departments must authorize any work/s which could affect or interfere with any iThemba LABS activities. This shall be done via the issuing of an NRF/iThemba LABS General Works Permit to all Mandatories."

15.20 Rope Access

The Principal Contractor shall comply with and ensure that all work is done in accordance with but is not limited to i.e. CR 18, all relevant regulations, legislations, Standards (SABS & EN Codes, IRATA code of Practice and all other Best Practices. All anchor points and Fall Protection Equipment shall conform with Section 44 of the OHS Act 85/993. The Principal Contractor shall ensure all rope access operators are competent and licensed to carry out their work. Only trained and competent persons shall conduct these activities. All relevant appointments shall be completed with proof of competency placed on file. Adequate Site Supervision shall be present at all times. All equipment shall be inspected by a competent person with proof placed on file.
Site specific Risk Assessments and Fall Protection Plan including a site-specific Rescue Plan shall be compiled by a competent person with proof placed on file. All work areas shall be adequately demarcated with relevant signage displayed, alternatively spotters must be present. The competent Rope Access Supervisor must monitor weather conditions and stop all activities based on his discretion and experience.

15.21 Access Routes

On the Site and, if so required, within such distance of the Site as may be stated by the Client/Client Representative, the Contractor shall control the movement of all vehicles and construction equipment, including that of his suppliers, so that they remain on designated routes, are distributed so as not to cause an undue concentration of traffic, and that all relevant laws are complied with.

In addition, the movement of such vehicles and construction equipment shall be planned and operated to minimise disruption to regular users of the routes.
As far as possible the Contractor shall use existing access routes. Damage to existing access roads because of construction activities shall be repaired to the satisfaction of the Engineer, using material like that originally used. The cost of the repairs shall be borne by the Contractor.

Any directional signage required by the Contractor for the purposes of directing the movement of his own vehicles and construction equipment (or that of his contractors or suppliers) must be of a design and in a location approved by the Client/Client Representative. Directional signage may not be erected in such a manner that it interferes with sight lines or pedestrian movement.

15.22 Plant and Machinery

15.22.1 Pressure Equipment Regulations

The Principal Contractor and their contractors shall comply with the Pressure Equipment Regulations and SANS 10087, 10238 etc. including but is not limited to,

- Providing competency and awareness training to the operators,
- Providing PPE or clothing,
- Inspect Equipment regularly and keep record of inspections,
- Providing appropriate firefighting equipment (Fire Extinguishers) on hand.
- Correct storage of cylinders

15.22.2 Fire Extinguishers and Firefighting Equipment

The Principal Contractor shall provide adequate, regularly serviced fire-fighting equipment located at strategic points on site, specific to the classes of fire likely to occur. The appropriate notices and signs must be posted up as required. All fire extinguishers to be handled and inspected by competent persons in compliance with CR 25 & 29.

The Principal Contractor to provide a Fire Risk Assessment.

Note: The Principal Contractor shall ensure that sufficient and suitable storage is provided for all flammable liquids

The Principal Contractor shall ensure that sufficient employees are trained in the use of Fire Equipment

15.22.3 Hired Plant and Machinery

The Principal Contractor shall ensure that any hired plant and machinery used on site is safe for use. The necessary requirements as stipulated by the OHS Act 85/1993 and Construction Regulations (February 2014) shall apply. The Contractor shall ensure that operators hired with machinery are competent and that certificates are kept on site in the Health and Safety file. All relevant Contractors must ensure the same.

15.22.4 General Machinery

The Principal Contractor shall ensure compliance with the OH'S Act 85/1993, which include inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE or clothing, and training those who operate machinery.

15.23 Explosive Actuated Fastening Device (If Applicable)

The following should be complied to when using Explosive Actuated Fastening Device, to comply with CR 21 and must include but is not limited to,

- Appointed in writing
- Competent with proof of training
- Risk Assessment and Safe Operating Procedure
- Signage and Demarcation
- Inspection record of Explosive Actuated Fastening Device and cartridges

15.24 Portable Electrical Tools

The Principal Contractor and their contractors shall ensure that the use of all portable electrical tools follows relevant legislation.
The Contractor shall ensure that all electrical tools, electrical distribution boards, extension leads, and plugs are kept in safe working order. Regular inspections and toolbox talks must be conducted to make workers aware of the dangers and control measures to be implemented e.g. Personal protection equipment, guards, etc.

A competent person to undertake routine/daily inspections and records are kept. Only authorized trained persons to use the tools, the safe work procedures to apply. Awareness training to be carried out and compliance enforced always, and PPE and clothing are provided and maintained. **All power tools shall be inspected by the Authorised Operator daily with proof placed on file**

15.25 Welding Equipment

- Only authorized / competent persons to use the equipment. **(Proof of training to be provided)**
- Welder using correct PPE - eye/ face/foot/body/respirator.
- Flashback arrestors fitted when using gas welding equipment.
- Fire prevention methods to be applied.
- Where electric arc welders are used, equipment only to be used in a dry area, protected from wetness.
- All welding to be carried out in designated area, where not applicable welding screens to be used.
- Demarcation and signage
- Task Specific Risk Assessments and Method Statements Required
- Hot Work Permits to be issued

16. PUBLIC AND SITE VISITOR'S HEALTH AND SAFETY

Both the Client and the Principal Contractor have a duty in terms of the OHS Act 85/1993 to do all that is reasonably practicable to prevent members of the public and site visitors from being affected by the construction activities. Site visitors must be briefed on the hazards and risks they may be exposed to and what measures are in place or should be taken to control these hazards and risks. A record of these inductions must be kept on site in accordance with the Construction Regulations.

Hoarding, Fencing or any other suitable measures must be provided to protect members of the public and their vehicles passing / entering the site, in accordance with Construction Regulation 27. Sufficient Safety, direction Signage and Flagmen to be placed to direct traffic near the site.

Fixed and adequate site hoarding (Physical Barriers) must be provided and must be at least 1.8m in height. The Principal Contractor shall consider all wind conditions. Principal Contractor to ensure that no unauthorized persons enter the construction area by implementing access control measures / registers.

No trucks shall be parked outside the hoarding areas unless Authorised by the Client/Client Representative

Note the Facility will be operational. The Principal Contractor and their contractor shall take adequate control measures to avoid any damage, injuries or interreference with either property, staff and plant or equipment of iTHEMBA Labs. The Principal Contractor and their contractor shall avoid all unauthorised areas

17. NIGHT WORK (If Applicable)

Where work is required to be done during the night, and approved by the Client/Client Representative , the Contractor shall make adequate provision for additional lighting to ensure that the equipment and the areas where work is to be done are lighted.

The Contractor shall also make sure that this additional lighting is provided such that it does not interfere with the general traffic. Adequate lighting/illumination to be provided where required with backup generators. **Security to be provided as and when needed.**
All emergency procedures to be in place. Adequate PPE to be provided for all employees e.g. Hi-Viz Vests.

Note: Principal Contractor to ensure that Adequate Supervision is provided including Health and Safety

No work shall be done outside working hours unless the Client/Client Representative has been informed with prior approval to works being executed by the Principal Contractor. Note, approval must be in writing

18. OCCUPATIONAL HEALTH

The Risk to be looked at includes:

18.1 Occupational Hygiene

Exposure of workers to occupational health hazards and risks is very common in any work environment, especially in construction. Occupational exposure is a major problem and Principal Contractor must ensure that proper health and hygiene measures are put in place to prevent exposure to these hazards.

18.2 Ventilation

Adequate ventilation / extraction in hazardous areas e.g. chemicals/ adhesives / welding / petrol or diesel/ motors running and in confined spaces.

18.3 Noise

Tasks identified where noise exceeds 85 dBA. All reasonable steps to be taken to reduce noise levels at the source. Hearing protection to be used where noise levels cannot be reduced below 85dBA. The contractors shall comply with CR 9, Section 8 of the OH'S Act 85/1993 and the Noise-induced Hearing Loss Regulation

18.4 Dust

Principal Contractor to ensure that employees working with grinders, drills, civil works, etc. are issued with dust masks and dust exposure to be minimized at all times. Suitable measures to be implemented by the Principal Contractor to ensure that members of the public are not detrimentally affected by such activities. Working Area to be fully cladded with a Hundred Percent Shade Cloth or any other suitable equivalent.

Note, all contractors shall use Dustless Grinders when working in restricted areas Furthermore, the Principal Contractor shall provide adequate dust control measures when busy with excavations, deliveries, and or possible crushing, civil works

18.5 Welfare Facilities

The Principal Contractor shall provide at least one sanitary facility for every 30 employees on site, including changing and hand washing facilities. Safe and adequate eating areas must be provided for all employees including contractors. Waste bins must be strategically placed and emptied regularly. Safe and clean storage areas must be provided for workers to store personal belongings and personal protective equipment. **Note, adequate seating with tables to eat must be provided.**

Contractors shall ensure that employees are segregated from Building Material, Tools etc. when using the same stores/containers etc.
Principal Contractor and their contractors shall familiarise themselves with the local municipalities requirements and provide control measures to avoid water wastage

18.6 Waste Management

Principal Contractor must implement their waste management in line with Environmental **within the applicable regulated Norms and Standards** and shall include but is not limited to,

- Rubble to be stored neatly in bags/bins and collected as needed.
- Principal Contractor to provide sufficient Bins / Bags at all times and must be removed on a regular basis or as and when needed.
- All hazardous material to be stored separately and must be disposed of at an authorized landfill site. Proof of Disposal to be provided
- Rubble shall not be allowed to accumulate on site and shall be removed at regular intervals
- Adequate storage is required for all Cement Bags and Hazardous Substances
- Spill Kits to be readily available
- The Principal Contractor shall implement a Recycling Program and shall recycle all material as far as reasonably practicable including separation of material and general waste.

Note, all and any material that can be Recycled, must be Recycled

18.7 Alcohol and Other Drugs

The Principal Contractor and their contractors to ensure that no alcohol and other drugs are allowed on site. No person may be under the influence of alcohol or any other drugs while on the construction site. Any person on prescription drugs must inform his/her superior, who shall in turn report this to the Contractor forthwith. Any person suffering from any illness / condition that may have a negative effect on his/her safety performance must report this to his/her superior, who shall in turn report this to the Principal Contractor forthwith.

Any person suspected of being under the influence of alcohol or other drugs must be sent home immediately, to report back the next day for a preliminary inquiry.

The Contractor concerned must follow a full disciplinary procedure and a copy of the disciplinary action must be forwarded to the Principal Contractor for his records. No Smoking is allowed on site.

19. ANNEXURE A- ACKNOWLEDGEMENT OF H&S SPECIFICATION

Acknowledgement of Receipt of the Health and Safety Specification:

I, _____representing

_____Contractor

Have satisfied myself with the content of the construction Health and Safety Specification and shall ensure that the Contractor and its personnel comply with all obligations / requirements in respect thereof.

Signature of Principal Contractor	**DATE**
Signature of Client/Client Representative	**DATE**

COMMENTS:

Compiled by:
Frontline Safety Health & Environmental Consultants

20. ANNEXURE B APPOINTMENT OF PRINCIPAL CONTRACTOR

Appointment of Principal Contractor

IN TERMS OF THE OCCUPATIONAL HEALTH AND SAFETY ACT, ACT 85 OF 1993 & CONSTRUCTION REGULATIONS 2014

CONSTRUCTION REGULATION 5(1)(k)

I, ……. Client Responsible Person, for……. do hereby appoint: …….as the Principal Contractor of.....*Project*

Responsibilities:

- *Prepare a Health and Safety Plan to comply with the requirements of the Construction Regulation 5(1)(b), and in compliance with the Health and Safety Specification for the Project.*
- *Ensure co-operation between all contractors to enable each of those contractors to comply with the provisions of these regulations.*
- *Provide all contractors with the required safety specification for their area of responsibility.*
- *Appoint each contractor in writing in accordance with Construction Regulations.*
- *Ensure implementation of the contractor's health and safety plan*
- *Stop contractors from working if not in accordance with the client specification*
- *Provide health and safety information to contractors should their design change*
- *Ensure all contractors are registered and in good standing with the compensation commissioner*
- *Ensure contractors submitting tenders have made provision for health and safety during construction*
- *Ensure risk assessments are conducted & the identified controls are communicated to all employees and visitors.*
- Ensure Compliance to Occupational Health and Safety Act 85/1993, Construction Regulations 2014, Community Fire Safety Bylaw and Relevant Sans Codes.

Signature: …… **Date:** ……

Client / Client Representative

Acceptance

I, ……. hereby accept and acknowledge that I understand the requirements of this appointment.

Signature: ……. **Date:** ……

21. ANNEXURE C BASELINE RISK ASSESSMENT

BASELINE RISK ASSESSMENT FOR HEALTH AND SAFETY SPECIFICATION:
iTHEMBA LABS: HVAC Upgrade D-Block and N-Block

Activity	Risk Rating	Hazard	Control Measure	Responsible Person
1. Off-loading of Material/ deliveries	**H**	• Possible fatalities/ injuries • Possible load falling • Public Safety- potential injuries to workers and members of the public	• All work areas to be adequately demarcated-All Activities to done under supervision • Ensure a spotter is available if and when needed. • Once site has been secured it must be maintained to avoid unauthorised. • Site security to be available. • Relevant construction signage to be displayed • Contractors to be aware of live services e.g. electrical cables.	CR 8.1
	M	• Possible Collision/contact with property or stationary vehicles, workers and members of the public	• Driver to be in possession of a valid driver's licence. • All notices and signs to be obeyed. Driver to adhere to the speed limits. Employer and Driver to ensure that he is not intoxicated and must be of sober habits.	CR 8.1
2. Site Establishment Carrying of material	**M**	• Possible Contact with fellow employees and results into possible injuries.	• Employees to take caution when walking on site • Employees to keep material as close to themselves or structure as possible to avoid possible contact with persons • Ensure your vision is not obstructed. • Watch your blind spots and get assistance when carrying heavy and large objects	CR 8.1
	L	• Possible Falling material and possible foot and body injuries	• Operatives to ensure that all material are adequately secured. Appropriate PPE to be worn at all times. Don't carry material in precarious (dangerous) positions so as to obstruct your vision etc.	CR 8.1
	L	• Possible Ergonomics /Possible back injuries	• Employees to ensure that they use correct bending techniques. Please get assistance when lifting heavy objects.	CR 8.1
3. Off-loading of containers by means of Cranes	**H**	• Possible fatalities/ injuries • Possible Uncontrolled release of Container and material	• All work areas to be adequately demarcated with relevant signage displayed. • Competent flagman and riggers to be present • Only competent person to execute lifting operations • All operators to have relevant documentation as per CR 23 and DMR 18(2015) • Task Specific Risk Assessments and Method Statement must be readily available and communicated to all relevant persons with proof placed on file • Load test certificates for all lifting equipment and lifting Machinery. • All Contractors to be informed of live services e.g. electrical cables. • Only certified and load tested Lifting Equipment and Machinery shall be used. Lifting equipment shall be of good standard with correct latches etc.	CR 8.1

		• Possible Collision with property or stationary vehicles, workers and members of • the public	• All work areas to be adequately demarcated with relevant signage displayed. • Competent flagman and riggers to be present • Only competent person to execute lifting operations. • All deliveries shall take place in the designated areas	CR 8.1
		• Possible Fall of persons while placing or removing chains from containers	• Safe Access to be provided.	CR 8.1
4. Working Close to Public	**H**	• Possible Fatalities/Injuries • Falling of Persons into manholes • Possible Injuries/ Fatalities	• Adequate Site Hoarding and relevant signage required. Adequate demarcation and signage required at all work areas. Principal Contractor to comply with CR 9 and Section 8 and 9 of the OHS Act 85/1993. Spotters to be present	
5. Excavations/ trenches with Plant and Manually	**H**	• Possible fatalities/ injuries • Possible Electrocution due to unknown electrical cables	• Only Competent Persons to conduct Activities. Task Specific Risk Assessments and method statements to be provided. All contractors to comply with CR 9, CR 10, CR 12, 13 and CR 23. • Way leaves or drawings to be obtained from the Client. Where wayleaves are not available adequate control measures must be implemented e.g. using a Cable Detector to determine the presence of possible services especially electrical cables. • All work to be conducted under supervision	CR 8.1
		• Possible Damage to existing services	• Way leaves or drawings to be obtained from the Client. Where way-leaves are not available adequate control measures must be implemented e.g. using a Cable Detector to determine the presence of possible services especially electrical cables. • Only competent persons to excavate. • Compliance with CR 13. • All work to be conducted under supervision	CR 8.1
		• Possible Excavation collapse	• Competent persons and contractor to be appointed in writing to supervise excavations. • Daily inspections to be conducted • Adequate bracing and shoring required as and when needed. Plant to stay at least 1m clear of Embankment • Temporary Works Design Drawings required as and when needed and compliance with CR 12	CR 8.1
			• Excavation inspected regularly (as per legal requirements) (register completed).	CR 8.1
			• Access provided at least every 6 meters.	CR 8.1
			• Shoring and bracing whenever necessary in opinion of competent person. Contractor to consult and communicate with the relevant Engineers	CR 8.1
			• Backfilling done as soon as practicable.	CR 8.1
			• Appropriate personal protective equipment issued.	CR 8.1
			• Undertaking to wear signed and wearing enforced.	CR 8.1
			• Relevant Signage to be provided and displayed	CR 8.1
		• Possible falling of Persons and plant into excavation	• Task Specific FPP by competent person. • Safe Access required for all mobile plant and persons • Designated walkways	CR 8.1

			• Physical barrier of at least 1-meter-high must be provided with relevant signage displayed	CR 8.1
			• Backfilling to be done as soon as practicable.	CR 8.1
6. Operating of Mobile plant	**H**	• Possible fatalities/ injuries • Possible Colliding with employees, public, possibly fatal. Damage to property	• Only Competent Persons to conduct Activities. Task Specific Risk Assessments to be provided. All operators to comply with CR 13 and CR 23. • Valid Drivers' License required for All operators • Competent person who is medically fit must operate mobile plant. This is also required from hiring companies. • Always be aware of other plant in your area and if the plant comes too close or in your working area rather stop operating and be safe. Never reverse without checking behind you to ensure that it is safe to do so. Operator must be on the lookout for fellow employees and members of the Public coming onto site unnoticed. All plant shall a fully functional reverse buzzer.	CR 8.1
		• Vibration of plant can lead to falling objects from bucket	• Do not operate loader if there is anyone in the working area. Don't overload loading bucket and ensure that material is adequately secured	CR 8.1
		• Possible Risks when plant is stationary - People driving into plant.	• Mobile plant must have appropriate lighting and reflectors to identify the location of the plant. Park in designated areas with boom lowered or raised	CR 8.1
		• Damage to structure or plant. Loss of Machine	• Machine must be locked, and keys taken with operator or given to supervisor to prevent unauthorized person operating machine.	CR 8.1
7. Lifting of Pipes	**H**	• Possible fatalities/ injuries • Unplanned release or dropping of load.	• Task Specific Method statements and Risk Assessments required as per CR 9 • Load Test certificates of chains and slings to be obtained and placed on file. • Compliance with CR 23 and DMR 18. • All machinery to be used for its intended purpose	CR 8.1
	H	• Objects falling from boom/bucket	• Lifting to be supervised to ensure the stability of the machine and the load. Loads must not be slewed over personnel, public vehicle or where there is a risk of possible injuries or property damage. • spotter to be used where driver's vision is impaired or where operating in congested areas.	CR 8.1
8. Working with Hazardous Substances	**L**	• Possible Respiratory problems.	• Respirators to be used when spending even short periods of time. Adequate ventilation required. Ensure that all containers are clearly identified when decanting	CR 8.1
		• Dermatitis, Skin burns, Skin sensitization	• Avoid contact with the skin as far as reasonably practicable. Use barrier cream if possible.	CR 8.1
		• Possible Eye injuries	• Remove clothing that has been contaminated by wet hazardous substances.	CR 8.1
			• Wear suitable PPE as listed below. Wash hands thoroughly after contact and use a barrier cream.	CR 8.1
			• Follow Safety instructions (MSDS) as indicated by the MSDS.	CR 8.1
9. Handling and Storage of Flammable material	**H**	• Possible fatalities/ injuries • Possible Explosion/fires Possible	• Principal Contractor shall comply with all relevant legislation and regulations and shall include but is not limited to i.e., CR 9, 25, 29 General Safety Regulation 2B and Section 8 & 9 of the OHS Act. • Task Specific Method Statements and Risk Assessments. Hot work system to be implemented as per the Specification	CR 8.1

			• Store all Hazardous Substances in the correct categories. Store all flammable material separately. Ensure relevant signage is clearly displayed. Adequate fire extinguishers to be readily available. Fire Risk Assessment to be conducted by a competent person. Hazardous bins to be provided	
		• Possible burns to body	• Only competent persons to conduct all activities. • PPE shall be used as the last resort • Adequate Fire Control Required	
10. Electrical Installations	**H**	• Possible fatalities/ injuries • Possible Electrocution, even fatal. • Damage to equipment	• Task Specific Method statements and Risk Assessments required as per CR 9 • Competent contractor to be appointed if necessary. Equipment to be used to detect live/high voltage cables. • Restricted areas to be identified. • All installations must comply with SANS 10142 & the regulations of the OHS Act 85/1993 CR 24 and Electrical Installation Regulations • Toolbox Talks to be conducted on Risk Assessments with declarations / acknowledgement signed daily. • Relevant PPE to be used. Lockout procedures to be provided. Only competent persons to be used with proof of competency to be provided.	CR 8.1
			• CoC must be issued for all electrical installations. • All temporary electrical installations to be inspected at least weekly and prior to use. All cables to be treated as live • Suitable PPE shall be used	CR 8.1
11. Working with Portable Electrical Tools	**H**	• Possible Contact with moving parts.	• Task Specific Risk Assessments required as per CR 9. Compliance to CR 24. • Only competent personnel should operate these tools.	CR 8.1
			• Machines to be checked before use, guards are correctly fitted and work properly.	CR 8.1
		• Noise above 85Dba	• Employees to be issued with relevant PPE including hearing protection.	CR 8.1
		• Possible Malfunction of Blade	• Blades should be regularly inspected to ensure they are sharp/good condition	CR 8.1
		• Possible Back Injuries	• Employees to be trained on proper lifting and bending techniques.	CR 8.1
12. Working with Hand Tools	**M**	• Possible Eye injury	• Visual checks must be completed by operatives on tools prior to their use. • Eye protection is to be provided and used whenever work is done using cold chisels or other tools where there is risk of flying particles or other pieces of the tool breaking off.	CR 8.1
		• Possible Injury to hands, feet and body	• Tools are required to be suitable for the purpose for which they to be used. • Open bladed knives, screwdrivers, and other sharp tools are to be carried and used so as not to cause injury to the user or others.	CR 8.1
		• Possible Tripping over tools	• Tools should not be left lying around, they constitute a severe tripping hazard, and they are liable to get damaged.	CR 8.1
13. Lifting Operations	**M**	• Uncontrolled release of material	• Task Specific Method Statements and Risk Assessments required with proof of communication.	CR 8.1

			• Rescue Plan and task specific Fall Protection Plan required, to be compiled by competent person. • Competent Banksman/Rigger to be readily available	
		• Malfunction of lifts and lifting equipment	• Banksman/Rigger to have signalling device • No person to be under suspended load • No Crane operations when banksman/Rigger is not available or present. Only appointed banksman/rigger to assist with lifting operations.	CR 8.1
			• Load test certificates to be obtained. Competent contractor to be appointed.	
14. Working in Confined Space	**H**	• Possible Body Injuries, Property Damage, Possible	• Task Specific Method Statements and Risk Assessments required with proof of communication. • The Principal Contractor to prepare a confined space procedure in line with General Safety Regulation (5) OHS Act including Task Specific Risk Assessments, Method Statements and Emergency Procedures. Ensure that all work areas are adequately demarcated • Ensure that all ducts are adequately secured and that it can take the relevant loads	CR 8.1
		• Respiratory complication due to Lack of Ventilation • Hazardous Material being used e.g. Sealants etc.	• Safe Access Required at all times. Adequate Ventilation and supervision required at all times • All hazardous substances to be assessed and ensure that MSDS are provided, all employees to be informed and First Aider has copies. Permit to enter required. Constant Oxygen Monitoring. Area to be declared Gas free	CR 8.1
15. Working at Heights including but is not limited to Scaffolds and Ladders	**H**	• Possible fatalities/ injuries • Fall of persons, Possible Death	• Task Specific Fall Protection Plan, Risk Assessments required • PC shall comply with CR 9 and CR 10. • All employees shall be in possession of Working at Heights Training • All work to be done under supervision. • Compliance with Fall Protection Plan. • Rescue kit to be available on site. • PPE to be worn at all times. • Buddy system to be implemented • All employees exposed to heights must be declared medically fit by an Occupational Health Practitioner. (Annexure 3) • Note: The Principal Contractor and their contractors shall ensure that all lifelines are load tested and all Safety Harnesses shall be inspected on a Daily basis by a competent person with proof of inspections placed on file. • Compliance with Fall Protection Plan. • Daily inspections prior to use and to be recorded at least monthly. Compliance with CR 10 and GSR 13A.	CR 8.1
	H	• Possible fall or persons/ injuries /material • Falling/slipping	• As far as reasonably possible, all equipment to be tied to rope. • No Items to be thrown from roof, but to be safely lowered. • No persons to work underneath overhead work area or ground. • No work on open structures at heights in wet weather. • No work on scaffolding during wet conditions.	CR 8.1
16. Scaffold erecting & dismantling	**H**	• Possible fall or persons/ injuries /material	• Design Drawings required. Work on scaffolds to be coordinated by appointed scaffold supervisor.	CR 8.1

		• Possible Falling of persons, Collapse of Scaffold structures and damage property and employees.	• Lanyard to be used when erecting & dismantling scaffolding. (Scaffold erectors) Compliance with SANS 10085-1:2004 and CR 16 • All scaffolding to be inspected daily and after inclement weather and findings recorded in a register. • Fully boarded platforms must be provided at all times • Only those employees who are authorised may be on the scaffold. • Where safe platforms cannot be erected, safety harnesses are compulsory.	
			• Guard rails and toe boards compulsory. • PPE required for persons working on scaffolding: safe shoes; hardhats. Area below to be cordoned off. Platforms to be cleaned on a daily basis. • Only competent erectors to change structure of scaffold. • No overloading of scaffold. PPE used: Safety boots, helmets, overalls.	CR 8.1
17. Temporary Works	**H**	• Possible fall or persons/ injuries /material • Possible Collapse of Structure	• Task Specific Risk Assessment s and Method Statement Required prior to activity • Compliance with CR 12. • Competent Contractor to be appointed • Temporary Works designer to be appointed • Design drawings to be approved by engineer and must be current	CR 8.1
			• Handover Certificates required Before Concrete Pours and Before Stripping any Temporary Works material (Proof to be placed on file) • Task specific risk assessment to be compiled and Formwork to be inspected daily by competent person with proof placed on file	CR 8.1
	H	• Falling of Persons/Material/Equipment	• All material to be adequately secured • Task Specific Fall Protection Plan • Adequate Signage and Demarcation required. • Only Authorised persons to enter these areas- erecting and stripping. Area must be declared safe prior to any person entering decks • All RISK assessments and method statements to be communicated with relevant persons (Proof placed on file.)	CR 8.1
18. Work at Heights/Roof Work including Cladding, Trusses and Purlins, Structural, etc.	**H**	• Possible Fall of persons and material	• Task Specific Fall Protection Plan, Risk Assessments and Method Statements required • PC shall comply with CR 9 and CR 10. • All employees shall be in possession of Working at Heights Training issued by an Accredited Service Provider • All work to be done under supervision. • Compliance with Fall Protection Plan. • Rescue kit to be available on site. • PPE to be worn at all times. • Lifelines to be installed as and when needed ad must be secured to a fixed structure • How the roof work was planned/Method Statements. • That the roof workers are competent (trained, experienced, knowledgeable) • Lifelines (Proof of Certification) and anchor points (Load Tested) are provided and installed by a competent person and with proof placed on file	CR 8.1

			• That no Roof work is carried during inclement weather or where conditions are hazardous to workers. • That fragile material/areas are demarcated, and signs posted. • That suitable platforms are provided where fragile materials exist. That there are suitable and sufficient guardrails or barriers and toe boards or other similar means of protection to prevent the fall of any person, material or equipment. Rescue Plan. • All employees exposed to heights must be declared medically fit by an Occupational Health Practitioner. (Annexure 3) Note: The Principal Contractor and their contractors shall ensure that all lifelines are load tested and all Safety Harnesses shall be inspected on a Daily basis by a competent person with proof of inspections placed on file.	
	H	• Falling Objects / Equipment. Falling/slipping	• As far as reasonably possible, all equipment to be tied to rope. • No Items to be thrown from roof, but to be safely lowered. • No persons to work underneath overhead work area or ground. • No work on open structures at heights in wet weather. • No work on scaffolding during wet conditions.	
19. HVAC installations	**H**	• Falling of persons and material	• Task Specific Risk Assessments to be provided • Fall arrest equipment must be used when fall prevention is not possible • Safe access to be provided • All ducts to be adequately secured on all levels • Adequate signage and demarcation required as and when needed	CR 8.1
	H	• Ergonomics	• Task Specific Risk Assessments to be provided and compliance with CR 7 & CR 9. Ensure that safe access is provided at all times	CR 8.1
	H	• Possible restrictions while working in ducts	• Task Specific Risk Assessments to be provided and compliance with CR 9. • Safe Access Required at all times. • Adequate Ventilation and supervision required at all times	CR 8.1
20. Demolition	**H**	• Possible Body Injuries. • Possible Falling Objects. • Possible Collapse of Structures • Public Safety	• Principal Contractor to comply with but not limited to, CR 9, CR 14, Section 8 & 9 of the OH'S Act 85/1993. • Task Specific Method Statements and Risk Assessments required. • Method Statements to be discussed with Engineers for comment • Only competent persons to conduct activities. • Adequate Control measures required for both Employees and Public Safety • Limit Interference with Public • Good communication with Structural Engineers and all relevant parties • All demolition works to be in line with the relevant drawings • All Services to be identified and to be isolated as needed	CR 8.1
21. Lift Installations	**H**	• Possible Falls of persons and objects	• The Competent Lift Contractor must comply with SANS 50081-1;1545-1; 1545-2; 1545-3 and the Lift, Escalator and Passenger Conveyor Regulations.	CR 8.1

			• Proof of notification to the DOL to be obtained (Annexure 1) • All unprotected edges to be adequately secured • Task Specific Risk Assessment s and Method Statement Required prior to activity • Fall Protection Plan Required • Adequate Fall Protection Equipment	
		• Malfunction of lifts and lifting equipment	• Proof of notification to the DOL to be obtained (Annexure 1) • Load test certificates to be obtained. Competent contractor to be appointed.	
22. Rope Access	**H**	• Possible Fall of persons and material	• The Principal Contractor shall comply with and ensure that all work is done in accordance with but is not limited to i.e. CR 7, CR 9, CR 10, CR 18, all relevant regulations, legislations, Standards (SABS & EN Codes, IRATA code of Practice and all other Best Practices. All anchor points and Fall Protection Equipment shall conform with Section 44 of the OHS Act 85/993. • Task Specific Method Statements, Risk Assessments, Fall Protection Plan and Rescue Plan shall be compiled and communicated to all relevant employees with proof placed on file. • Only competent and certified persons to conduct rope access activities. • All employees shall be medically fit as per CR 7. • All work areas shall be adequately demarcated with relevant signage displayed. No work during inclement weather	CR 8.1
23. Tower Crane Erecting, Dismantling and operations (If applicable)	**H**	• Possible Fall of Persons and Material • Possible Malfunction of Equipment • Possible toppling of Crane • Failure of concrete bases, over loading, non-compliant equipment • Possible injuries	• Principal Contractor shall comply with all relevant legislation and regulations and shall include but is not limited to i.e. DMR 18, CR 7, 8, 9, 10, 22 • Furthermore, the Principal Contractor shall ensure that the following is provided and enforced prior to any activities and shall include but is not limited to i.e. • Task Specific Method Statements and Risk Assessments. • All employees shall be adequately informed with proof placed on file. • Only competent and medically fit employees shall operate and conduct all operations • Adequate control measures shall be provided with regards to Inclement Weather • All equipment shall comply with the relevant standards and DMR 18	CR 8.1
24. Working Close to Water (If applicable)	**H**	• Possible Drowning	• PC to provide task specific risk assessments • Principal Contractor (PC) to provide Safe Means of Access. PC to comply with CR 26 and all other legislation • All work to be done under supervision. • Emergency procedures and rescue plan to be provided.	CR 8.1
25. Working close to Radiation Facilities	**H**	• Possible Exposure to Radiation • Accidental spillage • Possible health effects • Possible Inhalation • Possible skin contact	• "Any work that must be performed in any Radiation Protection Controlled Area requires the RSHEQ Department: Radiation Protection Manager to be notified before such work is commenced." • Task Specific Risk Assessments with proof of communication • Competent Persons to conduct activities • Adequate and task specific PPE required • Emergency Procedures	

Note:

The above list is by no means exhaustive and should not be limited to these activities but must cover all activities that forms part of the said construction work. Each activity must be split down to individual tasks and all associated hazards identified and listed in the risk assessment. This ensures that the critical tasks and subsequent critical hazards are not missed.

All Activities are to be re-assessed by the Principal Contractor and their contractors prior to start of work and must be communicated with all relevant employees with proof placed on file

NB: Although some of the work related to health and safety work is mentioned /noted in certain measured items in the bill of quantities it remains the contractor's responsibility to allow in his tender price for all work related to health and safety and the requirements as per this Health and Safety Specification and the OH'S Act 85/1993.

Additional Information/General Notes

1. The location of the proposed building is located at Old Faure Road, Faure, Western Cape, 7131, South Africa

2. **The Principal Contractor shall liaise with all relevant parties prior to any activities and adhere to the terms and conditions as set out by the Project Manager/ iThemba Labs.**

3. **The Principal Contractor shall familiarise themselves with all requirements as set out by iThemba Labs. This information will be available in the Mandatory Agreement of iThemba Labs.**

4. Hoarding and Signage shall be maintained on a daily basis and shall be erected within the construction zone and or as needed

5. Traffic shall be accommodated with the least delay and discomfort to the public and residents.

6. All work operations shall be limited within the site boundaries and relevant work areas

7. The roads shall be kept clean at all times with safe access to the staff and visitors of iThemba Labs

8. Where unidentified services are located on site the contractor is to report this immediately to the Client/ Client Representative and is to adequately protect these services until identified and the necessary instruction issued by the Client Representative

9. Principal Contractor and their Contractors to only use access routes that has been identified by the Client/ Client Representative

10. No loitering

11. Control required for possible Community/Civil Unrest

12. The Principal Contractor shall comply with Asbestos Regulation 21, where any Asbestos material is meant to be handled.

NRF/iTHEMBA LABS HEALTH AND SAFETY SPECIFICATION AND OCCUPATIONAL HEALTH AND SAFETY ACT 37(2) AGREEMENT

Special Conditions and Protocols to be complied with as part of an Contract with NRF/iThemba LABS

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1. **PURPOSE**

1.1 The purpose of this document is to:

1.1.1 Outline the NRF/iThemba LABS Health and Safety Specifications and establish an Agreement between the Mandatory and the Client, that being NRF/iThemba LABS, for a stipulated contract or agreement period for the delivery of services and / or goods.

1.1.2 Ensure effective communication of the requirements for the safe work practices to contractor under contract and subcontract to NRF/iThemba LABS.

1.1.3 Ensure better co-ordination and management of Contractors at NRF/iThemba LABS.

1.1.4 Provide guidance of the minimum requirements for the safe systems of work and practices for contractors.

1.1.5 Ensure and clarify NRF/iThemba LABS personnel's different roles and responsibilities with regard to Contractor management.

2. **DEFINITIONS**

2.1 **Mandatory / Mandatories:** Shall refer to Contractors, Sub-Contractors, Agents and their employees.

2.2 **OHSA:** Occupational Health and Safety Act, no. 85 of 1993.

2.3 **CLIENT:** National Research Foundation (NRF), acting through its National Facility, iThemba Laboratory for Accelerator Based Sciences (iThemba LABS).

2.4 **COIDA:** Compensation for Occupational Injuries and Disease Act, no. 130 of 1993

2.5 **CONTRACT:** The contracting agreement which governs the deliverables of goods and services between the Client and the Mandatory.

2.6 **PCMP:** Project and Construction Management Professions Act, No. 48 of 2000

2.7 **PrCHSA:** Project Management Construction Health and Safety Agent

2.8 **CHSM:** Construction Health and Safety Manager

2.9 **PrCHSO:** Project Management Construction Health and Safety Officer

2.10 **RSHEQ Department:** Radiation, Safety, Health, Environmental and Quality Management Department.

2.11 **GNR:** Government Notice Regulations

2.12 **GMR2:** General Machinery Regulations Section 2 appointment

2.13 **PPE:** Personal Protective Equipment

2.14 **Noise Zone:** any work area where noise levels exceed 85 dB(A) in accordance with the OHSA, Noise-Induced Hearing Loss Regulations, GNR 307 of 7 March 2003

2.15 **HIRA:** Hazard Identification and Risk Assessment

2.16 **HCS:** Hazardous Chemical Substances

3. ROLES AND RESPONSIBILITIES

3.1 It is the responsibility of RSHEQ to periodically review the system and the procedure.

3.2 It is the responsibility of each person employing / appointing / controlling Contractors to comply with this procedure.

3.3 It is the responsibility of the NRF/iThemba LABS SCM / Project manager / Bid committee to ensure that orders are only placed with Contracting Companies who:

3.3.1 Have a satisfactory safety performance history and Complies with the OHSA.

3.3.2 Have the necessary skills and expertise to carry out the work.

3.4 It is the responsibility of the NRF/iThemba LABS Project manager to clearly define the scope of work to be done.

3.5 It is the responsibility of the RSHEQ/Project manager to:

3.5.1 Ensure the Safety file and all the relevant documentation is received and checked

3.5.2 Ensure the Contractor and the Contractor's employees have all received safety induction.

3.5.2 Ensure validity of COID registration and Letter of Good standing

3.5.3 Issue the Contractor with the Contractor Work Permit and ensure all other relevant permits to work are issued before work commences.

3.5.4 Inform the Contractor of hazards likely to affect the health and safety of the Contractor's employees.

3.5.5 Ensure the Contractor and sub-Contractors comply with this agreement.

3.5.6 Do frequent visual inspections/Audits on-site to ensure compliance.

3.5.7 Oversee the wearing of applicable PPE at all times whilst contractors are performing activities at iThemba LABS' premise.

3.6 It is the responsibility of the Mandatory:

3.6.1 Ensuring PPE is provided to contracted employees as identified in the Risk Assessment or method statement

3.6.2 Ensure this procedure are complied with by all his/her employees

3.6.3 Ensure they have the necessary competencies and resources to carry out the work safely and all employees are trained, competent and legally appointed

3.6.4 Ensure fall protection plan when working at heights are in place.

3.6.5 Ensure WI's are available for High-risk work before commencing work.

3.6.6 Ensure method statements is available in accordance to the scope of work.

3.6.7 Ensure a risk assessments (HIRA's) is conducted for all tasks

3.6.8 Ensure the list of Hazardous Chemical Substances and copies of MSDS of HCS's to be used during the contract, are handed in to RSHEQ for review.

3.6.9 Ensure tools and equipment are in good condition and safe to use (where required, on registers e.g. PPE, ladders, scaffolding etc.).

3.6.10 Ensure licenses and permits are available when required.

4. OHSA 37(2) AGREEMENT

4.1 In terms of this Agreement, the Mandatary shall familiarize him / herself with the working Environment and Premises and that he / she agrees to the Arrangements and Procedures, as prescribed by the NRF/iThemba LABS, and as prescribed in terms of Section 37(2) of the OHSA, for the purpose of compliance with the OHSA.

4.2. The Mandatary acknowledges that this Agreement constitutes an agreement in terms of Section 37(2) of the OHSA, whereby all responsibility for health and safety matters relating to the work that the Mandatary and its Employees are to perform on the NRF/iThemba LABS Premises shall be the obligation of the Mandatary.

4.3. The Mandatary further warrants that he and/or the Employees undertake to maintain all necessary compliance with the OHSA. Without derogating from the generality of the above, nor from the provisions of this Agreement, the Mandatary shall ensure that the clauses as hereunder described are at all times strictly adhered to by himself and the Employees.

_____ _____

MANDATORIES DATE

4.4. The Mandatary therefore undertakes to ensure that the health and safety of any person on the Premises is not endangered by the conduct and / or activities of the Employees whilst they are on the NRF/iThemba LABS Premises.

4.5 The Mandatary shall be deemed to be an employer in his own right whilst on the NRF/iThemba LABS Premises. In terms of Section 16(1) of the OHSA, the Mandatary shall ensure that the requirements of the OHSA are complied with by him / herself and/or his/her Chief Executive Officer.

5. STATUTORY AND NRF/iTHEMBA LABS REQUIREMENTS

5.1 All Mandatories working within the premises of iThemba LABS, shall comply with the Regulations of the Occupational Health and Safety Act, No. 85 of 1993 and all other iThemba LABS requirements.

5.2 All Mandatories shall comply with conditions of the Compensation for Occupational injuries and Disease Act, No. 130 of 1993. All Mandatories shall be required to provide a letter of good standing with the Compensation Commission and shall be required to complete the attached form in this document as stated under **Appendices 01**.

5.3 All Mandatories shall be required to review, complete and agree to the terms stated in this Agreement before finalization of any contractual agreement between the Mandatory and NRF/iThemba LABS.

6. GENERAL REQUIREMENTS

6.1 Where reasonably practicable, a Mandatory shall be required to provide a Safety File with all relevant project and safety information pertaining to the contracted works / project in terms of the OHSA and its relevant Regulations.

6.2 Where Sub-Contractors are in use, the Primary Contractor shall also ensure that all Sub-Contractors under their management provide a Safety File / Safety Plan in relation to the works they shall conduct.

6.3 A copy of this safety file / plan will be kept with the Mandatory at all times and will be updated throughout the course of the project. The Safety File shall be available at all times for auditing by the NRF/iThemba LABS Project Manager, RSHEQ Department and any Department of Labour Inspectorate.

6.4 All Safety Files / Safety Plans shall, as a minimum requirement, be in line with guideline as stated in this document under **Appendices 02**.

6.5 The iThemba LABS Project Manager, RSHEQ Department and other affected Departments must authorize any work/s which could affect or interfere with any iThemba LABS activities.

This shall be done via the issuing of an NRF/iThemba LABS **General Works Permit** to all Mandatories.

6.6 Mandatories and subcontractors shall be required to attend RSHEQ Induction Training which will be conducted by the NRF/iThemba LABS RSHEQ Team before commencement of any work.

6.7 Mandatories shall stay confined to their area/s of work. Any required deviation must be discussed with the NRF/iThemba LABS Project Manager and the RSHEQ Department.

6.8 A Mandatory shall provide reasonable notification to the NRF/iThemba LABS Project Manager of any intention to deviate from specified work areas / work plans or requirements to enter into any areas related to the project being performed. The time periods for notification shall be agreed upon between the Mandatory and the NRF/iThemba LABS Project team members.

6.9 The NRF/iThemba LABS Project Team Members and the RSHEQ Department reserve the right to conduct site inspections at any reasonable time it sees fit to ensure compliance with Contract and Safety requirements. The Mandatory is required to be available and assist during all site inspections.

6.10 As per Construction Regulations requirements, Section 7 (1e), Mandatories shall be required to hand over a consolidated version of the Safety File the NRF/iThemba LABS Project Manager upon completion and sign off contracted works.

7. SITE ESTABLISHMENT AND SAFETY SIGNAGE

7.1 Mandatories will be allowed to establish a work site at the NRF/iThemba LABS Facility only if provisions are agreed upon within the contract. Such area shall be demarcated and fenced off in such a manner that it does not impede traffic flow, interfere with NRF/iThemba LABS operations, does not impede on any emergency response processes and does not create a hazardous environment.

7.2 All Mandatories shall be required to conspicuously display appropriate, SANS approved Safety Signage at all work sites established on the NRF/iThemba LABS facility.

7.3 Mandatories shall take all reasonable actions to prevent unauthorized personnel from accessing the established work site.

7.4 Mandatories will be required to maintain and hazard free worksite and uphold high standards of housekeeping throughout the duration of the contract.

7.5 The Mandatory and its employees shall be designated specific kitchen and ablution facilities for their use as agreed by the NRF/iThemba LABS Project Manager, RSHEQ Department and the Mandatory. All other NRF/iThemba LABS kitchen and ablution facilities, with the exception of the agreed upon space, shall not be occupied and / or used by the Mandatory

and any of its employees. The Mandatory shall have the responsibility of keeping the designated premises clean and disinfected at all times.

7.6 Where the designation of kitchen and bathroom facilities is not possible or cannot be accommodated for by NRF/iThemba LABS, the Mandatory shall be required to source portable facilities for placement at the designated work site on the NRF/iThemba LABS Facilities. The Mandatory shall have the responsibility of keeping these premises clean and disinfected at all times.

7.7 These areas shall be marked with appropriate signage by the Mandatory.

8. SUB-CONTRACTORS

8.1 The Primary Contractor/s shall inform the NRF/iThemba LABS Project Manager who awarded the contract of any sub-contractors who may work on site.

8.2 The Primary Contractor shall ensure that each Sub-Contractor complete **Appendices 01** and submit to the NRF/iThemba LABS Project Manager and the RSHEQ Department prior to commencement of work.

8.3 The Primary Contractor shall ensure that the sub-contractor complies fully with all statutory and iThemba LABS requirements.

9. CONSTRUCTION WORKS

9.1 In the case where Construction Work will take place, all Mandatories shall comply with the requirements as stated in the Construction Regulations, GNR 84 of 7 February 2014 in the Occupational Health and Safety Act, No. 85 of 1993.

9.2 Mandatories shall be required to submit a detailed Safety File / works plan which will include all Safety programs, Risk Assessments, Legal appointments, equipment and tools lists, Personnel information and details and other relevant project requirements as per Construction Regulations noted in 8.1.

9.3 NRF/iThemba LABS reserve the right to employ the services of a Professional Agent or any other Professional appointment in terms of the Project and Construction Management Professions Act, No. 48 of 2000 and the Construction Regulations, GNR 84 of 2014.

10. PERSONAL PROTECTIVE EQUIPMENT

10.1 All Mandatories shall be equipped with the minimum Personal Protective Equipment (PPE) when conducting work at the iThemba LABS site:

- Full work overall
- Safety shoes or boots
- High visibility vest
- Impact rated safety eye wear or goggles

- Impact rated hard hat
- Hearing Protection

10.2 Safety harnesses (2 or 3-point type) shall be used whenever work is performed at a height of two (2) meters or higher **unless** a suitable work platform with handrails is provided.

10.3 Suitable impact rated eye and / or face protection must be used whenever there is a danger of flying particles, sparks or splashing of chemicals.

10.4 Hearing protection must be used whenever a noise zone is entered. Earmuffs shall be worn whenever impact noise, e.g. Use of a jackhammer, is taking place.

10.5 Appropriate welding gloves and welding helmet shall always be used during welding operations.

10.6 Impact rated Hardhats shall be worn by all personnel when work above head height is taking place.

10.7 The Mandatory and/or their appointed representative is responsible for provision of the necessary protective equipment, the training of their employees in the proper use of the equipment and to ensure, where applicable, the equipment is used in its proper context.

10.8 The Mandatory shall ensure that all PPE damaged during the course of the employee's duties shall be replaced within 2 hours. The employee shall then be allowed to continue with that operation for which the PPE was required.

11. TOOLS AND EQUIPMENT

11.1 Mandatories shall submit a list of all portable electrical tools and equipment to the Project Manager and RSHEQ Department as part of their safety file submission.

11.2 Mandatories shall provide their own ladders, trestles, scaffolds, lifting tackle, tools and portable equipment.

11.3 Makeshift or unsafe equipment shall not be permitted on the premises and will be confiscated / be removed for the duration of the contract.

11.4 No insulation tape or similar "quick fixes" may be used on any electrical wiring or cables. Joins in cables must be approved by the NRF/iThemba LABS GMR2 and / or RSHEQ Department prior to use on the premises.

11.5 Mandatories may not operate NRF/iThemba LABS lift trucks, vehicles, jibs or cranes. In exceptional instances, the Project Manager and / or RSHEQ Department together with the NRF/iThemba LABS GMR2 may grant permission. In such an event, the Mandatory shall produce a valid Certificate of Competency as described in the Driven Machinery Regulations of the Occupational Health and Safety Act, Act 85 of 1993. A copy of the Certificate will be

kept on the person of the Mandatory who operates the above-described equipment. Any employee of NRF/iThemba LABS may ask such Mandatory to produce the said Certificate.

11.6 All tools and equipment must be declared to security whenever a Mandatory enters or leaves the premises. It is the duty of the Mandatory to ensure that articles or equipment are recorded in a security register whenever they are brought on site.

11.7 Unless permission is granted in writing by an NRF/iThemba LABS Manager or the appointed NRF/iThemba LABS Project Manager, all portable tools or equipment brought on site must be removed at the end of the day's work. Any tools left on site is done so at the Mandatories risk and NRF/iThemba LABS and any of its personnel will not be held liable for loss, theft or damage of any kind.

11.8 Mandatories must conduct daily inspections of all tools and equipment in their possession and use and provide an inspection report to that effect as part of their safety file for auditing purposes. NRF/iThemba LABS Project Manager and RSHEQ Department reserve the right to audit such a document against the equipment listed and in use as and when reasonably required.

12. TRANSPORT

12.1 Mandatories shall ensure that all vehicles in use by them and brought onto the iThemba LABS premises shall be in a roadworthy condition, licensed and insured. All drivers of such vehicles will have the required license and no vehicle shall be used for passenger conveyance unless it is designed for this purpose.

12.2 If any vehicle is used to transport hazardous substances / materials, the mandatory shall ensure that the vehicle is compliant with the Hazardous Chemical Substance Regulations, GNR 1179 of 25 August 1995, Section 14 and / or the Transportation of Dangerous Goods and Substances by Road under the National Road Traffic Act, no. 93 of 1996.

13. WORKING AT HEIGHTS OR ELEVATED AREAS

13.1 No work may be performed above the heads of persons or aisles or roads unless suitable precaution has been taken to ensure the safety of persons and property below. The affected area must also be identified beforehand and effectively cordoned off.

13.2 Where the need for use of scaffolds or extension ladders is required, a comprehensive working at heights safety plan must be in place and that all personnel by informed of the plan. Mandatories shall notify the NRF/iThemba LABS Project Manager and the RSHEQ Department when such works will take place.

13.3 All scaffolds shall be erected, inspected and passed for use by competent personnel.

13.4 All scaffolds and suspended loads must be left safe before leaving work at the end of every shift, i.e. loads lowered to the ground, scaffolds securely tied down and all loose tools and equipment secured against falling.

13.5 Where scaffolding is erected, handrails, toe boards, etc. must be embodied. All such equipment shall be lowered to the ground, supervised by a competent person.

14. USE OF OVERHEAD CRANES, LIFTING TRUCKS AND OTHER LIFTING EQUIPMENT

14.1 The following shall apply if the Mandatory has to operate overhead cranes on site:

14.1.1 The Mandatory shall ensure that all his employees who have to operate a crane or lift truck to render services as stipulated in the contract have had formal training as required by the Driven Machinery Regulations, GNR 540 of the 24 June 2015 under the Occupational Health and Safety Act, no. 85 of 1993.

14.1.2 The Mandatory shall ensure that the training is valid in terms of the Regulations and Act as stated in 10.1.1.

14.1.3 The Mandatory shall present certificates of training to the NRF/iThemba LABS RSHEQ Department, GMR2 and the Project Manager before work commences.

15. LOCKOUT / ISOLATION PROCEDURE FOR POWERED EQUIPMENT OR DEVICES

15.1 No one shall work above or on moving machinery, energy driven mechanical apparatus, electrical panel or switchgear unless it has been isolated from power or movement by means of applying a lockout device on the main switch or other applicable means of activation for that equipment.

15.2 The NRF/iThemba LABS GMR2 and RSHEQ Department must be notified immediately when the need to lockout any device / equipment as contemplated in 10.1 is required

15.3 The NRF/iThemba LABS GMR2 and RSHEQ Department must grant permission before a lockout device/s can be applied. All equipment shall be checked by a competent person/s from the Mandatory together with the NRF/iThemba LABS GMR2 to ensure a lockout process has been completed and that all devices or equipment is properly shutoff before any work can take place on the effected equipment.

15.4 Upon completion of the required work, the NRF/iThemba LABS GMR2 and RSHEQ Department must be notified before any lockout devices are removed and equipment or devices are energized or activated for use.

16. PRECAUTIONS AGAINST FIRES AND HAZARDOUS SUBSTANCE MANAGEMENT

16.1 All Mandatories shall take all necessary precautions to eliminate all fire hazards and to prevent fire damage.

16.2 All Mandatories shall have adequate Fire Fighting equipment in their possession with an up-to-date service record and personnel trained in basic firefighting and the use of such equipment.

16.3 All Mandatories shall ensure that his employees do not smoke anywhere on the premises except in areas identified as smoking bays.

16.4 The Mandatory shall first obtain a **Hot Work Permit** from the NRF/iThemba LABS Project Manager or RSHEQ Department before any naked flame or grinder is used anywhere outside a workshop. The permit is valid for one day only and shall be kept on the person who is using a naked flame.

16.5 All fires shall immediately be reported to the NRF/iThemba LABS Project Manager and the RSHEQ Department.

16.6 Any hazardous chemicals / substances / materials brought on site by the Mandatory must always be accompanied by **Material Safety Data Sheets.**

16.7 Paint, thinners, petrol, oil or any flammable materials shall be stored within a designated area under supervision of the **Hazardous Materials / Substances Controller**.

16.8 Any work which involves Lead, Asbestos and other Hazardous Chemical Substances will be conducted in terms of the Occupational Health and Safety Act, no. 85 of 1993 and its relevant legislation.

16.9 The use of an Approved Inspection Authority, authorized by the Department of Labour, to conduct a Risk Assessment and facilitate a personnel and environmental monitoring program will be required where work with asbestos is taking place or any other work with hazardous chemicals / materials which constitutes a significant risk / hazard to the health and safety of personnel.

17. INTOXICATION AND ILLNESS

17.1 No intoxicating substance of any form shall be allowed on the NRF/iThemba LABS Premises. Any person suspected of being intoxicated shall not be allowed on the premises.

17.2 Any person required to take medication, which may affect sobriety, shall notify the relevant responsible person thereof, as well as the potential side effects of the medication.

17.2 The Mandatory shall ensure that none of his/her employees report to the site while ill to such a degree where their own Health, Safety and wellbeing is jeopardized and where risk to other personnel may also exist.

18. FIRST-AID

18.1 The Mandatory will be required to have their own First-Aider/s appointed for the duration of the project. These First-Aiders must be in possession of a valid First-Aid Certificate.

18.2 The Mandatory must have a first-aid box in their possession at all times that is compliant with the General Safety Regulations, no. 3 and its relevant annexure.

19. HOUSEKEEPING AND WASTE MANAGEMENT

19.1 The Mandatory shall uphold high standards of housekeeping throughout the course of their contract to ensure a safe working environment.

19.2 The NRF/iThemba LABS Project Manager and RSHEQ Department together with the appointed Contractor shall authorize areas where rubble and other waste material may be stored. This shall be done in a way that does not present a risk / hazard to personnel, interfere with any processes, obstruct movement and traffic flow and create an Environmental fallout.

19.3 All surplus, waste material and builders' rubble shall be removed from the premises on completion of the contract or as otherwise specified by the Project requirements / Project Manager. iThemba LABS reserves the right to remove such material against cost within one week after completion of the contract if the contractor fails to do so within the allotted project time frame.

20. WORK IN AREAS WHERE RADIOACTIVE MATERIALS ARE PRESENT

20.1 Any work that must be performed in any Radiation Protection Area requires the RSHEQ Department: Radiation Protection Manager to be notified before such work is commenced.

20.2 Contractors will adhere to all iThemba LABS Radiation Protection Protocols. Failure to do so shall result in termination of all contracts and removal from the premises.

21. SECURITY

21.1 Mandatories are required to report to Security Personnel at the Main Gatehouse. Security will contact the Project Manager to verify the validity of the contractor before allowing access to the facility.

21.2 All contractor vehicles will be subjected to a search before entry and when leaving the premises.

21.3 Mandatories are required to remain in their areas of operation and are not allowed to move around the facility unless authorized by the NRF/iThemba LABS RSHEQ Department and Project Manager.

21.4 Mandatories are not permitted to stay on site after their shift has been completed.

21.5 Mandatories shall not interact or interfere with the perimeter fencing of iThemba LABS, both internally or externally, unless permitted in writing to do so by authorized iThemba LABS personnel.

21.6 Any Mandatory and / or its personnel found to be illegally removing iThemba LABS property shall be subject to action as stipulated in Section 23 of this Agreement.

21.7 NRF/iThemba LABS and its Security Personnel do not accept any responsibility for the safekeeping of any material, tools or equipment belonging to any Mandatory on site.

22. PROCEDURES IN THE EVENT OF AN ACCIDENT

22.1 The Contractors shall report any injuries sustained by his employee to the Department of Labour. The injuries and responsibilities are as defined in Section 24 of the OHSA, no. 85 of 1993.

22.2 All incidents shall be reported to the iThemba LABS Project Manager and the RSHEQ Department. Copies of all documentation pertaining to the incident shall be provided

22.3 The Contractor shall report all injuries to the Compensation Commissioner using the required legal documentation as contemplated in the Occupational Health and Safety Act and Compensation for Occupational Injuries and Diseases Act.

22.4 In the event of an accident causing the loss of a life or the possibility of the loss of life, no person shall disturb the site at which the accident occurred or remove any objects involved in the accident before the arrival of an inspector from the Department of Labour and the South African Police Services.

23. INDEMNITY AND INSURANCE

23.1 NRF/iThemba LABS shall not be held liable for any loss, damage, injury or death caused by the Mandatories and their employees. The Mandatory indemnifies NRF/iThemba LABS and holds it harmless against all and any claims, losses, demands, liability, costs and expenses of whatsoever nature which may arise at any time out of circumstance referred to in this agreement, provided that such loss, damage, injury or death is not caused by a willful act or omission or gross negligence of NRF/iThemba LABS.

23.2 The Mandatory shall therefore assume liability for any loss or damage which may be caused by the Mandatories or it's employee's negligence. The Mandatory indemnifies NRF/iThemba LABS from such loss or damage caused by the Mandatories breach of any terms of this Agreement.

23.3 The Mandatary undertakes to ensure that they carry the appropriate insurance cover as specified in the Contract, including third party public liability cover. This information will be provided to the NRF/iThemba LABS on demand or before any work is allowed to commence.

24. PRECAUTIONARY MEASURES

24.1 All Contractors must determine the degree of risks and / or hazards related to the work they have tendered for by conducting a comprehensive Risk Assessment (See Appendices 02 for guidelines) and implement the identified precautionary measures throughout the length of the contract.

24.2 iThemba LABS reserves the right to audit all processes related to Hazard and Risk Management at any reasonable time during the length of the contract.

25. FAILURE TO COMPLY WITH PROCEDURES

25.1 Failure to comply with the contents of this document and any provisions of the OHS Act not specifically included in this agreement could result in legal prosecution by the Department of Labour.

25.2 Non-compliance by the Mandatory with any of the requirements as stipulated in this document could result in any or all of the following actions being taken by the NRF/iThemba LABS:

25.2.1 The Mandatory could be requested to leave the premises and the contract for the project tendered for would become null and void. All costs incurred by NRF/iThemba LABS such actions would be borne by the Mandatory.

25.2.2 A specific member of contractor staff who breaches this contract could be requested to leave the premises without delay and would not be permitted to enter the premises in future. Any cost incurred would be borne by the Mandatory.

25.2.3 Equipment, which would be deemed as unsafe, would be confiscated and returned upon completion of the specific contract. Any costs incurred would be borne by the Mandatory.

26. TRADE UNIONS

26.1 No employees of a Mandatory shall be allowed to actively further the interest of any Trade Union/s on site.

27. CLARIFICATION

27.1 If any Mandatory requires clarification on any of the terms or provisions of this agreement, it should contact the NRF/iThemba LABS in writing and address the query to the appropriate contact person.

28. DURATION OF AGREEMENT / CONTRACT

28.1 The agreement / contract shall remain in force for the duration of the work to be performed by the Mandatory and / or whilst the Employees and / or Sub-Contractors are on the NRF/iThemba LABS Site.

29. HEADINGS

29.1 The headings in this Agreement are for reference purposes only. These shall not be construed as having any interpretative value in themselves, nor any indication as to the meaning of the contents of the paragraphs contained in this Agreement.

30. ACCEPTANCE

I, _____ (Mandatories), by signing this document, hereby warrant that I shall bear all responsibility for adherence of all Legislation and Regulations applicable to the agreed contract work and particularly for the full and proper implementation of the provisions of the Occupational Health and Safety Act, No. 85 of 1993 and all other Regulations without exception.

Signed

_____ _____

Section 16.1 Appointment (OHSA) **Date**

And / or

_____ _____

Section 16.2 Appointment (OHSA) **Date**

And / or

_____ _____

Appointed Safety / Compliance Officer **Date**

And / or

_____ _____

PrCHSA (PCMP) **Date**

And / or

_____ _____

CHSM (PCMP) **Date**

And / or

_____ _____

PrCHSO (PCMP) **Date**

_____ _____

MANDATORIES DATE

31. APPENDICE 01: PRIMARY / SUB-CONTRACTOR COIDA INFORMATION

Name of Firm: _____

Address: _____

_____

_____

Telephone: _____

Mobile: _____

E-mail: _____

Type of work being performed

_____

_____

Commencement date of work: _____

Completion date of work: _____

For South African Primary / Sub-Contractors Only

Is your firm registered with Compensation Commission: Yes ☐ No ☐

If yes, your membership number: _____

Number of Personnel on the premises: _____

Name of competent person on site and his contact number

_____

_____ _____

Signed Date

Note: Attach Valid copy of Letter of Good Standing with Compensation Commission

_____ _____

MANDATORIES DATE

32. APPENDICE 02: SAFETY FILE / SAFETY PLAN GUIDELINE FOR CONTRACTORS

1. PURPOSE

The purpose of this document is to outline the requirements for a Safety File to guide contractors on both legal and iThemba LABS requirements.

2. SCOPE

This shall apply to all contractors scheduled to conduct work at iThemba LABS which can be defined as construction or listed work in accordance with the relevant legislation.

3. DEFINITIONS

- OHSA – Occupational Health and Safety Act
- GNR – Government Notice Regulations
- Construction Work – Any work in connection with the construction, erection, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure. Any work in connection with the construction, erection, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer, or water reticulation system, or the moving of earth, clearing of land, the making of excavation, piling, or any similar civil engineering structure or type of work.
- Listed Work – Any work where personnel will be exposed to hazards and hazardous materials or substances and is identified by the Minister as listed work under specific conditions and/or circumstances.
- Competent Person – Any person who has, in respect of the work or task to be performed, the required knowledge, training and experience and where applicable, the qualifications, specific to that work or task.

4. RELEVANT LEGISLATION

The relevant legislation shall include but not limited to:

- The Occupational Health and Safety Act, No. 85 of 1993
- The Construction Regulations GNR 84 of 2014

5. REQUIREMENTS

A Safety File / Safety Plan should contain the following basic information in order to be legally compliant:

1. Mandatory Agreement with client (37.2 Agreement)
2. Letter of Good Standing (Workman's Compensation)
3. Health and Safety Plan
4. Emergency Plan and Procedures
5. Health and Safety Policies
6. PPE Issue Register
7. Toolbox Talks
8. Accident / Incident Investigation
9. Employee Details

10. Medical certificates
11. Proof of Competency (Certificates)

A more detailed breakdown of a Safety File is as follows. The list below serves as a guideline. The Health and Safety File must be specific to the task / job / project being performed:

- **Administrative**
  - Mandatory Agreements
  - Permit to do Construction Work (If applicable)
  - Notification of Construction Work (If Applicable)
  - Client Health and Safety Requirements
  - Letter of Good Standing (Workman's Compensation)
- **Plans**
  - SHE Plan
  - Emergency Plan and Procedures
  - Fall Protection Plan (If working at heights)
- **Policies**
  - OHS Policy
  - Smoking Policy
  - Environmental Policy
- **Risk Assessments**
  - Daily Safety Task Instructions
  - Hand Tool Operations
  - Portable Electric Tools
- **Legal Appointments (Delegation of duties)**
  - Safety Supervisor
  - Hand Tool Inspector
  - Portable Electric Tool Inspector
  - Ladder Inspector
- **Registers and Check sheets**
  - Hand Tool Register
  - Portable electric Tool Register
  - Portable Ladder Register
- **Employee Details**
  - Employee Register
  - I.D. Copies
  - Medical Certificates
  - Proof of Competence

- **Compensation for Occupational Injuries and Diseases (COID)**
  - Incident Register
  - Accident Incident Register
  - W.CI2 Document

6. RISK ASSESSMENT TEMPLATE

See Section 9 for a Risk Assessment Template which can be utilized for the completion of Base line Risk Assessments. This template only serves as a guideline and the use of any other template is acceptable.

7. CONTRACTOR'S AGREEMENT

- All contractors are required to complete the iThemba LABS Contractual Obligation form before commencing any work on site.
- This form must be included in the Safety File under "Client Health and Safety Requirements"

8. REVIEW PERIOD

This procedure shall be reviewed every two (2) years or as changes to the relevant legislation take place.

9. RISK ASSESSMENT TEMPLATE **(Note: this template serves as a guideline)**

Company	
Performed by	
Period Performed	
Review	
SEE LAST PAGE FOR RISK RATING AND LEGEND	

Hazards Identified	Specify	Health Effects	Risk Rating					Medical Surveillance	Recommendations
Physical			**P**	**E**	**C**	**RR**	**RC**		

Hazards Identified	Specify	Health Effects	Risk Rating					Medical Surveillance	Recommendations
Chemical			**P**	**E**	**C**	**RR**	**RC**		

MANDATORIES DATE

Hazards Identified	Specify	Health Effects	Risk Rating					Medical Surveillance	Recommendations
Psychological			**P**	**E**	**C**	**RR**	**RC**		

LEGEND			
ABBREVIATION	**DESCRIPTION**	**ABBREVIATION**	**DESCRIPTION**
HPD	Hearing Protective Devices	RPD	Respiratory Protective Devices
MSDS	Material Safety Data Sheet	SOP	Standard Operating Procedures
OHS	Occupational Hygiene Survey	SWP	Safe Work Procedures
PPE	Personal Protective Equipment	WRULDS	Work Related Upper Limb Disorders

Safety Risk Assessment Legend

Probability (P)	
1	unlikely to occur
2	some chance
3	could occur
4	good chance, probable
5	will occur

Exposure (E)	
1	rarely, annually, quarterly
2	occasionally, monthly
3	often, weekly
4	frequently, daily
5	continuously

Consequence (C)	
1	Insignificant, no health effect
2	first aid only, reversible health effect, minor
3	seeking medical help, temporary
4	irreversible health effects, permanent
5	Disabled / Fatality

Total = P + E + C		
RR	Risk Rating	
RC	Risk Classification	
11 – 15	**High**	Immediate action to be taken
6 – 10	**Medium**	Corrective action to be taken
3 – 5	**Low**	Adequate control, requires monitoring

MANDATORIES DATE