SPECIFICATION FOR HVAC WORKS

Hindustan Petroleum Corporation Ltd
Visakha Dispatch Station
VR-ATP Area, Naval Base Post
Visakhapatnam - 530 014
Andhra Pradesh

Mott MacDonald Consultants (India) Pvt. Ltd.
Kothari House, CTS No. 185
Off Andheri - Kurla Road
Andheri (East)
Mumbai 400 059

Architect: FreeSpanz Design Build Pvt. Ltd.
6A, H.R. Apt., Rani Sati Marg, Pathanwadi, Malad (East), Mumbai – 400 097

SPECIFICATION FOR HVAC WORKS

Client	HINDUSTAN PETROLEUM CORPORATION LTD.
MMCI Project No.	254625

Issue and Revision Record:

Rev	Date	Originator	Checked	Approved	Description
A	06/11/09	SPW	SM	PJC	ISSUED FOR TENDERING
B					
C					

List of Content **Page No**

1 Preface

The Client intends to get supply, installation & testing commissioning of Heating, Ventilation and Air Conditioning (HVAC) & allied works as listed in the Bill of quantities (BOQ) for the proposed Administration building at "Re-sitement of Integrated Marketing Facility at Vishakhapatnam – Black Oil Terminal".

2 Technical Specifications

2.1 Scope of Work

Scope of work covered under this tender shall be supply of the necessary equipment, installation, erection, testing and commissioning of the Services system. The skilled and unskilled labour as also lifting tools and the Contractor will provide tackle and any other materials and equipment that may be required. The actual extent of work vis-à-vis the distribution system shall be as indicated in the drawings/specifications.

2.2 Indian Standard Specifications

The particular specification for the work is as detailed hereinafter. These specifications shall be read in conjunction with the relevant Indian Standard, Chief fire officer's recommendations and the obtainable local practice as detailed in various regional handbooks of practice and the work shall be executed accordingly. Where the specifications in any of the standards are at variance with the Specifications detailed herein, the most stringent amongst them shall govern. Contractor shall ensure that execution of total work is in accordance to this.

2.3 Quality of Materials & General Standards of Work

The contractors under this contractor commits himself to use first class material and assumes full responsibility for the quality of all material incorporated or brought for incorporation in the work. The work shall be executed in accordance with best engineering practice and as per directions of Client/Consultants.

2.4 Scaffolding

The Contractor shall provide all scaffolding and ladders required for the proper execution of the work.

2.5 Measurements

The mode of measurements for quantification of 'variation' vide clause of General Conditions shall be as per provisions of the relevant Indian Standards. The Contractor shall provide all the measuring tapes and other accessories necessary.

3 Tools & Materials & Storage

3.1 The contractor at his own cost and charge shall provide all materials, tools, tackles, scaffolding, labour and water, necessary for the completion of the whole work in all respects.

3.2 The contractor shall pay the fees for testing the materials if directed by the Architects and local authorities or other statutory authorities.

3.3 The contractor will obtain, from time to time, various permissions and the completion certificates as per rules of all local and statutory; authorities.

3.4 The contractor shall co-ordinate for the material and storage facility with the Building Contractor.

3.5 Any materials, brought at site, shall not be removed without the written authority of the Architects or Consulting Engineer and when the contractor shall have received payment in respect of any certificates in which it is stated that the value of any unfixed materials on the work has taken into account, such materials shall become the property of Employer and the Contractor shall be liable for any loss or damage hereto.

3.6 The contractor shall insure the work against damages, for such sum as the Architects or Consulting Engineers may from time to time direct. All Insurance policies are yet to be taken out in the joint name of Employer and the Contractor in an office selected by the Architect or Consulting Engineer and all policies and receipts shall be deposited with Architects or Consulting Engineers.

3.7 All the brackets and hangers for pipes shall be fixed to the wall or RCC slab using 'Dash' fasteners wherever necessary.

3.8 The amount shown against the provisional item and/or contingencies in the schedule are provisional and for the estimating purposes only and the Contractor is neither concerned for its execution nor to charge any commission on these items. The owner reserves the right to get the work done for these items through a separate independent contractor.

3.9 Surplus material from the site shall be carted away by the Contractor without any cost to the Employer and the storage space provided to the Contractor shall be handed over to the employer clean and ready for occupation.

4 Safety Codes

4.1 First aid appliance including adequate supply of sterilised dressings and cotton wool shall be maintained in a readily accessible place.

4.2 An injured person shall be taken to a public hospital without loss of time, in cases where the injury necessitates hospitalisation.

4.3 Suitable and strong scaffolds should be provided for workmen for all works that cannot safely be done from ground level.

4.4 No portable single ladder shall be over 8 metres in length. The width between the side rails shall not be less than 30 cm (clear) and the distance between two adjacent rungs shall not be more than 30 cm. When a ladder is used an extra person shall be engaged for holding the ladder.

4.5 The excavated material shall not be placed within 1.5 metres of the edge of the trench or half of the depth of trench whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.

4.6 Every opening in the floor of a building or in working platform to be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one metre.

4.7 No floor, roof or other part of the structure shall be so overloaded with debris or materials as to render it unsafe.

4.8 Workers employed on mixing and handling material such as asphalt, cement mortar or concrete and lime mortar shall be provided with protective footwear and rubber hand gloves.

4.9 Those engaged in welding works shall be provided with Welder's protective eye shields and gloves.

4.10 (i) No paint containing lead or lead products shall be used except in the form of paste or readymade paints.

(ii) Suitable face masks should be supplied for use by the workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scrapped.

4.11 Overalls shall be supplied by the Contractor to the paints and adequate facilities shall be provided to enable the working painters to wash during the periods of cessation of work.

4.12 Hoisting machines and tackle used in the works, including their attachments, anchorage and supports shall be in perfect condition.

4.13 The ropes used in hoisting or lowering material or as a means of suspension shall be of durable quality and adequate strength and free from defects.

5 Section I - Air-Conditioning System

5.1 Variable Refrigerant Volume (VRV) System

Supply and installation of Variable Refrigerant Volume System, Factory assembled, factory charged, factory run tested of mentioned capacity. System should consist of accessible Scroll type compressors, Air-cooled condenser, steel base for mounting the above components, refrigeration piping, fittings, valves, refrigerant and oil, controls and ancillaries and nos. of various types of indoor units.

All the Out door units of the system shall be suitable for operation with 415 V +/_ 10%, 50 Hz, 3 Ph, 4 wire AC supply where as all indoor units preferable should be with 230 V, 50Hz Single Phase supply only. System should include all protection devices / Controls to with stand fluctuation / variation in power supply.

Out door units shall be able to operate over a range of out door ambient Temperature from 0° C to 50° C. Sound pressure levels of the out door units shall not exceed 75 dBA at 1M from the unit. The sound data should be measured in accordance with ARI standard 575.

System shall provided stable, trouble free and safe operation and provides flexibility in operation of indoor units with independent control of each indoor unit including partial operation. The system should be provided Multi compressor circuit for better flexibility. The system should be self intelligent to run on low out door temperature for better power consumption irrespective of nos. of indoor units in operations.

System should have provision for up gradation as and when required for its 50% capacity. Modular system shall be incorporated for all required control for parallel operation of Compressors, Condenser fans and Indoor units along with all refrigerant liquid control. The system should be designed for proper oil return to compressor along with distribution of all in each compressor.

Out door unit should be provided with anti corrosive treatment with powder-coated finish. Unit will be skid - mounted type and should be installed on suitable size cushy foot mount for vibration control.

Operation of the VRV system shall be through independent wired remote controllers and through Central Controller as specified.

5.2 Condensing Unit

Condensing units of the system shall be provided incorporating following details:

The Condenser coil shall be Air-cooled type with copper tubes and aluminum fins. The condenser coils shall be of adequate size and shall have an integral sub cooler circuit for sub

cooling of the liquid. Condenser coil shall have a refrigerant side working pressure of 400 psig with anti corrosive treatment.

Condenser shall have multiple piping and cabling connection option. Pump down facility should be provided in the refrigerant system by providing good quality hand / shut off valves to avoid loss of Refrigerant gas during maintenance. The condenser fans shall be propeller type, with aluminum blades, low speed, and low vibration levels and quite in operation with IP 55 Protection.

All the compressors of the out door units must be hermetically sealed scroll type. Each module of out door unit must have separate 1# inverter compressor, suitable to operate at heat load proportional to indoor requirement.

"Anti Corrosive" treatment (Blue Fins) for Al fins of Condenser Coils is mandatory and shall carry warranty of at least Five (5) years. The treatment should be suitable for areas of high pollution and salt laden air.

The outdoor units must be suitable for more then 150 Meter Refrigerant piping between outdoor unit & the farthest indoor units and total piping of 300 Meter for all the indoor units. Allowable level difference between out door unit & indoor units shall be 50 Meter in case of out door unit on top & 40 Meter in case of out door unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15 m.

Back up operation, in case of failure of one of the compressors of out door unit, for single module outdoor units or failure of one of the modules in case of multiple modules outdoor units shall be possible. The VRV outdoor unit shall always be supplying at least 33% of back up operation, of the full load capacity.

The outdoor unit shall employ system of equal run time for all the compressors, inverter or on/ off type, within each out door unit – Single Module or Multi Module.

Starter for the Out door Unit compressor shall "Direct on Line" type. Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting.

Refrigerant control in the out door unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.

The outdoor units shall confirm to Technological Guideline for Harmonic Suppression – JAEG 9702-1995. High Harmonic Environmental Target Level for Power Distribution system shall be 5%.

Out door units shall be complete with following safety devices:

- High pressure switch
- Fan driver overload protector
- Over current relay
- Inverter Overload Protector
- Fusible Plug

Unit shall be supplied with

- Installation manual
- Operation Manual
- Connection Pipes
- Clamps

5.3 Ductable Split Units

The cooling coils shall me made of Copper Tubing having extended aluminum fins. The tubes shall be mechanically expanded for positive bonding between tubes and fins. The cooling coil circuit shall be fed with liquid refrigerant through the expansion device and distributor. The

blower shall be statically and dynamically balanced and designed for silent operation at required airflow rates against required static pressure. The filters shall be washable synthetic media type arranged for convenient cleaning and replacement. The drain pan shall be fabricated out of heavy steel sheet. Insulated with expanded polyethylene sheet. The casing shall be of heavy gauge GI, duly powder coated for weather protection.

5.4 Cassette Type Indoor Units (With Cordless Remote)

These units shall be installed between the bottom of finished slab & top of false ceiling. The maximum allowable height for the cassette type units shall be 288 mm.

The unit must have in built drain pump, suitable for vertical lift of 750 mm. The unit casing shall be Galvanized Steel Plate.

Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The noise level of unit at the highest operating level shall not exceed 55 dB(A), at a vertical distance of 1.5 m from the grille of the unit. Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit (288 mm maximum). The unit shall be supplied with suitable decorative panel.

The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & re install.

The unit will be connected in series to a suitable out door unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the “Bill of quantities”.

The unit shall be supplied with following from the factory
- Operation Manual
- Installation Manual
- Paper pattern for installation
- Drain hose/ Clamp metal/ Washer fixing plate/ Sealing pads/ Clamps/ Screws/
- Washer for hanging bracket/ Insulation for fitting

5.5 HI – Wall Mounted Split Units: (Indoor Unit)

With decorative look to match with the interior Layout of Corded Remote type complete

In PVC construction. Evaporating unit comprising of DX Cooling coils, blower, electric motor, insulated sandwiched drain Tray, and junction box for electrical connections, 20 micron HDPE washable filter. etc.

5.6 Controls and Interlocking

Entire system shall have Microprocessor Controls. Microprocessor should have Auto Check Function to indicate Piping and cabling errors. Micro processor should control speed or switching or by pass of Compressors, Condensers, Fans, and liquid management

Functions along with the system for proper oil return and stable and safe operation of system. Micro Processor shall have pre set memory, which shall not be erased on power failure. Units should have automatic restart in case of mains failures.

Precision Temperature Control should be mandatory with Electronic Expansion Valves adjusting to load fluctuation and operating load fluctuation to maintain ± 0.5° C of set point with PID control Algorithm.

Individual controllers with wired or wireless remote for operation, status etc. shall be used. All units should have self – Diagnostic Function to pre warn of failure or problems with function codes.

Power to the control system shall be generated inside the units from common power supply.

Central wiring shall be FRLS grade and simple with control and transmission wiring being common.

Individual areas would have remote controllers for controlling individual units. Controlled units shall have digital indication of temperature along with setting and other functions. ON / OFF switch, timer, RTC, operation of the fans, swing of louvers and other operation modes as desired including diagnostics.

5.7 Wired / CORDLESS Remote Controller

Wired / Cordless remote controller shall be supplied as specified in the "Bill of Quantities"

The controller must have large crystal display screen, which displays complete operating status.

The digital display must allow setting of temperature with 1 Deg C interval.

Remote shall be able to individually program by timer the respective times for operation start and stop within a maximum of 72 hours

Remote must be equipped with thermostat sensor in the remote controller that will make possible more comfortable room temperature control The remote shall be able to monitor room temperature & preset temperature by microcomputer & can select cool/ heat operation mode automatically. The remote must constantly monitor malfunctions in the system & must be equipped with a "self diagnosis function" that let know by a message immediately when a malfunction occurs.

In case of corded remote it shall be possible to wire the remote up to 500 RMT.

5.8 Central Remote Controller

Central Remote controller shall be supplied as specified in the "Bill of Quantities"

Central Control unit shall be suitable for On / OFF and Temperature control of Zones including scheduling, Malfunction and status display shall be available. It should be Compatible with BMS of standard makes. Setting of address for each unit should be automatic and need not be programmed.

Following functions shall be possible
Control Max 64 Groups (128 indoor units)
Zone control
Malfunction code display
All the functions available with wired remote controller
It should be possible to wire the remote to 1000m

Central Controller shall be compactable to connect with Fire Detection System.

5.9 Refrigerant Piping & Insulation

All refrigerant piping shall be in high grade copper (18 Gauge) including all connections, Tees, Reducers, etc. Required nos. of Refrigerant joints with insulation should be provided for uniform flow of refrigerant through all Indoor units.

All refrigerant piping shall be insulated with suitable thickness of Closed Cell Elastomeric thermal Insulation material. All joints on the insulation should be sealed with good quality sticking compound. All joints should be covered with 2" wide Aluminum tape.

Entire Refrigerant piping inside the building should be installed on the wall / ceiling with proper clamping arrangement and refrigerant piping out side the building (i.e. on Terrace, Shafts) should be properly clamped on MS / GI brackets on the wall of duct / shaft.

Sufficient valving shall be included to allow compressor / s to be removed for service & to allow the refrigerant to be pumped in to and contained in the condenser. The unit shall be equipped with a liquid line shut off valve, filter drier, liquid line sight glass, and solenoid valve & insulation where required to prevent condensation forming.

5.10 Electrical Work

The electrical work will be carried out as per IE rules. The Employer will provide incoming cable with earthling for each Out door unit. The further distribution of control cabling and earthing of GI shall be carried out by the contractor.

5.11 Drain Piping

Condensate from the Indoor unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of rigid PVC pipe of 6 Kg./cm sq. pressure rating with water tight threaded connections. Leading from the Indoor unit to a suitable drain point. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant / adhesives.

5.12 Exposed Roof Insulation

The exposed roofs, walls shall be insulated with 50 mm thick fire retarded quality expanded polystyrene from the inside. The material shall be fixed with 85 / 20 grade hot bitumen and GI screw washers. The insulation sheets shall be further fixed with GI diagonal wires and BOPP tapes.

5.13 Sheet Metal Work

The galvanized steel sheet shall confirm to IS: 277 Ducts shall be made of GI sheet confirm to IS: 655 as under:

Max. Side (mm)	Thickness of Sheet (mm)	Type of Joint	Bracing
Up to 750	0.63	25 GI Flange	None
751 to 1500	0.80	25 x 3 MS angle flange	25 x 25 x 3 angles 1.25 m from joint
1501 to 2250	1.00	32 x 3 MS angle flange	32 x 32x 3 angles 1.25 m from joint
2251 to above	1.25	32 x 3 MS angle flange	32 x 32 x 3 angle 1.25 m from joint

All ducts shall be rigid and shall be adequately supported at every 6' distance and braced where required with standing seems, tees or angles or ample size to keep the ducts true to shape and to prevent bulking, Vibration or breathing.

Duct support shall be as per the following:

Max. Side (mm)	Spacing	MS angle size (mm)	MS rod Dia. (mm)
Up to 750	2.5 m	32 x 32 x 3	6
751 to 1500	2.5 m	40 x 40 x 3	6
1501 to 2250	2.5 m	50 x 50 x 3	10

All the joints shall be made tight and all interior surface shall be smooth. Bends shall be made with radius not less then one half the width of the duct or with properly designed interior curved vanes.

A good quality NIKIFOAM / PROFEEL / FELT of uniform thickness and width shall be used as gasket between flanged joints. The gasket shall be fixed by a suitable adhesive.

All dampers shall be louver dampers of robust construction and tight fitting of opposed blade type design, the method of handling and control, shall be suitable for the location and service required.

Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation, control or setting in any desired position. Dampers and their operating devices shall be made robust, easily opera table and accessible through suitable access doors. Every damper shall have indication device clearly showing damper position at all times.

All supply and return air outlets will be of extruded aluminum and shall be powder coated with volume control damper of opposed blade type with Matt finish black color for supply air only.

5.14 Testing

The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions. The final balancing of air quantity through each grille or diffuser shall be recorded and submitted to the Consultants for approval. The performance test of the entire system shall be carried out and shall comply as per applicable clauses of Sustainable Design requirements (Document no. 254625-300-SP-CIV-016 Rev. A) for HVAC.

5.15 Painting

Angle iron flanges, stiffeners, hangers and supports shall be painted with two coats primer and those remaining uncovered further two coats of synthetic enamel paints of approved color.

I. G. I. Not bolts to be used for duct connection at 6” pitch on periphery and shall be of hot dip galvanized.

J. The Evaporating unit will be connected to ducting by means of flexible connections of canvas type with zip.

5.16 CO2 Sensor with Exhaust Fan

The scope includes CO2 Sensor mounted in Return air path of the Air-conditioning system synchronized with propeller type exhaust Fan with associated controls & Accessories.

All associated items herein to be supplied, delivered, installed, commissioned, tested and handed over.

Provide specialist’s agencies representative’s services including coordination and supervision in start up and testing.

TOTAL AIR QUALITY MONITOR

Monitoring, Regulation and Reporting of Air Quality shall be performed automatically on continuous basis. The Indoor Air Quality shall be as specified in Section 02 of **Sustainable Design requirements (Document no. 254625-300-SP-CIV-016 Rev. A)**

The Monitor shall comprise two individual sections; Sensor Section and Display Section. The Sensor Section shall be common, regardless of the Display Section. Sensor and Display Sections shall be fully factory mounted complete with factory installed wiring between these, and mounted in one integral ABS housing. All electrical and control cable termination shall be

provided in a Terminal Block housed in a rated Junction Box, mounted on the Monitor. All field wiring shall be carried out through this, without the need to open the Monitor. The Junction Box shall also serve as an easy field wall mount device.

The Monitor shall be suitable for tracking Total Carbon Dioxide

On PD, display shall be 5.7 inch, Color, 320 x 240 Touch Screen LCD, capable of displaying all or individual parameters, as chosen by the user. On AD, display shall be backlit monochrome, 4 line x 20 character LCD display.

The monitor shall be programmable at site by user through Membrane Switch Keyboard, mounted below the screen. Programming Levels shall include System Set Up, Upper and Lower Ranges, Alarm Level, Bar or Line Graph*, Alarm Report*, Time History* and Real Time Reports* with user specific time periods.

The Sensor Section shall be provided with 256 MB RAM, Micro Processor, Flash Memory, Real Time Lithium Battery back up*, Terminal Block for output signal 0-10V, and One NO Dry Contact rated for 24V AC/DC 3 Amps, for each function, Wireless Communication for download to Data Logger, 2.0 USB, RS232, and Ethernet outputs for download to Lap Top, or PC, or Network*. Antenna shall be capable of wireless transmission through dry wall, aluminum or light metal or fiberboard ceiling or wall.

If installed in non-visible location, user shall have option to procure a remote Monitor, to be installed up to 25 feet (8M) away. In this case, the sensor module shall be provided with a blind cover, inter connecting cable (25 feet or 8 M) between Monitor and Remote Display. LCD shall be factory provided. This is titled CZ8-SD.

Power supply for the monitor shall be 12V (AC/DC) 3Amp, Adapter 110/12 (220/12) shall be factory provided.

The Monitor shall be factory provided with Lithium battery to power Real Time Clock and for data storage*.

For fail safe and long time operation, printed circuit board of Sensor Section shall be immersed in 24 carat gold 3 Micron thick. The populated board shall be conformal coated to prevent damage from dust, moisture, condensation, traces or acid, and ozone.

All parts and components of the Monitor shall be lead free and shall comply with ROHS (Restriction in use of Hazardous Substances).

6 Section II - Ventilation System

6.1 Exhaust & Fresh Air Fans

Scope

Scope of work under this section comprises the supply, erection, testing and commissioning of the ventilation system of the capacities set forth in the Schedule of Equipment.

All fans shall be static and dynamically balanced.

6.2 Propeller Fans

The fans shall be selected for heavy-duty operation. Fan housing shall be one-piece rugged steel construction. The fan shall be in accordance with IS-2312

The fan impeller shall be propeller type. The hub and the impeller shall be dynamically balanced and frames and arms shall be mounted on rubber bushings.

The motor shall be Flameproof / Non –Flameproof type & totally enclosed type, with capacitor start and run type motor, rated for continuous duty and rugged in construction. The motor shall have pre-lubricated double ball bearing and shall be provided with class A / E insulation.

The air sucked from the room shall pass over the motor and to the outside Fans shall be provided with gravity type louvers unless otherwise stated. The inner portion of shutters shall have a wire mesh bird guard.

6.3 Testing & Balancing

After the installation of the entire system is completed in all respects, system shall be tested & balanced for required performance. Fan shall be tested for the performance and test results shall be furnished to Consultants for approval and acceptance.

6.4 Painting

On completion of the erection and testing, fans shall be painted with the two coats of an appropriate paint of approved colour.

Appendix I: Attachments

Documents

Document No.	Rev.	Description
254625-300-SP-GEN-001	C	Local Conditions
254625-300-SP-CIV-016	A	Sustainable Design Requirements

Drawings

Drawing No.	Rev.	Description
254625-300-MEC-A1-0001	A	Adminstration building Ground floor & First floor ducting plan.

SCHEDULE OF QUANTITIES FOR BLACK OIL AT VISHAKHA MARKETING TERMINAL RESITEMENT PROJECT TENDER FOR ADMIN BUILDING					
Sr. No.	**D E S C R I P T I O N**	**Unit**	**Quantity**	**Rate**	**Amount**
A	**Ventilation System**				
1	**Propeller type axial FRESH AIR FAN**				
	The Fresh Air fans shall be complete as per technical specifications, Freash Air fan summary sheet and the drawings and as described below:				
	The fans shall be selected for heavy-duty operation. Fan housing shall be one-piece rugged steel construction. The fan shall be in accordance with IS-2312.The fan impeller shall be propeller type. The hub and the impeller shall be dynamically balanced and frames and arms shall be mounted on rubber bushings. The motor shall be totally enclosed type, with capacitor start and run type motor, rated for continuous duty and rugged in construction. The motor shall have prelubricated double ball bearing and shall be provided with class A / E insulation. The fans shall be complete with gravity shutters and leak proof closing mechanism and suitable for wall mouting with necessary framework. The costs shall include making of holes and fixing of louvers on the external facia and with the fans mounted on the inner facia of the wall. Power cable with plug top and an isolator shall also be provided with the fan. The Fresh Air fans shall be capable of following capacities:				
	a) 1800 CFM	**NOS.**	**1**		
2	**Propeller type axial FRESH AIR FAN**				
	The Fresh Air fans shall be complete as per technical specifications, Freash Air fan summary sheet and the drawings and as described below:				
	The fans shall be selected for heavy-duty operation. Fan housing shall be one-piece rugged steel construction. The fan shall be in accordance with IS-2312.The fan impeller shall be propeller type. The hub and the impeller shall be dynamically balanced and frames and arms shall be mounted on rubber bushings. The motor shall be Flame proof, totally enclosed type, with capacitor start and run type motor, rated for continuous duty and rugged in construction. The motor shall have prelubricated double ball bearing and shall be provided with class A / E insulation. The fans shall be complete with gravity shutters and leak proof closing mechanism and suitable for wall mouting with necessary framework. The costs shall include making of holes and fixing of louvers on the external facia and with the fans mounted on the inner facia of the wall. Power cable with plug top and an isolator shall also be provided with the fan The Freash Air fans shall be capable of following capacities:				
	a) 700 CFM	**NOS**	**1**		
3	**Propeller type axial EXHAUST FAN**				
	The exhaust fans shall be complete as per technical specifications, exhaust fan summary sheet and the drawings and as described below:				

SCHEDULE OF QUANTITIES FOR BLACK OIL AT VISHAKHA MARKETING TERMINAL RESITEMENT PROJECT TENDER FOR ADMIN BUILDING					
Sr. No.	**D E S C R I P T I O N**	**Unit**	**Quantity**	**Rate**	**Amount**
	The fans shall be selected for heavy-duty operation. Fan housing shall be one-piece rugged steel construction. The fan shall be in accordance with IS-2312.The fan impeller shall be propeller type. The hub and the impeller shall be dynamically balanced and frames and arms shall be mounted on rubber bushings. The motor shall be totally enclosed type, with capacitor start and run type motor, rated for continuous duty and rugged in construction. The motor shall have prelubricated double ball bearing and shall be provided with class A / E insulation. The fans shall be complete with gravity shutters and leak proof closing mechanism and suitable for wall mouting with necessary framework. The costs shall include making of holes and fixing of louvers on the external facia and with the fans mounted on the inner facia of the wall. Power cable with plug top and an isolator shall also be provided with the fan The exhaust fans shall be capable of exhausting following capacities:				0
	a) 1800 CFM	**NOS.**	**1**		
	b) 300 CFM	**NOS.**	**1**		
	c) 225 CFM	**NOS.**	**5**		
	d) 200 CFM	**NOS.**	**1**		
	e) 150 CFM	**NOS.**	**2**		
4	**Propeller type axial EXHAUST FAN**				
	The exhaust fans shall be complete as per technical specifications, exhaust fan summary sheet and the drawings and as described below:				
	The fans shall be selected for heavy-duty operation. Fan housing shall be one-piece rugged steel construction. The fan shall be in accordance with IS-2312.The fan impeller shall be propeller type. The hub and the impeller shall be dynamically balanced and frames and arms shall be mounted on rubber bushings. The motor shall be Flame proof, totally enclosed type, with capacitor start and run type motor, rated for continuous duty and rugged in construction. The motor shall have prelubricated double ball bearing and shall be provided with class A / E insulation. The fans shall be complete with gravity shutters and leak proof closing mechanism and suitable for wall mouting with necessary framework. The costs shall include making of holes and fixing of louvers on the external facia and with the fans mounted on the inner facia of the wall. Power cable with plug top and an isolator shall also be provided with the fan The exhaust fans shall be capable of exhausting following capacities:				
	a) 700 CFM	**NOS.**	**1**		
B	**VRV - LOW SIDE WORK (REFER DRAWINGS)**				
1	**Sheet Metal Duct Work As Per IS: 655**				
	GI sheet metal Duct:				
	a) 24G	**M2**	**1100**		
	b) 22G	**M2**	**200**		

SCHEDULE OF QUANTITIES FOR BLACK OIL AT VISHAKHA MARKETING TERMINAL RESITEMENT PROJECT TENDER FOR ADMIN BUILDING					
Sr. No.	**D E S C R I P T I O N**	**Unit**	**Quantity**	**Rate**	**Amount**
2	**Diffuser**				
	Supply & Installation of Alluminium Powder coated Modular Diffuser with Volume Control Damper (Outer Size 600 X 600).	**Nos.**	**9**		
	Supply Installation of Alu.Powder coated Modulkar Diffusers without Volume Control Damper .(Outer Size 600 X 600).	**Nos.**	**9**		
3	**Grille**				
	Supply , Installation of Alu. Powder coated Grille.	**M2**	**45**		
4	**Damper**				
	Supply , Installation of Alu. Coller damper of opposed blade type with Bass Bush.	**M2**	**11**		
	G. I. Volume control Duct damper of opposed blade type with Brass Bush	**M2**	**7**		
5	**Insulation of Sheet Metal Duct**				
	A) Acoustic Insulation: As per Specification. 12MM THK.	**M2**	**200**		
	B) Thermal Insulation : As per Specification. 12MM THK.	**M2**	**700**		
	Fabrication				
6	**Sensors**				
	CO_2 Sensor with 500 CFM capacity Exhaust Fan for Office area - As per Specifications.	**NOS.**	**1**		
C	**VRV - HIGH SIDE WORK**				
1	**Condensing Unit / Out door Unit of VRV System**				
	For total Capacity (System shall have equal capacity modules) as per details mentioned in Technical Specifications and requirements. **System will be operated by Eco -friendly Refrigeret gas R - 410 /R - 407 C.** All condensers will be installed on side wall of the building on Epoxy Painted MS Stand with adequate space for maintenance facility.MS Stands will be provided by AC Contractor.				
	A) 23 TR	**NOS.**	**1**		
2	**Indoor Units**				
	A) Ceiling Suspended Ductable Type Split Unit as mentioned in Technical Specifications.				
	i) 8.0 TR	**NOS.**	**1**		
	ii) 5.5 TR	**NOS.**	**2**		
	B) Ceiling Suspended Cassette Type Split Unit (4 - Way Type) as details mentioned in Technical specifications				
	i) 2.0 TR	**NOS.**	**1**		
	ii) 1.5 TR	**NOS.**	**3**		
	C) Indoor Wall Mounted Hi – Wall split units as details mentioned in Technical Specifications.				
3	**Refrigerant Piping**				
	Refrigerant piping of Copper along with Insulation & all accessories like, T, Bend, Elbows complete piping shall be pressure tested for 400 PSI. Piping shall be properly Clamped / Installed on Ceiling / Wall by providing GI angle, bracket, threaded support, nut, washer etc., complete piping shall be pressure tested for 400 PSI. Insulation of Refrigerant Piping shall be with nitrile rubber Thermal Insulation. All joints shall be ceiled with good quality adhesive as mentioned in Technical specifications.				
	Pair of hard piping with 19 mm thick nitrile rubber insulation.	**RM**	**185**		
	Pair of soft piping with 13 mm thick nitrile rubber insulation.	**RM**	**115**		

SCHEDULE OF QUANTITIES FOR BLACK OIL AT VISHAKHA MARKETING TERMINAL RESITEMENT PROJECT TENDER FOR ADMIN BUILDING					
Sr. No.	**D E S C R I P T I O N**	**Unit**	**Quantity**	**Rate**	**Amount**
4	**Refrigerant Joints**				
	Pair of Refrigerant joints in copper piping (factory insulated) for above Refrigerant piping.	**NOS.**	**6**		
5	**Remote Controller**				
	Wired Remote / Cordless Remote controller with each Indoor unit confirming to all tender technical specifications.				
	i) Cordless type	**NOS.**	**7**		
	ii) Central Remote Controller for entire VRV System as per Tender Technical Specifications.	**NOS.**	**1**		
6	**Control Cabling**				
	2C x 1.0 Sqmm Cu cabling in flexible PVC conduit between ODU & IDU & between ODU & central controller	**RM**	**450**		
7	**Drain Piping**				
	Rigid PVC drain piping of 6Kg / cm sq. rating as per mentioned in specifications.				
	a) 25 mm Ø	**RM**	**125**		
	b) 32 mm Ø	**RM**	**15**		

LOCAL CONDITIONS

Hindustan Petroleum Corporation Ltd
Visakha Dispatch Station
VR-ATP Area, Naval Base Post
Visakhapatnam - 530 014
Andhra Pradesh

Mott MacDonald Consultants (India) Pvt. Ltd.
Kothari House, CTS No. 185
Off Andheri - Kurla Road
Andheri (East)
Mumbai 400 059

C

LOCAL CONDITIONS

Client	HINDUSTAN PETROLEUM CORPORATION LTD.
MMCI Project No.	254625IN01

Issue and Revision Record:

Rev	Date	Originator	Checked	Approved	Description
A	16/03/09	VV	SG	RB	Issued for Comments
B	05/05/09	VV	SG	AVM	Issued for Information
C	07/09/09	SVS	VK	SG	Issued for Information

LOCAL CODITIONS

PROJECT DESCRIPTION : HPCL Black Oil | **LOCATION : Visakhapatnam, India**

LOCAL CONDITIONS:

ELEVATION : 3.0 m ABOVE MEAN SEA LEVEL	CLIMATE : Highly Corrosive
DESIGN OF COOLING TOWER: WBT 29.5 ^{0}C	WIND DIRECTION: South-West to North-East
DESIGN OF HVAC	WIND VELOCITY : Basic wind speed 50 m/sec AT 10 m EL (IS 875 Part(3))
SUMMER : 37 ^{0}C DBT, 26.5 ^{0}C WBT 50 % RH	SEISMIC DESIGN FACTOR : Zone II (IS 1893 Part 1 : 2002) TOPOGRAPHY FACTOR, K3 : 1.22
WINTER : 15.4 ^{0}C DBT, 14.9 ^{0}C WBT 65 % RH	RAINFALL MAX / MIN (MM / DA): Max * mm & Design * mm
MONSOOON : 33.8 ^{0}C DBT , 29.2 ^{0}C WBT 80 % RH	DESIGN RAINFALL INTENSITY: 75mm/hr

MIN. DESIGN WIND LOAD FOR STRUCTURES: As Per IS-875 part III

DRY BULB TEMPERATURE:

	Outdoor		Indoor		Control Room	
	Temp. (^{0}C)	RH	Temp. (^{0}C)	RH	Temp. (^{0}C)	RH
Site Rated (Max/Min)	40.7	50%	*	*	25	55%
Max./Min. (Mech. Design)	45	50%	NA	NA	50	55
Design Wet Bulb	29.2		NA	NA	NA	NA

TROPICALISATION REQUIRED: - NO

WINTERIZATION REQUIRED : - NO

UTILITY BATTERY LIMITS :

ELECTRICIAL

	UNITS	PRIMARY DISTBN. (HV)	MV(415V) VOLTAGE	DG FED EMERGENCY POWER	AC UPS	DC SYSTEM
VOLTAGE ,	kV	33kV ± 10%	415 V ± 10%	415 V± 10%	230V± 1%	110V DC
FREQUENCY,	Hz	50 ± 5%	50± 5%	50± 5%	50± 1%	-
COMBINED VOLTAGE FREQUENCY	%	± 10	± 10	± 10	-	-
PHASE		3 Ph	3 Ph	3 Ph	1 Ph	-
DESIGN TEMP FOR ELEC. EQPT.	^{o} C	50				

LIQUIDS

	UNITS	COOLING WATER		CHILLED WATER	CHILLED BRINE	HOT WATER	HOT OIL
		TG	UTILITY	↑	↑	↑	↑
SUPPLY PRESSURE	kg/cm^{2}g	↑	↑				
DESIGN PRESSURE	kg/cm^{2}g						
SUPPLY TEMPERATURE	^{0}C						
DESIGN TEMPERATURE	^{0}C	NA	NA	NA	NA	NA	NA
TEMPERATURE RISE / DROP	^{0}C	↓	↓	↓	↓	↓	↓
PRESSURE DROP MAXIMUM	kg/cm^2						
FOULING FACTOR	m^{2}h^{0}C/kcal	↓	↓	↓	↓	↓	↓

GASES

	UNITS	PLANT AIR	INSTR. AIR	NITROGEN	STEAM				
					HP	MP	LP	LPE	LLP
PRESSURE : NORMAL	kg/cm^{2}g	↑	↑	↑	↑	11	3.0	↑	↑
: DESIGN	kg/cm^{2}g	↓	↓	↓	↓	13	3.45	↓	↓
TEMPERATURE : NORMAL	^{0}C	NA	NA	NA	NA	187	145	NA	NA
: DESIGN	^{0}C	↓	↓	↓	↓	217	180	↓	↓

Rev	Description	Originator	Checker	Approver	Date
A	Issued for Client comments / Approval	VK	GS	RB	16.03.2009
B	Issued for Information	VK	GS	AVM	05.05.2009
C	Issued for Information	SVS	VK	GS	07.09.2009

SUSTAINABLE DESIGN REQUIREMENTS

Hindustan Petroleum Corporation Ltd
Visakha Dispatch Station
VR-ATP Area, Naval Base Post
Visakhapatnam - 530 014
Andhra Pradesh

Mott MacDonald Consultants (India) Pvt. Ltd.
Kothari House, CTS No. 185
Off Andheri - Kurla Road
Andheri (East)
Mumbai 400 059

Architects: FreeSpanz Design Build Pvt. Ltd.
6A, H.R. Apt., Rani Sati Marg, Pathanwadi, Malad (east), Mumbai 400 059

SUSTAINABLE DESIGN REQUIREMENTS

Client	HINDUSTAN PETROLEUM CORPORATION LTD.
MMCI Project No.	254625

Issue and Revision Record:

Rev	Date	Originator	Checked	Approved	Description
A	29/07/09	GBP	NVM	SMA	ISSUED FOR COMMENTS
B					
C					

List of Content **Page No**

SECTION 01 – GENERAL SUSTAINABLE REQUIREMENTS

Part 1 - General

1 Summary

1.1 This Section includes general requirements and procedures for achieving the most environmentally conscious Work possible within the limits of the Construction Schedule, Contract Sum, and available materials, equipment, and products.

2 Objectives

2.1 To obtain acceptable Indoor Air Quality (IAQ) for the completed project and minimize the environmental impacts of the construction and operation, the Contractor during the construction phase of this project shall implement the following procedures singly or in combination:

1. Select products that minimize consumption of non-renewable resources, consume reduced amounts of energy and minimize amounts of pollution to produce, and employ recycled and/or recyclable materials. To help purchasers incorporate environmental considerations into purchasing decisions, it is the intent of this project to conform with the Five Guiding Principles on environmentally preferable purchasing. The five principles are:
   a. Include environmental considerations as part of the normal purchasing process.
   b. Emphasize pollution prevention early in the purchasing process.
   c. Examine multiple environmental attributes throughout a product's or service's life cycle.
   d. Compare relevant environmental impacts when selecting products and services.
   e. Collect and base purchasing decisions on accurate and meaningful information about environmental performance.
2. Control sources for potential IAQ pollutants by controlled selection of materials and processes used in project construction in order to attain superior IAQ.
3. Products and processes that achieve the above objectives to the extent currently possible and practical have been selected and included in these Construction Documents. The Contractor is responsible to maintain and support these objectives in developing means and methods for performing the work of this Contract and in proposing product substitutions and/or changes to specified processes.

3 Related Documents

3.1 Drawings and general provisions of the Contract, including General Conditions and other Specification Sections, apply to this Section.

3.2 Related Sections include the following:

1. Sustainable Design Requirements specific to the Work of each of the Sections.
2. Construction Waste Management
3. Testing for Indoor Air Quality
4. General Commissioning Requirements

4 Definitions

4.1 Agrifiber Products: Composite panel products derived from agricultural fiber.

4.2 Biobased Product: A commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials

4.3 Biobased Content: The weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight

4.4 Certificates of Chain-of-Custody: Certificates signed by manufacturers certifying that wood used to make products has been tracked through its extraction and fabrication to ensure that is was obtained from forests certified by a specified certification program

4.5 Composite Wood: A product consisting of wood fiber or other plant particles bonded together by a resin or binder

4.6 Construction and Demolition Waste: Includes solid wastes, such as building materials, packaging, rubbish, debris, and rubble resulting from construction, remodeling, repair and demolition operations. A construction waste management plan is to be provided by the Contractor.

4.7 LEED: The Leadership in Energy & Environmental Design green building rating systems developed and adopted by the U.S. Green Building Council (USGBC) & Indian Green Building Council (IGBC). The systems certify levels of environmental achievement based on a point and credit scoring system.

4.8 LEED NC: The Leadership in Energy & Environmental Design green building rating system developed and adopted by the USGBC and IGBC for new construction and major renovations of buildings

4.9 LEED EB: The Leadership in Energy & Environmental Design green building rating system developed and adopted by the USGBC for operating and maintaining existing buildings

4.10 Light Pollution: Light that extends beyond its source such that the additional light is wasted in an unwanted area or in an area where it inhibits view of the night sky

4.11 Recycled Content Materials: Products that contain pre-consumer or post-consumer materials as all or part of their feedstock

4.12 Post-Consumer Recycled Content: The percentage by weight of constituent materials that have been recovered or otherwise diverted from the solid-waste stream after consumer use

4.13 Pre-Consumer Recycled Content: Materials that have been recovered or otherwise diverted from the solid-waste stream during the manufacturing process. Pre-consumer content must be material that would not have otherwise entered the waste stream.

4.14 Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 800 km from the Project site

4.15 Salvaged or Reused Materials: Materials extracted from existing buildings in order to be reused in other buildings without being manufactured

4.16 Sealant: Any material that fills and seals gaps between other materials

4.17 Volatile Organic Compounds (VOCs): Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions. Compounds

5 Submittals

5.1 General: Additional Sustainable Design submittal requirements are included in other sections of the Specifications.

5.2 Sustainable Design Submittals:

1 Heat Island Effect:

a. Site Paving: Provide manufacturer's cut sheets for all impervious paving materials, highlighting the Solar Reflectance Index (SRI) of the material. Also, provide cut sheets for all pervious paving materials.

b. Roofing Materials: Submittals for roofing materials must include manufacturer's cut sheets or product data highlighting the Solar Reflectance Index (SRI) of the material.

2 Exterior Lighting Fixtures: Submittals must include cut sheets with manufacturer's data on initial fixture lumens above 90° from nadir for all exterior lighting fixtures.

3 Irrigation Systems: Provide manufacturer's cut sheets for all permanent landscape irrigation system components and for any rainwater harvesting system components, such as cisterns.

4 Water Conserving Fixtures: Submittals must include manufacturer's cut sheets for all water-consuming plumbing fixtures and fittings (toilets, urinals, faucets, showerheads, etc.) highlighting maximum flow rates and/or flush rates. Include cut sheets for any automatic faucet-control devices.

5 Process Water Use: Provide manufacturer's cut sheets for all water-consuming commercial equipment (clothes washers, dishwashers, ice machines, etc.), highlighting water consumption performance. Include manufacturer's cut sheets or product data for any cooling towers, highlighting water consumption estimates, water use reduction measures, and corrosion inhibitors.

6 Elimination of CFCs AND HCFCs: Provide manufacturer's cut sheets for all cooling equipment with manufacturer's product data, highlighting refrigerants; provide manufacturer's cut sheets for all fire-suppression equipment, highlighting fire-suppression agents; provide manufacturer's cut-sheets for all polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation, highlighting the blowing agent(s).

7 Appliances and Equipment: Provide copies of manufacturer's product data for all Bureau of Energy Efficiency (BEE) eligible equipment and appliances, including office equipment, computers and printers, electronics, and commercial food service equipment (excluding HVAC and lighting components), verifying compliance with minimum 3-star rating.

8 On-Site Renewable Energy Systems: Provide cut sheets and manufacturer's product data for all on-site renewable energy generating components and equipment, including documentation of output capacity.

9 Measurement and Verification Systems: Provide cut sheets and manufacturer's product data for all controls systems, highlighting electrical metering and trending capability components.

10 Salvaged or Reused Materials: Provide documentation that lists each salvaged or reused material, the source or vendor of the material, the purchase price, and the replacement cost if greater than the purchase price.

11 Recycled Content: Submittals for all materials with recycled content (excluding MEP systems equipment and components) must include the following documentation:

a. Cost of each material or product, excluding cost of labor and equipment for installation

b. Manufacturer's product data, product literature, or a letter from the manufacturer verifying the percentage of post-consumer and pre-consumer recycled content (by weight) of each material or product

c. An electronic spreadsheet that tabulates the Project's total materials cost and combined recycled content value (defined as the sum of the post-consumer recycled content value plus one-half of the pre-consumer recycled content value) expressed as a percentage of total materials cost. This spreadsheet shall be submitted every third day of the month with the Contractor's Certificate. It should indicate, on an ongoing basis, line items for each material, including cost, pre-consumer recycled content, post-consumer recycled content, and combined recycled content value.

12. Regional Materials: Submittals for all products or materials expected to contribute to the regional calculation (excluding MEP systems equipment and components) must include the following documentation:

a. Cost of each material or product, excluding cost of labor and equipment for installation

b. Location of product manufacture and distance from point of manufacture to the Project Site

c. Location of point of extraction, harvest, or recovery for each raw material in each product and distance from the point of extraction, harvest, or recovery to the Project Site

d. Manufacturer's product data, product literature, or a letter from the manufacturer verifying the location and distance from the Project Site to the point of manufacture for each regional material

e. Manufacturer's product data, product literature, or a letter from the manufacturer verifying the location and distance from the Project Site to the point of extraction, harvest, or recovery for each regional material or product, including, at a minimum, gravel and fill, planting materials, concrete, masonry, and any other applicable material.

f. An electronic spreadsheet that tabulates the Project's total materials cost and regional materials value, expressed as a percentage of total materials cost. This spreadsheet shall be submitted every third day of the month with the Contractor's Certificate. It should indicate on an ongoing basis, line items for each material, including cost, location of manufacture, distance from manufacturing plant to the Project Site, location of raw material extraction, and distance from extraction point to the Project Site.

13. Biobased Products:

    a. Rapidly Renewable Products: Submittals must include written documentation from the manufacturer declaring that rapidly renewable materials are made from plants harvested within a 10-year or shorter cycle and must indicate the percentage (by weight) of these rapidly renewable components contained in the candidate products, along with the costs of each of these materials, excluding labor and delivery costs.

    b. Certified Wood: Submittals for all wood-based materials must include a statement indicating the cost of each product containing FSC Certified wood, exclusive of labor and delivery costs, and certificates of chain-of-custody from manufacturers certifying that specified certified-wood products were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2 "Principles and Criteria."

14. Outdoor Air Delivery Monitoring: Provide manufacturer's cut sheets highlighting the installed carbon dioxide monitoring system components and sequence of controls shop drawing documentation, including CO2 differential set-points and alarm capabilities.

15. Interior Adhesives and Sealants: Submittals for all field-applied adhesives and sealants, which have a potential impact on indoor air, must include manufacturer's MSDSs or other Product Data highlighting VOC content.

    a. Provide manufacturers' documentation verifying all adhesives used to apply laminates, whether shop-applied or field-applied, contain no urea-formaldehyde.

16. Interior Paints and Coatings: Submittals for all field-applied paints and coatings, which have a potential impact on indoor air, must include manufacturer's MSDSs or other Product Data highlighting VOC content

17. Exterior Paints and Coatings: Submittals for all field-applied paints and coatings, which have a potential impact on ambient air quality, must include manufacturer's MSDSs or other manufacturer's Product Data highlighting VOC content.

18 Floorcoverings:

    a. Carpet Systems: Submittals for all carpet must include the following:

        1. Manufacturer's product data verifying that all carpet systems meet or exceed the testing and product requirements of the Carpet and Rug Institute Green Label Plus program.

    b. Resilient Flooring: Submittals for all resilient floorcovering must include manufacturer's product data verifying certification under either the Greenguard for Children & Schools or FloorScore indoor emissions testing program.

    c. Engineered Wood Flooring and Bamboo Flooring: Submittals for all engineered wood flooring and bamboo flooring must include manufacturer's product data verifying certification under either the Greenguard or FloorScore indoor emissions testing program.

19 Composite Wood and Agrifiber Binders: Submittals for all composite wood and agrifiber products (including but not limited to particleboard, wheatboard, strawboard, agriboard products, engineered wood components, solid-core wood doors, OSB, MDF, and plywood products) must include manufacturer's product data verifying that these products contain no urea-formaldehyde resins.

20 Entryway Systems: Provide manufacturer's cut sheets for all walk-off systems installed to capture particulates, including permanently installed grates, grilles, slotted systems, direct glue-down walk-off mats, and non-permanent roll-out mats.

21 Air Filtration: Provide manufacturer's cut sheets and product data highlighting the following:

a. Minimum Efficiency Reporting Value (MERV) for filtration media in all air handling units (AHUs)

b. Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed AHUs are used during construction

22. Mercury in Lighting: Provide manufacturer's cut sheets or product data for all fluorescent or HID lamps highlighting mercury content.

23. Lighting Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all lighting controls systems components.

24. Thermal Comfort Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all thermal comfort-control systems components.

25. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes which has flyash content. Provide the following submittals:

a. Copies of concrete design mixes for all installed concrete

b. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project

c. Quantities in cubic yards of each installed concrete mix

26. Gypsum Wall Board: Provide manufacturer's cut sheets or product data verifying that all gypsum wallboard products are moisture and mold-resistant.

27. Fiberglass Insulation: Provide manufacturer's cut sheets or product data verifying that fiberglass batt insulation contains no urea-formaldehyde.

28. Duct Acoustical Insulation: Provide manufacturer's cut sheets or product data verifying that mechanical sound insulation materials in air distribution ducts consists of an impervious, non-porous coatings that prevent dust from accumulating in the insulating materials.

29. Green Housekeeping: Provide documentation that all cleaning products and janitorial paper products meet the VOC limits and content requirements of this specification section.

5.3 Project Materials Cost Data: Provide a spreadsheet in an electronic file indicating the total cost for the Project and the total cost of building materials used for the Project, as follows:

1. Not more than 60 days after the Preconstruction Meeting, the General Contractor shall provide to the Owner and Architect a preliminary schedule of materials costs for all materials used for the Project organized by specification section. Exclude labor costs and

all mechanical, electrical, and plumbing (MEP) systems materials and labor costs. Include the following:

a. Identify each reused or salvaged material, its cost, and its replacement value.

b. Identify each recycled-content material, its post-consumer and pre-consumer recycled content as a percentage the product's weight, its cost, its combined recycled content value (defined as the sum of the post-consumer recycled content value plus one-half of the pre-consumer recycled content value), and the total combined recycled content value for all materials as a percentage of total materials costs.

c. Identify each regional material, its cost, its manufacturing location, the distance of this location from the Project site, the source location for each raw material component of the material, the distance of these extraction locations from the Project site, and the total value of regional materials as a percentage of total materials costs.

d. Identify each biobased material, its source, its cost, and the total value of biobased materials as a percentage of total materials costs. Also provide the total value of rapidly renewable materials (materials made from plants that are harvested in less than a 10-year cycle) as a percentage of total materials costs.

e. Identify each wood-based material, its cost, the total wood-based materials cost, each FSC Certified wood material, its cost, and the total value of FSC Certified wood as a percentage of total wood-based materials costs.

2 Provide final versions of the above spreadsheets to the Owner and Architect not more than 14 days after Substantial Completion.

5.4 Construction Waste Management: See Section on "Construction Waste Management" for submittal requirements.

5.5 Construction Indoor Air Quality (IAQ) Management: Submittals must include the following:

1. Not more than 30 days after the Preconstruction Meeting, prepare and submit for the Architect and Owner's approval, an electronic copy of the draft Construction IAQ Management Plan in an electronic file including, but not limited to, descriptions of the following:

a. Construction procedures for meeting or exceeding the minimum requirements of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, 1995, Chapter 3, including procedures for HVAC Protection, Source Control, Pathway Interruption, Housekeeping, and Scheduling

b. Construction procedures for protecting absorptive materials stored on-site or installed from moisture damage

c. Schedule of submission to Architect of photographs of on-site construction IAQ management measures such as protection of ducts and on-site stored oil installed absorptive materials

d. Construction procedures if air handlers must be used during construction, including a description of filtration media to be used at each return air grille

e. Construction procedure for replacing all air-filtration media immediately prior to occupancy after completion of construction, including a description of filtration media to be used at each air handling or air supply unit

2. Not more than 30 days following receipt of the approved draft Construction IAQ Management Plan, submit an electronic copy of the final Construction IAQ Management Plan in an electronic file, along with the following:

   a. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for all filtration media to be installed at return air grilles during construction if permanently installed AHUs are used during construction.

   b. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media in all air handling units (AHUs).

3. Not more than 14 days after Substantial Completion provide the following:

   a. Documentation verifying required replacement of air filtration media in all air handling units (AHUs) after the completion of construction and prior to occupancy and, if applicable, required installation of filtration during construction.

   b. A minimum of 18 Construction photographs: Six photographs taken on three different occasions during construction of the SMACNA approaches employed, along with a brief description of each approach, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.

4. A copy of the report from testing and inspecting agency documenting the results of IAQ testing, demonstrating conformance with IAQ testing procedures and requirements defined in "Testing for Indoor Air Quality."

5.6 Commissioning: See Section on "Commissioning Requirements" for submittal requirements.

5.7 Sustainable Design Progress Reports: Submit reports for the following:

1. Construction Waste Management: Waste reduction progress reports and logs complying with the requirements of "Construction Waste Management."

2. Construction IAQ Management: See details below under Section for "Construction Indoor Air Quality Management" for Construction IAQ management progress report requirements.

6 Quality Assurance

6.1 General: Perform the work of this Section as a supplement and in accordance with applicable requirements of "Contractor Quality Control Program."

6.2 Preconstruction Meeting: After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner, Architect, and all Subcontractors to discuss the Construction Waste Management Plan, the required Construction Indoor Air Quality (IAQ) Management Plan, and all other Sustainable Design Requirements. The purpose of this meeting is to develop a mutual understanding of the Project's Sustainable Design Requirements and coordination of the Contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.

6.3 Construction Job Conferences: The status of compliance with the Sustainable Design Requirements of these specifications will be an agenda item at all regular job meetings conducted during the course of work at the site.

Part 2 - Products

1 Product Environmental Requirements

1.1 Site Clearing: Topsoil shall be provided by the Contractor from on-site material which has been stockpiled for reuse. Off-site borrow should only be used when on-site sources are exhausted. Chip and/or compost on site all vegetated material identified for removal.

1.2 Do not burn rubbish, organic matter, etc. or any material on the site. Dispose of legally in accordance with Specifications and the local statutory body rules and regulations. Burning of rubbish, organic material, and other material on-site contributes to air pollution.

1.3 Site Paving: All site impervious paving must be light colored, with a Solar Reflectance Index (SRI) of at least 29. Light-colored, high-reflectance paving is a way of reducing the localized heat build-up around paved surfaces that contributes to the urban heat island effect.

1.4 Roofing Materials: All roofing systems, other than vegetated roof systems, must comply with the following requirements:

a. Low-Sloped roofing less than or equal to 2:12 slope must have an SRI of at least 78.

b. Steep-Sloped roofing greater than 2:12 slope must have an SRI of at least 29.

China mosaic over roof is considered to meet this requirement.

1.5 Exterior Lighting Fixtures:

a. All exterior luminaires must emit 0% of the total initial designed fixture lumens at an angle above 90° from nadir.

b. Exterior lighting cannot exceed 80% of the lighting power densities defined by ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.

c. No lighting of building facades or landscape features is permitted.

1.6 Herbicides and Pest Control: Herbicides shall not be permitted, and pest control measures shall utilize organic biopesticides only.

1.7 Irrigation Systems: Any permanent landscape irrigation systems must be supplied entirely by collected rainwater or graywater.

1.8 Water-Conserving Fixtures: Plumbing fixtures and fittings shall use in aggregate at least 20% less water than the water use baseline calculated for the building after meeting the LEED Requirements for fixture performance. Flow and flush rates shall not exceed the following:

a. Toilets: dual flush 1.6/0.8 gallons per flush.

b. Urinals: no more than 0.5 gallons per flush or use

c. Lavatory Faucets: 2.2 gpm with automatic faucet controls

d. Kitchen Sink Lavatories: 2.2 gpm

1.9 Elimination of CFCs AND HCFCs:

a. Ozone Protection: Base building cooling equipment shall contain no refrigerants other than the following: HCFC-123, HFC-134a, HFC-245fa, HFC-407c, or HFC 410a.

b. Fire suppression systems may not contain ozone-depleting substances.

c. Extruded polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation shall not be manufactured with hydrochlorofluorocarbon (HCFC) blowing agents.

1.10 Appliances and Equipment: All BEE 3 star rated equipment and appliances, including office equipment, computers and printers, electronics, and commercial food service equipment (excluding HVAC and lighting components), shall qualify.

1.11 HVAC Distribution Efficiency:

a. All duct systems shall be constructed of galvanized sheet metal, aluminum, or stainless steel as deemed appropriate based on the application requirements. No fiberglass duct board shall be permitted.

b. All medium- and high-pressure ductwork systems shall be pressure-tested in accordance with the current SMACNA standards.

c. All ductwork shall be externally insulated. No interior duct liner shall be permitted.

d. Where possible, all air terminal connections shall be hard-connected with sheet metal ductwork. If flexible ductwork is used, no flexible duct extension shall be more than six feet in length.

e. All HVAC equipment shall be isolated from the ductwork system with flexible duct connectors to minimize the transmittance of vibration.

f. All supply and return air branch ducts shall include the appropriate style of volume damper. Air terminal devices such as grilles, registers, and diffusers shall be balanced at duct branch dampers, not at terminal face.

1.12 Measurement and Verification: Install controls and monitoring devices as required in order to comply with International Performance Measurement & Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003, Option D.

1.3 Salvaged or Reused materials: There shall be no substitutions for specified salvaged and reused materials and products.

1.4 Recycled Content of Materials:

1. Provide building materials with recycled content such that post-consumer recycled content value plus half the pre-consumer recycled content value constitutes a minimum of 30% of the cost of materials used for the Project, exclusive of all MEP equipment, labor, and delivery costs. The Contractor shall make all attempts to maximize the procurement of materials with recycled content.

    a. The post-consumer recycled content value of a material shall be determined by dividing the weight of post-consumer recycled content by the total weight of the material and multiplying by the cost of the material.

    b. The pre-consumer recycled content value of a material shall be determined by dividing the weight of pre-consumer recycled content by the total weight of the material and multiplying by the cost of the material.

    c. Do not include mechanical and electrical components in the calculations.

    d. Do not include labor and delivery costs in the calculations.

    e. Utilize all on-site existing paving materials that are scheduled for demolition as granulated fill, and include the cost of this material had it been purchased in the calculations for recycled content value.

1.5 Regional Materials: Provide a minimum of 40 percent of building materials (by cost) that are manufactured and extracted/harvested within a 800km radius of the project site, exclusive of labor and delivery costs. The Contractor shall make all attempts to maximize the procurement of materials within this specified 800 km radius.

1.6 Biobased Products:

1. Solid Wood Products: All new solid-wood-based materials will be certified as "FSC 100%" by an independent third party in accordance with FSC Forest Stewardship Council "Principles and Criteria" and will have received Chain-of-Custody Certification.

2. Other Wood Products: All other new wood-based materials will be certified by an independent third party in accordance with any of the following standards:

   a. FSC: Forest Stewardship Council "Principles and Criteria" and has received Chain-of-Custody Certification.

3. Preservative-treated lumber with chromated copper arsenate (CCA) treatments is not permitted, and lumber with copper-based treatments (such as ACQ) is permitted only for ground-contact applications.

4. Wood-based materials include but are not limited to the following materials (when made from wood), engineered wood products, or wood-based panel products:

   a. Rough carpentry
   b. Miscellaneous carpentry
   c. Heavy timber construction
   d. Wood decking
   e. Particleboard
   f. Plywood
   g. Metal-plate-connected wood trusses
   h. Structural glued-laminated timber
   i. Finish carpentry
   j. Architectural woodwork
   k. Wood paneling
   l. Wood veneer wall covering
   m. Wood flooring
   n. Wood lockers
   o. Wood cabinets
   p. Wood doors
   q. Non-rented temporary construction, including bracing, concrete formwork, pedestrian barriers, and temporary protection

1.7 Outdoor Air Delivery Monitoring:

1. All spaces with an occupant density greater than 1 person per 40 square feet must include at least one CO2 monitor located between 3 feet and 6 feet above the finished floor.

2. All spaces with occupant density less than 1 person per 40 square feet must include a direct outdoor airflow monitor, capable of measuring the minimum outdoor airflow rate within 15% accuracy.

3. Monitoring equipment must be configured to generate a building automation system alarm and a visual or audible alert when CO2 concentrations vary by 10% or more from set point.

1.8 Adhesives and Sealants:

1. All adhesives and sealants used inside the building's thermal envelope must be third-party certified under one of the following programs:

   a. Indoor Advantage Plus from Scientific Certification Systems, Inc.

   b. Greenguard Children and Schools from Greenguard Environmental Institute

   c. Collaborative for High Performance Schools

2. All adhesives and sealants, regardless of where they are used, must comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24):

   a. Concrete Curing Compound: 60 g/L

   b. Concrete Sealer: 10 g/L

   c. Concrete Form Release Agents: 0g/L

   d. Garage Deck Sealer: 50g/L

   e. Wood Glues: 20 g/L

   f. Millwork and Casework Adhesives: 20g/L

   g. Metal to Metal Adhesives: 30 g/L

   h. Adhesives for Porous Materials (Except Wood): 50 g/L

   i. Subfloor Adhesives: 50 g/L

   j. Plastic Foam Adhesives: 50 g/L

   k. Carpet Adhesives: 50 g/L

   l. Carpet Pad Adhesives: 50 g/L

   m. Carpet Seam Sealer: 50g/L

   n. VCT and Sheet Vinyl Adhesives: 50 g/L

   o. Cove Base Adhesives: 50 g/L

   p. Rubber Floor Adhesives: 60 g/L

   q. Wood Flooring Adhesives: 100 g/L

   r. Ceramic Tile Adhesives: 65 g/L

   s. Gypsum Board and Panel Adhesives: 50 g/L

   t. Gypsum Drywall Joint Compound: 20 g/L

   u. Portland Cement Plaster: 20 g/L

   v. Multipurpose Construction Adhesives: 70 g/L

w. Cast Resin Countertop Silicone Sealant: 20g/L
x. Plastic Laminate Adhesives: 20 g/L
y. General Contact Adhesive: 80 g/L
z. Structural Glazing Adhesives and Compounds: 100 g/L
aa. Silicone Sealant: 50 g/L
bb. Pipe Thread Sealant: 50 g/L
cc. Duct Sealant: 10 g/L
dd. Plastic Cement Welding Compounds: 250 g/L
ee. ABS Welding Compounds: 400 g/L
ff. CPVC Welding Compounds: 270 g/L
gg. PVC Welding Compounds: 150 g/L
hh. Adhesive Primer for Plastic: 250 g/L
ii. Architectural Sealants: 250 g/L
jj. Single-Ply Roofing Membrane Adhesives: 250 g/L

3. Interior sealants shall not contain: mercury, butyl rubber, neoprene, SBR (styrene butadiene rubber), or nitrile.

4. Sealants and glazing compounds formulated with aromatic solvents (organic solvent with a benzene ring in its molecular structure) fibrous talc or asbestos, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium, or their components shall not be used.

5. Adhesives used to apply laminates, whether shop-applied or field-applied, shall contain no urea-formaldehyde.

1.9 Paints and Coatings:

1. Interior Paints and Coatings: For interior field-applied applications, use paints and coatings that comply with the following limits for VOC content:

a. Flat Paints and Coatings: Not more than 50 grams of VOC per liter of coating less water and exempt compounds, including pigments

b. Non-Flat Paints and Coatings Except High Gloss: Not more than 150 grams of VOC per liter of coating less water and exempt compounds, including pigments.

c. High Gloss Paints and Coatings: Not more than 150 grams of VOC per liter of coating less water and exempt compounds, including pigments. High Gloss Coatings are coatings that register a gloss of 70 or above on a 60-degree meter according to ASTM Test Method D 523 as specified in paragraph (e)(6).

d. Water-Based Polychromatic Finish Coatings: Not more than 150 g/L (150 g/L for primer and flat polychromatic paint)

e. Anti-Corrosive Coatings: Not more than 250 grams of VOC per liter of coating less water and exempt compounds

f. Sanding Sealers: Not more than 275 grams of VOC per liter of coating less water and exempt compounds

g. Waterproofing Sealers: Not more than 250 grams of VOC per liter of coating less water and exempt compounds

h. Concrete Slab Sealers: Not more than 200 grams of VOC per liter of coating less water and exempt compounds

i. Polyurethanes: Not more than 200 grams of VOC per liter of coating less water and exempt compounds

j. Stains: Not more than 250 grams of VOC per liter of coating less water and exempt compounds

k. Varnish for clear wood finishes: Not more than 350 grams of VOC per liter.

l. Lacquer: Not more than 550 grams of VOC per lit.

2. Interior paints shall not contain antimicrobial additives (such as fungicides and biocides).

3. Exterior Paints and Coatings: For exterior applications, use paints and coatings that comply with the following limits for VOC content:

a. Flat Paints and Coatings: Not more than 50 grams of VOC per liter of coating less water and exempt compounds, including pigments

b. Non-Flat Paints and Coatings: Not more than 150 grams of VOC per liter of coating less water and exempt compounds, including pigments

c. High Gloss Paints and Coatings: Not more than 150 grams of VOC per liter of coating less water and exempt compounds, including pigments. High Gloss Coatings are coatings that register a gloss of 70 or above on a 60-degree meter according to ASTM Test Method D 523 as specified in paragraph (e)(6)

d. Anti-Corrosive Coatings: Not more than 250 grams of VOC per liter of coating less water and exempt compounds

e. Sanding Sealers: Not more than 275 grams of VOC per liter of coating less water and exempt compounds

f. Varnishes: Not more than 350 grams of VOC per liter of coating less water and exempt compounds

g. Stains: Not more than 250 grams of VOC per liter of coating less water and exempt compounds

3. Restricted Components: Paints and coatings shall not contain any of the following:

a. Acrolein

b. Acrylonitrile

c. Analine dyes

d. Antimony

e. Benzene

f. Butyl benzyl phthalate

g. Cadmium

h. Di (2-ethylhexyl) phthalate

i. Di-n-butyl phthalate

j. Di-n-octyl phthalate

k. 1,2-dichlorobenzene
l. Diethyl phthalate
m. Dimethyl phthalate
n. Ethylbenzene
o. Formaldehyde
p. Hexavalent chromium
q. Isophorone
r. Lead
s. Mercury
t. Methyl ethyl ketone
u. Methyl isobutyl ketone
v. Methylene chloride
w. Naphthalene
x. Toluene (methylbenzene)
y. 1,1,1-trichloroethane
z. Vinyl chloride
aa. Xylene

1.10 Floorcoverings:

1. All carpet systems, including adhesives, must meet or exceed the Carpet and Rug Institute Green Label Plus Indoor Air Quality Test Program.

2. All carpet adhesives shall meet the requirement of not more than 50 grams of VOC per liter.

3. Engineered wood flooring and bamboo flooring must be certified under the Greenguard or FloorScore indoor emissions testing programs.

1.11 Composite Wood and Agrifiber Binders: All composite wood, agrifiber products, and wood doors shall contain no added urea-formaldehyde resins.

1. Systems furniture and seating made with coatings or sealants that contain any of the following solvents are not permitted: naptha, benzene, toluene, xylene, hexavalent chromium.

1.12 Entryway Systems: Walk-off systems to capture particulates shall be installed at least 6 feet long in the direction of entry travel at all entryways directly connected to the outdoors that are used as regular entry points by building users. Acceptable entryway systems include:

1. Permanently installed grates, grilles, or slotted systems that allow for cleaning beneath them

2. Permanently installed direct glue-down walk-off mats

3. Non-permanent roll-out mats, but only if a service organization is contracted for maintenance on a weekly basis

1.13 Air Filtration: Install air filtration media that provides a Minimum Efficiency Reporting Value (MERV) of 13 or better in all air handling units for processing both return and outside air that is delivered to the air supply system. Replace all filtration media after the completion of construction and prior to occupancy.

1.14 Mercury in Lighting:

1. Provide only low-mercury fluorescent or HID lamps with mercury content limited to the following:

    a. T-5 and T-8 fluorescent lamps: 80 picograms per lumen hour

1.15 Lighting Controls: Install and calibrate controls as specified by Electrical in order to comply with LEED IAQ lighting controllability requirements.

1.16 Thermal Comfort: Install and calibrate controls as specified in Heating, Ventilation, and Air-Conditioning.

1.17 Blended Cement Concrete:

1. Cementitious Materials: Provide composite mix of portland cement and ground granulated blast-furnace slag or fly ash or blended hydraulic cement and limit percentage (by weight) of portland cement (ASTM C150) in aggregate (total weighted average of cementitious material weight for all mixes and pours) to 40% less than standard regional concrete mix designs.

2. Limit percentage (by weight) of standard portland cement (C-150), to the cementitious portion of the mix while maintaining the above-25% required reduction in portland cement across the Project's total quantity of concrete.

1.18 Gypsum board: Use only non-paper-faced gypsum board. In wet locations a cementitious wallboard, made of portland or magnesium oxide cement, must be used.

1.19 Fiberglass Insulation: Fiberglass batt insulation shall contain no formaldehyde-based binders.

1.20 Duct Acoustical Insulation: Mechanical sound insulation materials within the duct shall consist of an impervious, non-porous coating that prevents dust from accumulating in the insulating materials.

1.21 Green Housekeeping:

1. Utilize cleaning products that meet the requirements of the Green Seal GS-37 standard.

Part 3 - Execution

1 Construction Waste Management

1.1 Develop and implement a Construction Waste Management Plan (CWMP), as defined in "Construction Waste Management," quantifying material diversion by weight in order to recycle, reuse, and/or salvage at least 75% (by weight) of construction, demolition, and land-clearing waste.

1.2 Clean materials which are contaminated prior to placing in collection containers. Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

1.3 Utilize any on-site existing paving materials that are scheduled for demolition as granulated fill or subbase material, and include the weight of this material in the calculations for material diverted from landfill disposal.

1.4 Arrange for materials collection by or materials delivery to the appropriate recycling or reuse facility.

1.5 Discuss CWMP procedures and measures as an agenda item at all regular job meetings conducted during the course of work at the site, and record progress in meeting minutes.

1.6 Submit monthly progress reports and documenting the status of the CWMP and current diversion percentage rates.

2 Construction Indoor Air Quality Management

2.1 Develop and implement a Construction IAQ Management Plan (CIAQMP) to prevent indoor air quality problems resulting from construction activities, including, at minimum, the following:

2.1.1 Construction activities must meet or exceed the minimum requirements of the SMACNA IAQ Guideline for Occupied Buildings under Construction, 1995.

2.1.2 During construction, protect all absorptive materials stored on-site or installed from moisture damage as described in the Construction IAQ Management Plan (CIAQMP) defined above. Specifically:

a. Exercise special care at all times in the storage of materials to prevent exposure to moisture.

b. Avoid installation of gypsum board and other porous materials until the building is weather-tight.

c. All standing water which accumulates on interior floors shall be removed on the day that it is observed.

d. Any drywall that has retained more than 20% moisture after 48 hours following exposure to moisture, or that has evidence of mold, must be disposed off.

e. The contractor shall identify and remove all porous building materials that become wet or damaged by moisture within 7 calendar days of such exposure.

2.1.3 During construction and HVAC system installation, provide the Architect with photographs of IAQ management measures (such as protection of ducts and on-site or installed absorptive materials), including six photographs on three different occasions depicting implemented SMACNA approaches.

2.2 Air Filtration:

2.2.1 Install air filtration media that provides a Minimum Efficiency Reporting Value (MERV) of 13 or better in all air handling units for processing both return and outside air that is delivered to the air supply system; replace all filtration media after the completion of construction and prior to occupancy.

2.2.2 Install air filtration media that provides a Minimum Efficiency Reporting Value (MERV) of 8 or better for filtration media installed at return air grilles during construction if permanently installed AHUs are used during construction. Inspect weekly and replace as required.

2.3 Discuss CIAQMP procedures and measures as an agenda item at all regular job meetings conducted during the course of work at the site, and record progress in meeting minutes.

2.4 Engage an independent testing and inspecting agency to conduct a baseline indoor air quality testing program after the completion of construction and prior to occupancy in accordance with Section 01 81 09 "Testing for Indoor Air Quality."

3 Commissioning

3.1 Commissioning: All building energy-related systems and building envelope components shall be commissioned in accordance with the requirements of Specification under "Commissioning Requirements" and related commissioning sections in other divisions in order to verify and ensure that fundamental building elements and systems are installed, constructed, calibrated to operate, and perform according to the Owner's Project Requirements, Basis of Design, and Construction Documents.

4 Measurement & Verification

4.1 For new construction, comply with the requirements of the International Performance Measurement & Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003, Option B or D.

END OF SECTION

SECTION 02 - TESTING FOR INDOOR AIR QUALITY

Part 4 - General

5 Related Documents

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions, other Specification Sections, and specifications of materials mentioned in this section, apply to this Section.

6 Summary

2.1 General: This section provides requirements for Baseline Indoor Air Quality (IAQ) Testing for maximum indoor pollutant concentrations for acceptance of the facility.

7 Related Sections

3.1 Coordinate with Commissioning activities.

3.2 All work shall comply with the section on “Testing, Adjusting and Balancing.”

8 Submittals

4.1 Baseline IAQ Testing: Submit a report for each test site specified for IAQ baseline testing as prescribed herein below and in the section on “Testing, Adjusting, and Balancing.”

9 Sequencing and Scheduling

5.1 Identify, program, and schedule all IAQ testing well in advance of construction in a manner to prevent delays to the performance of the work of this Contract in order to perform and complete all testing after the completion of construction activities and prior to occupancy.

Part 5 - Execution

10 Baseline IAQ Testing

1.1 HVAC System Verification: To assure compliance with recognized standards for indoor air quality including ASHRAE Standard 62.1-2004, the Contractor’s independent testing and balancing agency shall verify the performance of each HVAC system prior to Indoor Air Quality testing, including space temperature and space humidity uniformity, outside air quantity, filter installation, drain pan operation, and any obvious contamination sources.

1.2 Indoor Air Quality Testing: Upon verification of HVAC system operation, the Contractor shall carry out types of testing specified herein, to test levels of indoor air contaminants for compliance with specified requirements.

1.2.1 A test plan shall be submitted for the approval of the Commissioning Authority. The plan shall specify procedures, times, instrumentation, and sampling methods that will be employed.

1.2.2 Perform IAQ testing for at least the minimum number of required sampling locations, determined as follows: For each portion of the building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft., or for each contiguous floor area, whichever is larger, and include areas

with the least ventilation as calculated by Ventilation Rate Procedure of ASHRAE Standard 62.1-2004 and greatest presumed source strength as identified by Owner. Collect air samples on three consecutive days and average the results of each three-day test cycle to determine compliance or non-compliance of indoor air quality for each air handling zone tested.

a. Verify areas to be tested with the Commissioning Authority. Areas with 100% outside air ventilation rates such as laboratories are excluded from these testing requirements. The Commissioning Authority is the sole judge of areas exempt from testing.

1.2.3 Perform IAQ testing following the completion of all interior construction activities and prior to occupancy. The building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Perform testing prior to installation of furniture, workstation components, and casework.

1.2.4 Perform IAQ testing within the breathing zone, between 3'–0" and 6'–0" above the finished floor and over a minimum 4-hour period.

1.2.5 Collect air samples during normal occupied hours (prior to occupancy) with the building ventilation system starting at the daily normal start times and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.

1.2.6 Sample and record outside air levels of formaldehyde and TVOC contaminants at three outside air locations (as determined by Owner) simultaneously with indoor tests to establish basis of comparison for these contaminant levels by averaging the three outdoor readings for each contaminant.

1.2.7 Perform airborne mold and mildew air sampling and speciation with simultaneous indoor and outdoor readings.

1.2.8 Acceptance of respective portions of the building by the Owner is subject to compliance with specified limits of indoor air quality contaminant levels.

1.3 Indoor air quality shall conform to the following standards and limits:

a. Formaldehyde: <20 microgram/m3 (16.3 ppb)

b. Sum of VOCs: <200 microgram/m3

c. Carbon Monoxide: Not to exceed 9 ppm

1.4 Test Reports: Prepare test reports showing the results and location of each test, a summary of the HVAC operating conditions, and a listing of any discrepancies and recommendations for corrective actions, if required.

1.5 For each sampling point where the maximum concentration limits are exceeded, the Contractor is responsible for conducting additional flush-out with outside air and retesting the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting non-complying building areas, take samples from the same locations as in the first test. Retesting shall be performed at no additional expense to the Owner.

1.6 In the event that any non-compliant test results occur, Contractor must provide a written report to the Owner describing the source(s) of the non-compliant condition(s) and the corrective action(s) implemented.

11 Independent Materials Testing

2.1 Materials That Must Be Tested: All materials listed below that are proposed for use on this project shall be tested for permanent, in-place indoor air quality performance in accordance with requirements of these specifications. Results shall be furnished to the Site incharge. Materials meeting the criteria for independent testing are as follows:

a. Field-applied paint systems on appropriate substrate. Paint primers and intermediate coats (if used) should be applied with a typical drying time allowed between coats (not to exceed 7 days).

b. Carpet including manufacturer's recommended adhesive. The carpet will be applied to the appropriate flooring per manufacturer's instructions so that the testing is of the "carpet assembly."

c. Ceiling tile

d. Any fireproofing material that may be exposed to indoor air, directly or in a plenum, applied to appropriate substrate

2.2 Materials for Testing: Only test representative samples of actual products selected for use on this project.

2.3 Materials Test Reports: Submit test reports to the Sit In-charge. The report shall include raw emission levels, as well as the calculated resulting concentrations and the assumptions (loading, volume of space, ventilation rates) used to determine those resulting concentrations.

2..4 Product/Material Evaluation: All products/materials shown by testing to comply with emissions limits and other criteria specified in this section will be approved for use on this project subject to compliance with all other specified requirements of the Project Manual. Products/materials shown to exceed specified emission limits shall be discussed, test results interpreted, and a determination made as to alternative product uses or selections.

END OF SECTION

Section 03 – General Commissioning Requirements

Part 6 - General

12 Related Documents

1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1.2 Commissioning of Plumbing

1.3 Commissioning of HVAC

1.4 Commissioning of Electrical Systems

13 Summary

2.1 This section includes:

2.1.1 Commissioning: Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the Owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance, and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.

2.1.2 Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

a. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.

b. Verify and document proper performance of equipment and systems.

c. Verify that O&M documentation left on site is complete.

d. Verify that the Owner's operating personnel are adequately trained.

2.1.3 The commissioning process does not take away from or reduce the responsibility of the Contractor to meet the Contract Documents.

14 Related Sections include the following

Contract drawings and specifications, general provisions of the contract, including general and supplementary conditions, architectural, electrical, and mechanical provisions, and this Specification Sections apply to work of this Section.

15 Abbreviations

4.1 Abbreviations: The following are common abbreviations used in this Specification and in the Commissioning Plan.

A/E	Architect and design engineers	GC	General Contractor
CA	Commissioning authority	FT	Functional performance test
CC	Construction checklist	Cx Plan	Commissioning Plan document
CT	Commissioning Team	Cx	Commissioning

16 Coordination

5.1 Commissioning Team The members of the commissioning team consist of the CA, the GC, the Architect and Design Engineers (particularly the Mechanical Engineer), the and any other installing subs or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.

5.2 Management: The CA directs and coordinates the commissioning activities and reports to the Owner. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. The CA's responsibilities are the same regardless of who hired the CA.

5.3 Scheduling: The CA will work with the GC according to established protocols to schedule the commissioning activities. The CA will provide sufficient notice (generally two weeks' notice) to the GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

5.4 The CA will provide the initial schedule of primary commissioning events, or commissioning milestones, at the initial commissioning meeting. The Commissioning Plan provides a format for this schedule. As construction progresses and more detailed schedules are available from the GC, the CA will adjust the commissioning schedule accordingly.

17 Commissioning Process

6.1 Commissioning Plan: The commissioning plan provides guidance in the execution of the commissioning process. The Specifications will take precedence over the Commissioning Plan.

6.2 Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

6.3 Commissioning during construction begins with an initial Commissioning meeting conducted by the CA where the commissioning process is reviewed with the commissioning team members.

6.4 Additional meetings will be scheduled by the CA with necessary parties attending, to plan, coordinate, schedule future activities and resolve problems.

6.5 Equipment documentation is distributed by the A/E to the CA during the normal submittal process, including detailed start-up procedures.

6.6 The CA works with the Contractor in each discipline in developing startup plans and startup documentation formats, including providing the Contractor with construction checklists to be completed during the installation and startup process.

6.7 In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with construction checklists being completed before functional testing occurs.

6.8 The Contractors, under their own direction, will execute and document the completion of construction checklists and perform startup and initial checkout. The CA documents that the checklists and startup were completed according to the approved plans. This may include the CA witnessing start-up of selected equipment.

6.9 The CA develops specific equipment and system functional performance test procedures.

6.10 The functional test procedures are reviewed with the A/E, CA, and Contractors.

6.11 The functional testing and procedures are executed by the Contractors under the direction of, and documented by, the CA.

6.12 During initial functional tests and for critical equipment, the Engineer will witness the testing.

6.13 Items of non-compliance in material, installation, or setup are corrected at the Contractor's expense, and the system is retested.

6.14 The CA reviews the O&M documentation for completeness.

6.15 The project will not be considered substantially complete until the conclusion of Commissioning functional testing procedures as defined in the Commissioning Plan.

6.16 The CA reviews and coordinates the training provided by the Contractors and verifies that it was completed.

6.17 Deferred testing is conducted as specified or required.

18 Responsibilities

7.1 The responsibilities of various parties in the commissioning process are provided in this section. It is noted that the services for the A/E and CA are not provided for in this Contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed in the Commissioning Plan.

19 All Parties

8.1 Follow the Commissioning Plan.

8.2 Attend an initial commissioning meeting and additional meetings, as necessary.

20 General Contractor (GC)

9.1 Construction and Acceptance Phase:

Facilitate the coordination of the commissioning work by the CA, and with the GC and CA, ensure that commissioning activities are being scheduled into the master schedule.

a. Include the cost of commissioning in the total contract price.

b. Furnish a copy of all construction documents, addenda, change orders, and approved submittals and shop drawings related to commissioned equipment to the CA.

c. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks, and training.

d. Ensure that all Contractors execute their commissioning responsibilities according to the Contract Documents and schedule.

e. A representative shall attend the initial commissioning meeting and other necessary meetings scheduled by the CA to facilitate the Cx process.

f. Coordinate and schedule the training of owner personnel.

1. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

g. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.

h. Assist in equipment testing per agreements with sub-contractors.

i. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CA.

j. Through the Contractors they supply products to, analyze specified products and verify that the Designer has specified the newest most updated equipment reasonable for this project's scope and budget.

k. Provide information requested by CA regarding equipment sequence of operation and testing procedures.

1.Review test procedures for equipment installed by factory representatives.

9.2 Warranty Period

Ensure that Subcontractors execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

9.3 Ensure that Subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

21 Definitions

10.1 Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review, and training occur

10.2 Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents

10.3 Architect / Engineer (A/E): The prime consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer

10.4 Owner's Project Requirements: The Owner's Project Requirements is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The Owner's Project Requirements describes the systems, components, conditions, and methods chosen to meet the intent. Some reiterating of the design intent may be included.

10.5 Commissioning Authority (CA): An independent authority, not otherwise associated with the A/E team members or the Contractor, though he/she may be hired as a subcontractor to them. The CA directs and coordinates the commissioning activities. The CA does not take an oversight role.

10.5 Commissioning Plan: An overall plan, developed after bidding that provides the structure, schedule, and coordination planning for the commissioning process

10.6 Construction Checklist (CC): A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CA to the Sub. Construction checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension correct, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some construction checklist items entail simple testing of the function of a component, a piece of equipment, or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word construction refers to before functional testing. Construction checklists augment and are combined with the manufacturer's start-up checklist. Even without a commissioning process, Contractors typically perform some, if not many, of the construction checklist items a commissioning authority will recommend. However, few Contractors document in writing the execution of these checklist items. Therefore, for most equipment, the Contractors execute the checklists on their own. The Commissioning Authority only requires that the procedures be documented in writing and does not witness much of the completion of construction checklists, except for larger or more critical pieces of equipment.

10.7 Contract Documents: The documents binding on parties involved in the construction of this Project (drawings, specifications, change orders, amendments, contracts, etc.)

10.8 Contractor: The general contractor or authorized representative

1. Control system: The central building energy management control system

10.9 Data Logging: Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone data loggers separate from the control system

10.10 Deferred Functional Tests: FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that prevent the test from being performed

10.11 Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents

10.12 Factory Testing: Testing of equipment on-site or at the factory by factory personnel with a Project Manager present

10.13 Functional Performance Test (FT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation, and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and

pressures as specified, while functional testing is verifying that which has already been set up. The Commissioning Authority develops the functional test procedures in a sequential written form, coordinates, oversees, and documents the actual testing, which is usually performed by the installing Contractor or vendor. FTs are performed after construction checklists and startup are complete.

10.14 General Contractor (GC): The Contractor for this project. Generally refers to all the GC's subs as well. Also referred to as the Contractor, in some contexts.

10.15 Installing Contractor: Contractor who installs specific equipment and/or systems

10.16 Manual Test: Using hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation")

10.17 Monitoring: The recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems

10.18 Non-Compliance: See Deficiency

10.19 Non-Conformance: See Deficiency

10.20 Owner-Contracted Tests: Tests paid for by the Owner outside the GC's contract and for which the CA does not oversee. These tests will not be repeated during functional tests if properly documented.

10.21 Phased Commissioning: Commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time

10.22 Sampling: Functionally testing only a fraction of the total number of identical or near-identical pieces of equipment.

10.23 Seasonal Performance Tests: FTs that are deferred until the system(s) will experience conditions closer to their design conditions

10.24 Simulated Condition: Condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box)

10.25 Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance, or pressure to the transducer and DDC system to simulate a sensor value

10.26 Specifications: The construction specifications of the Contract Documents

10.27 Startup: The initial starting or activating of dynamic equipment, including executing construction checklists

10.28 Subs: The subcontractors to the Prime Contractor who provide and install building components and systems

10.29 Test Procedures: The step-by-step process that must be executed to fulfill the test requirements. The CA develops the test procedures.

10.30 Test Requirements: Requirements specifying what modes and functions, etc. shall be tested.

10.31 Trending: Monitoring using the building control system

10.32 Vendor: Supplier of equipment

10.33 Warranty Period: Warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

22 Systems to be Commissioned

The following checked systems are to be commissioned.

(_) Air Cooled Condensing Units
(_) Indoor Units
(_) Axial Fans
(_) Ductwork
(_) Automatic Temperature Controls – Including an intentional sequence of operation
(_) Testing, Adjusting, and Balancing
(_) Fire Alarm and Interface Items with HVAC
(_) Lighting Control Systems
(_) Lighting Control Programs

Part 7 - Products

23 Test Equipment

All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the ICI for the equipment being tested. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance. All equipment shall be calibrated according to the manufacturer's recommended intervals.

Part 8 - Execution

1 Meetings

1.1 Commissioning Meeting: Within 60 days of commencement of construction, the CA will schedule, plan and conduct a commissioning meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CA. Information gathered from this meeting will allow the CA to revise the Commissioning Plan, which will be distributed to all parties.

1.2 Miscellaneous Meetings: Other meetings, if required, will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular contractors. The CA will plan these meetings and will minimize unnecessary time being spent by contractors.

2 Startup, Construction Checklists, and Initial Checkout

2.1 The following procedures apply to all equipment to be commissioned.

2.2 General: Construction checklists are important to ensure that the equipment and systems are hooked up correctly and operational. Checklists also ensure that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full construction checkout. No sampling strategies are used. The construction testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

2.3 Startup and Initial Checkout Plan: The CA will assist the commissioning team members responsible for startup of any equipment in developing detailed startup plans for all equipment. The primary role of the CA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed. Parties responsible for construction checklists and startup are identified in the initial commissioning meeting and in the checklist forms.

2.3.1 The CA adapts, if necessary, the representative construction checklists and procedures from the related sections. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.

2.3.2 The CA provides these checklists and tests to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.

2.3.3 The Contractor responsible for the purchase of the equipment develops the full startup plan by combining (or adding to) the CA's checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

The full startup plan could consist of something as simple as:

a. The CA's construction checklists

b. The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end

c. The manufacturer's normally used field checkout sheets

2.3.4 The contractor submits the full startup plan to the CA for review and approval.

2.3.5 The CA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.

2.4 Sensor and Actuator Calibration

2.4.1 All field-installed temperature, relative humidity, CO, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated. Alternate methods may be used if approved by the CA beforehand. All test instruments shall have had a certified calibration within the last 12 months.

2.4.2 All procedures used shall be fully documented on the construction checklists or other approved forms, clearly referencing the procedures followed and written documentation of initial, intermediate, and final results.

2.4.3 Sensor Calibration Methods
All Sensors: Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

a. Sensors Without Transmitters--Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.

b. Sensors With Transmitters--Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform to specified control ramps, reset schedules, proportional relationship, reset relationship, and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or building automation system [BAS]) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

2.5 Execution of Construction Checklists and Startup

2.5.1 Four weeks prior to startup, the contractors and vendors schedule startup and checkout with the GC and CA. The performance of the construction checklists, startup and checkout are directed and executed by the contractor or vendor. When checking off construction checklists, signatures may be required of other contractors for verification of completion of their work.

2.5.2 The CA will, at their own discretion, observe, at minimum, the procedures for each piece of primary equipment unless there are multiple units. In no case will the number of units witnessed be less than four on any one building, nor less than 20% of the total number of identical or very similar units.

2.5.3 For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the CA shall observe a sampling of the construction and startup procedures.

2.5.4 The contractors shall execute startup and provide the CA with a signed and dated copy of the completed startup and construction tests and checklists.

2.6 Deficiencies, Non-Conformance and Approval in Checklists and Startup

2.6.1 The contractors shall clearly list any outstanding items of the initial startup and construction procedures that were not completed successfully. Outstanding deficiencies will be provided to the CA within two days of test completion.

2.6.2 The CA reviews the report and submits either a non-compliance report or an approval to the contractors. The CA shall work with the Prime contractors to correct and retest deficiencies or uncompleted items. The CA will involve the contractors and others as necessary. The contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated startup report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CA recommends approval of the execution of the checklists and startup of each system to the A/E using a standard form.

3 Phased Commissioning

3.1 The project will require startup and initial checkout to be executed in phases. This phasing will be planned and scheduled in a coordination meeting of the CA, and the Contractor. Results will be added to the master and commissioning schedule.

4 Functional Performance Testing

4.1 Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

a. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

4.2 Development of Test Procedures: Before test procedures are written, the CA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each contractor or vendor responsible to execute a test shall provide limited assistance to the CA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CA shall provide a copy of the test procedures to the contractors, who shall review the tests for feasibility, safety, equipment, and warranty protection.

4.3 Test Methods

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. Other test methods included below are approved, provided the system is reset to its original preset value.
2. Simulated Conditions
3. Overwritten Values

4. Simulated Signals
5. Altering Setpoints
6. Indirect Indicators
7. Setup
8. Sampling: Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference.

4.4 Coordination and Scheduling: The contractors shall provide sufficient notice to the CA regarding their completion schedule for the construction checklists and startup of all equipment and systems. The CA will schedule functional tests through the A/E, GC and other contractors. The CA shall direct, witness and document the functional testing of all equipment and systems. The contractors shall execute the tests.

1. In general, functional testing is conducted after construction testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

4.5 Problem Solving: The CA will recommend solutions to problems found; however, the burden of responsibility to solve, correct, and retest problems is with the GC.

5 Documentation, Non-Conformance and Approval of Tests

5.1 Documentation: The CA shall witness and document the results of all functional performance tests.

5.2 Non-Conformance

5.2.1 The CA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the A/E.

5.2.2 Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented.

5.2.3 Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.

5.2.4 As tests progress and a deficiency is identified, the CA discusses the issue with the contractor.

When there is no dispute on the deficiency and the contractor accepts responsibility to correct it:

a. The CA documents the deficiency and the contractor's response and intentions.

b. The contractor reschedules the test and coordinates with CA to establish a time and date that the test is to be repeated.

5.2.5 If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

a. The deficiency shall be documented and a copy given to the A/E and to the contractor representative assumed to be responsible.

b. Resolutions are made and the final acceptance authority is left with the A/E.

c. The CA documents the resolution process.

d. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The contractor reschedules the test and notifies the CA of the date and time the test is to be repeated. This will occur until satisfactory performance is achieved.

5.3 Cost of Retesting

The cost for the contractor to retest a construction or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the responsible parties.

a. For a deficiency identified, not related to any construction checklist or startup fault, the following shall apply: The CA will direct the retesting of the equipment once at no "charge" to the contractor for their time. However, the CA's time for a second retest will be charged to the contractor, who may choose to recover costs from the responsible Sub.

b. The time for the CA to direct any retesting required because a specific construction checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the contractor, who may choose to recover costs from the party responsible for executing the faulty construction test.

5.4 The CA retains all the documents until the end of the project.

6. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the Owner. In such case, the contractor shall provide the Owner with the following:

6.1 Within one week of notification from the A/E, the contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the A/E within two weeks of the original notice.

6.2 Within two weeks of the original notification, the contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions, which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.

6.3 The A/E will determine whether a replacement of all identical units or a repair is acceptable.

6.4 Two examples of the proposed solution will be installed by the contractor and the CA will be allowed to test the installations for up to one week, upon which the CA will decide whether to accept the solution.

6.5 Upon acceptance, the contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

7 Approval: The CA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CA. The CA recommends acceptance of each test to the Owner and A/E. The A/E gives final approval on each test, providing a signed copy to the CA and the contractor.

6 Training of Owner Personnel

6.1 The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.

6.2 The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

6.2.1 The CA shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CA shall decide how rigorous the training should be for each piece of commissioned equipment. The CA shall communicate the results to the contractor and vendors who have training responsibilities.

6.2.2 Each contractor and vendor responsible for training will submit a written training plan to the CA for review and approval prior to training. The plan will cover the following elements:

Equipment (included in training)

a. Intended audience
b. Location of training
c. Objectives
d. Subjects covered (description, duration of discussion, special methods, etc.)
e. Duration of training on each subject
f. Instructor for each subject
g. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
h. Instructor and qualifications

6.2.3 The CA develops an overall training plan and coordinates and schedules, with the Owner and contractor, the overall training for the commissioned systems. The CA develops criteria for determining that the training was satisfactorily completed. The CA recommends approval of the training to the A/E.

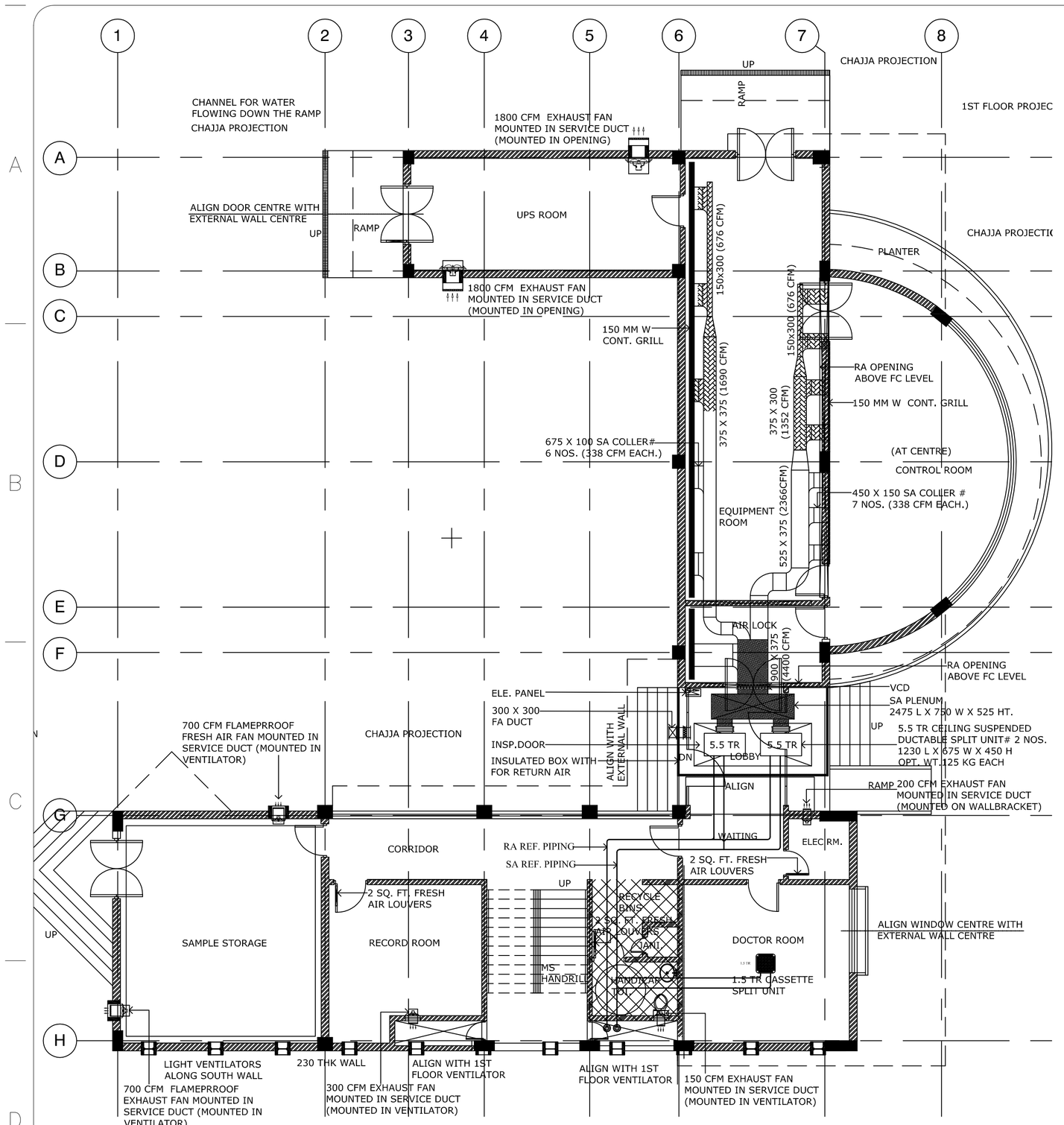
6.2.4 The GC will provide videotaping of the training sessions, with tapes cataloged by the GC, and added to the O&M manuals.

7 Written Work Products

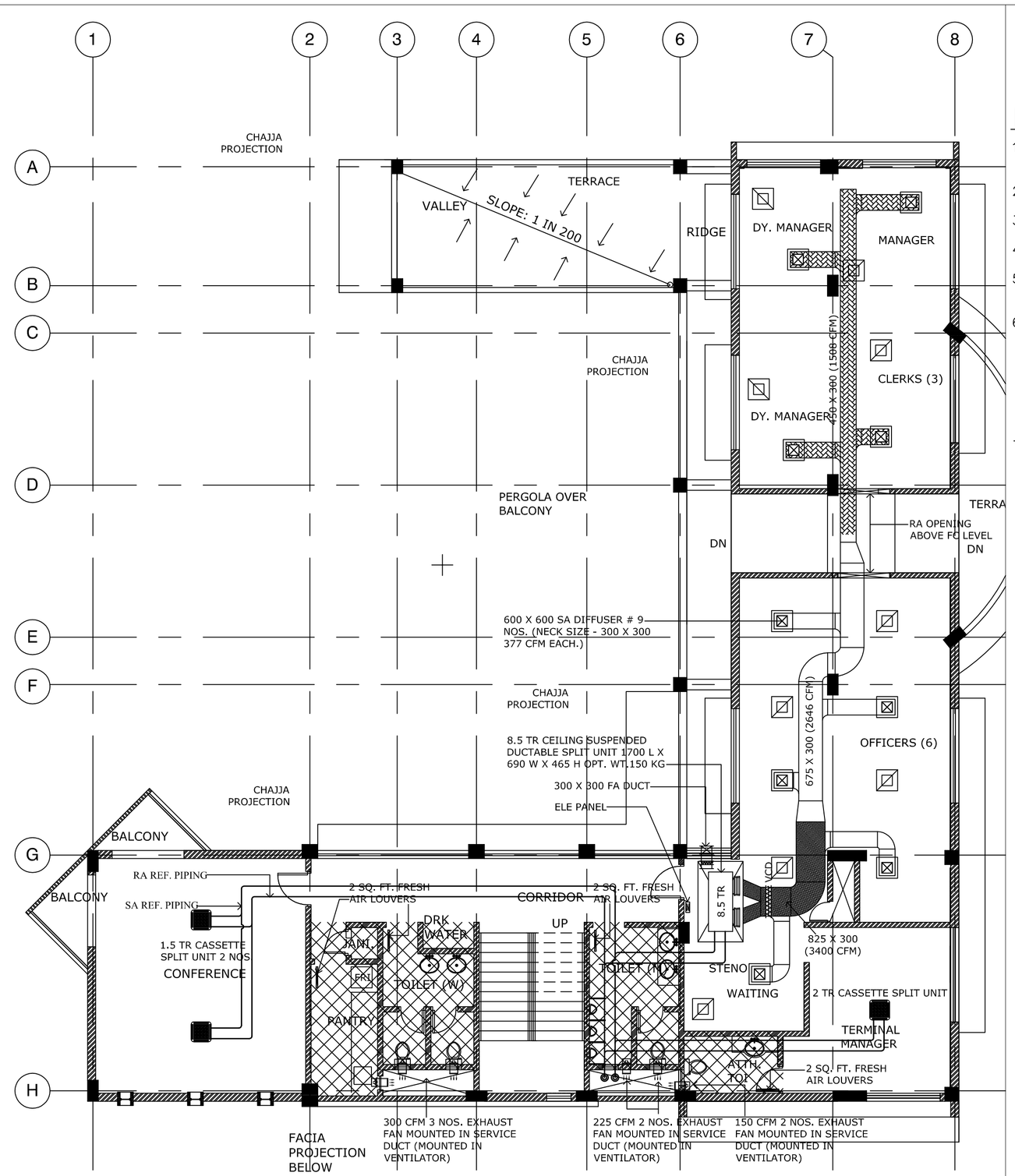
7.1 The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them, and the location of the specification to create them. In summary, the written products are:

Product	Developed By
Commissioning plan	CA
Commissioning meeting minutes	CA
Commissioning schedules	GC and CA with other contractors
Equipment documentation submittals	Contractors
Construction checklists	CA (Preliminary in Spec. Revised based on Approved Submittals)
Startup and initial checkout plan	Contractors and CA (Compilation of existing documents)
Startup and initial checkout forms filled out	Contractors
Final TAB report	TAB
Commissioning Progress Record	CA
Deficiency reports	CA
Functional test forms	CA
Filled-out functional tests	CA
O&M manuals	Contractors with review by CA
Commissioning record books and CD's	CA
Overall training plan	CA, GC, and Contractors
Specific training agendas	Contractors
Final commissioning report	CA

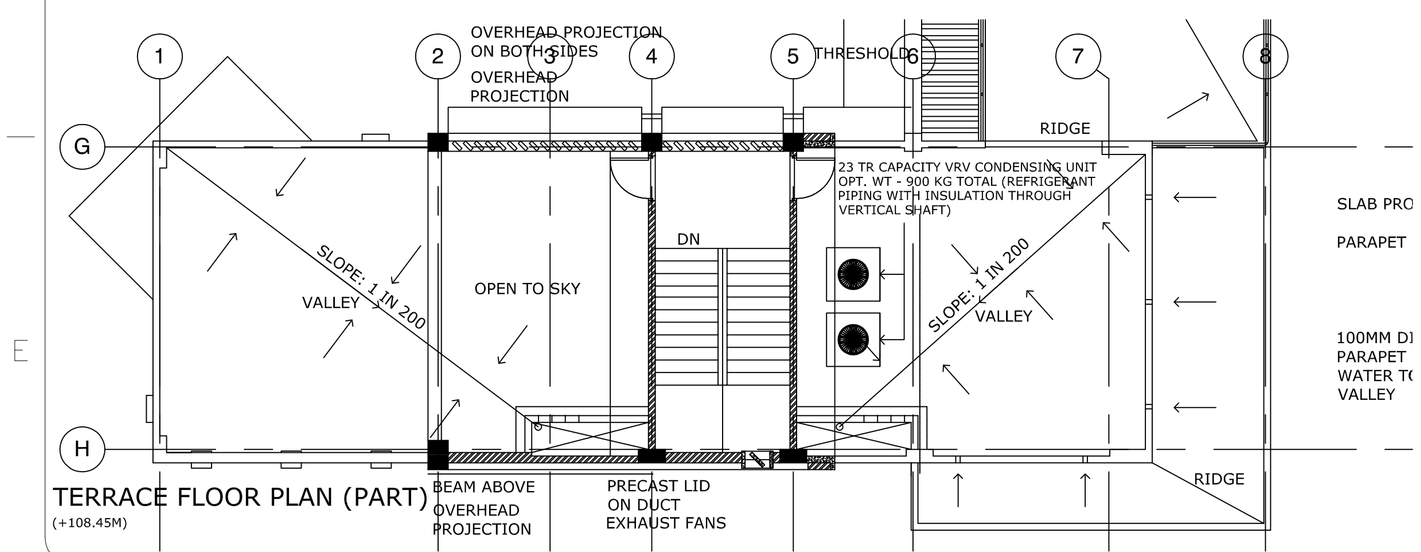
END OF SECTION



GROUND FLOOR PLAN
(+100.75M)



FIRST FLOOR PLAN
(+104.60M)



TERRACE FLOOR PLAN (PART)
(+108.45M)

NORTH

NOTES :–

1. ALL DIMENSIONS ARE IN MILLIMETRES, ELEVATIONS & CO–ORDINATES ARE IN METRES UNLESS OTHERWISE NOTED.
2. FGL EL 100.000 CORRESPONDS TO RL 4.000m ABOVE MSL.
3. DO NOT SCALE THE DRAWINGS. FOLLOW WRITTEN DIMENSIONS ONLY
4. ALL DIMENSIONS ARE FROM THE FACE OF THE WALL.
5. ALL EXTERNAL WALLS WILL BE 230 MM THK AND ALL INTERNAL WALLS WILL BE 115 MM THICK UNLESS OTHERWISE STATED.
6. INCASE OF CONFLICT BETWEEN THE DRAWING AND THE SPECIFICATIONS, SPECIFICATIONS SHALL HAVE PRECEDENCE.

SHEET LEGEND :–

- INSULATION
- INSULATION
- RETURN DIFFUSER
- SUPPLY DIFFUSER

DRAWING No.	REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	BY	CHK	APP	APPROVED BY & DATE	STATUS
254625–300–PIP–A0–3000	OVERALL PLOT PLAN	A	30/10/09	ISSUED FOR TENDER	MD	MPG		SDJ/XX/XX/XX	ISSUED FOR TENDER

SCALE: 1:100

DRAWN	MD	DATE	14/10/09
CHECKED	MP	DATE	14/10/09
APPROVED	–	DATE	–

CLIENT:
HINDUSTAN PETROLEUM CORPORATION LTD.
VISAKHAPATNAM, INDIA

Mott MacDonald
Mott MacDonald Consultants (I) Pvt. Ltd.
Kothari House, CTS No. 185,
J.B. Nagar, Off Andheri–Kurla Road,
Andheri (East), Mumbai 400059, INDIA

JOB NO:- 254625

PROJECT:
HINDUSTAN PETROLEUM CORPORATION LIMITED
VISAKH MARKETING INSTALLATION RESITEMENT PROJECT BLACK OIL TERMINAL

ARCHITECTURE; MEP; GREEN CONSULTANCY:
Free Span z design build pvt. ltd.
Sh. 6A, H.R. Apt., Rani Sati Marg, Near Tapovan, Malad (East), Mumbai 400097.
Website: www.freespanz.com Tel.: 022 0841 4935; Email: info@freespanz.com

CONTRACTOR:

DRAWING TITLE:
ADMINISTRATION BUILDING
GROUND FL & FIRST FL DUCTING PLAN

JOB NO.: 254625
EQUIPMENT NO.:

SHEET SIZE	DRAWING NUMBER	SHT. No.	REV
A1	254625–300–MEC–A1–0001	001	0