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ENGINYERIA INDUSTRIAL

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Títol PFC:
PROJECT OF HEATING, VENTILATING AND AIR CONDITIONING INSTALLATION
FOR A PHARMACEUTICAL PLANT

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Chapter 1. Project description

The scope of this project is to define the Heating, Ventilating and Air Conditioning system for a biotechnology manufacturing facility dedicated to the production of human vaccines.

The pharmaceutical facility is located in Helsinki (Finland). The site area occupies approximately 840 m²; total floor area has circa 1680 m² and is composed of two floors and six zones:

- **Administration.** Accounting, contract, finance, human resources.
- **Quality Assurance and Control.** Analytical lab and a classified area. Archiving of samples and critical documentation, physical and chemical testing of both bulk product and drug product (finishing product).
- **Warehouse.** Receiving and storage of raw material, distribution of bulk product to production area, storage and distribution of final product, storage of rejected material.
- **Packaging.** Receiving the drug product from the production area, execute inspection (manual or partially automated), labeling and packing of the final product.
- **Production area.** Classified area. Preparation of bulk product, filling, capping and sealing, vial and ampoule washing and sterilization, laundry.

The manufacturing facility will established a Line Production for the production of the following two vaccines:

- **Pentavalent vaccine** (commonly abbreviated as Penta), which is a combination of five vaccines in one: diphtheria, tetanus, whooping cough, hepatitis B and Haemophilus influenza type B (HIB). This product is classified as a killed vaccine and it is used mainly to children, to give protection and immunization against these diseases, as well as meningitis, pneumonia and otitis.

- **Tetanus immune globulin** (TIG) **vaccine,** which is a sterilized solution obtained from pooled human blood plasma, which contains the immunoglobulins (or antibodies) to protect against the infectious agents that cause various diseases. This vaccine is classified as a live vaccine.
Chapter 2. General requirements

A. Scope and contents

Article 1. The present general conditions have supplementary nature of the special conditions of the project.

Both, as part of the architectural project, is to regulate the execution of works by setting technical standards and quality requirements, including specific interventions that are, under the contract and in accordance with applicable law, the developer or owner of the work, contractor or builder thereof, technicians and managers, architect and surveyor or architect and technical laboratories and quality control entities and the relationships between them and their obligations in order to fulfill the contract works.

B. Documentation of contract works

Article 2. Up the contract documents the following order of priority as to the value of its specifications for failure or apparent contradiction:

1) Fixed conditions in the contract document itself or Construction Company, if any.
2) The special conditions
3) The present general conditions
4) The rest of the project documentation (report, plans, measurements and budget).

In the works that require it, the study will also be part of health and safety and quality control project of the building.

It shall contain the conditions and identifying areas of laboratory performance and quality control entities, if the work required it.

The orders and instructions of the technical department of the works are incorporated into the project as interpretation, complement or accuracy of its determinations.

In each document, specifications override literal graphs and drawings, dimension prevails over wide measure.
2.1. Optional requirements

A. Clarifying roles of the agents


The Law of Construction Planning (LOE) applies to the process of building, meaning the action and the result of building a permanent building, public or private, whose main use is covered by the following groups:

a) Administrative, health, religious, all forms of residential, educational and cultural.

b) Aeronautical, agricultural, energy, of hydraulics, mining, telecommunications (relative to telecommunications engineering) of land, sea, river and air; forestry industrial naval engineering and sanitation hygiene, and accessory to engineering works and their exploitation.

c) All other buildings whose uses are not specifically listed in the above groups.

When the project is aimed to make the construction of buildings for the uses listed in group a) the academic and professional qualifications will be the architect.

When the project is aimed to make the construction of buildings for the uses listed in group b) the academic and professional qualifications, in general, will be to engineer, engineer or architect and will be determined by the laws in force for each profession, according to their particular and specific skills.

When the project is aimed to make the construction of buildings for the uses listed in group c) the academic and professional qualifications will be to architect, technical architect, engineer or engineering technician and will be determined by current legislation for each profession according to their specific skills and specialties.

The promoter

Will sponsor any individual or entity, public or private, individually or collectively decide, promote, program or fund, own or other resources, the building work for themselves or for later sale, delivery or transfer to third parties under any title.

The obligations of the promoter:
a) To hold on the lot title to a right entitling him to build on it.
b) Provide the necessary documentation and information prior to the drafting of the project and construction manager to authorize the subsequent modifications.
c) Manage and obtain the required licenses and authorizations and sign the minutes of receipt of the work.
d) To appoint health and safety coordinator for the design and execution of the work.
e) Subscribe assurances covered by the LOE.
f) Provide the purchaser, if any, documentation of work performed, or any other document required by the competent authorities.

The designer

Article 4. The obligations of the planner:

a) To be in possession of the educational and professional qualifications of architect, technical architect or engineer, as appropriate, and meet the conditions required for the exercise of the profession. In case of legal, technical editor designate the project with professional qualifications enabling.
b) Draw the project subject to the regulations and what is stated in the contract and return it with the appropriate endorsements were mandatory.
c) Agree, if any, with the developer hiring partial collaborations.

The builder

Article 5. The obligations of the manufacturer:

a) Run the project work subject to applicable law and the instructions of the project manager and the director of the execution of the work, in order to achieve the quality required in the project.
b) Have the qualifications or vocational training that enables to fulfill the conditions required to act as a builder.
c) To designate the site manager who shall represent the builder’s artwork and that their qualifications or experience should be adequately trained in accordance with the nature and complexity of the work.
d) Assign work to the human and material means that its importance required.
e) Organize the construction, drafting plans and work that require planning or authorizing the temporary and work aids.

f) Develop the health and safety plan of the work under study for, and have, in any case, the implementation of preventive measures, ensuring compliance and enforcement of existing legislation on safety and health at work.

g) Take note and follow instructions coordinator for safety and health during the execution of the work, and if the site management.

h) Formalizing the outsourcing of certain parts of the work or facilities within the limits established by the contract.

i) Signing the stakeout or start and the minutes of receipt of the work.

j) Order and direct physical implementation under the project, technical standards and rules of good construction. To this end, holding the head of all personnel involved in the work and coordinates the activities of the subcontractors.

k) Ensure the adequacy of each and every one of the materials and construction elements used, prepared on site checking and rejecting its own initiative or on the order of the surveyor or technical architect, or prefabricated supplies that do not have guarantees or approvals required by applicable regulations.

l) To keep the books of orders and monitoring of the work, as well as health and safety and quality control, these if any, and give to the annotations aware that they are practiced.

m) Provide the surveyor or architect technical advance, the materials needed to carry out its mission.

n) Prepare partial labor certification and the proposed final settlement. o) Subscribe with promoter minutes of provisional acceptance and final.

o) To enter the work accident insurance and third party damage during construction.

p) Provide the project manager the necessary data for the preparation of the documentation of the work performed.

q) Provide access to the work, laboratories and quality control entities and duly approved contract for the performance of its functions.

r) Subscribe guarantees for property damage caused by faults and defects of the building under Article 19 of the LOE.
The Project Manager

Article 6. It is for the contractor:

a) To be in possession of the educational and professional qualifications of architect, technical architect, engineer or technical engineer, as appropriate, and meet the conditions required for the exercise of the profession. In case of legal persons, appoint technical project manager who has the professional qualifications enabling.

b) Check the layout and the adequacy of the foundation and the structure projected to the geotechnical characteristics of the ground.

c) Direct the work and in line with the project implementation, facilitating technical interpretation, economic and aesthetic.

d) Assist the works, as often required by their nature and complexity, to resolve the contingencies that occur in the play and record in the order book and assists the instructions for the correct interpretation of the project.

e) Prepare, at the request of the sponsor or his compliance, any changes in the project, required by the coming up of the work provided they conform to the regulatory provisions referred to and observed in the drafting.

f) Coordinate, by the surveyor or architect technical development program of the work and the project quality control of the work, subject to the Technical Building Code (CTE) and project specifications.

g) Check, by the surveyor or technical architect, the results of analyzes and reports by laboratories and / or quality control entities. h) To coordinate the intervention of other technical work, where appropriate, to attend the leadership role in aspects of their own specialty.

h) Conform to the partial certifications of work and final settlement.

i) To sign the act of redefinition or beginning of work and the final completion certificate and certification shape the partial and final settlement of the units of work performed, with appropriate endorsements were mandatory. k) To advise the developer during the construction process and especially in the act of receiving.

j) Prepare with the contractor graphic and written documentation of the project definitely executed to deliver the promoter.

k) Will be attached to these documents, at least, the minutes of receipt, identifying the relationship of the agents who spoke during the building process, as well as instructions on use and maintenance of the building and its facilities, in accordance with the regulations that apply to you. This documentation will be the book of the building and will be delivered to end users of the building.
The project execution director

Article 7. Surveyor or architect is for the technical direction of the execution of the work, that part of the project management, technical role assumes direct the conduct of the work and to control the construction quality and quantity and quality of what is built. Being specific functions:

a) To be in possession of academic and professional qualifications and fulfill the conditions required for the exercise of the profession. In case of legal persons, appoint the director of the technical execution of the work that has professional qualifications enabling.

b) Prepare the document for study and analysis of the project to develop programs and development organization of the work.

c) Plan, in view of the architectural project, the contract and applicable technical standards, quality control and cost of works.

d) Prepare, when required, the study of appropriate systems to the risks of working on the realization of the work and pass the health and safety study for the application.

e) Prepare, when required, the quality control project of building, developing specified in the project implementation.

f) Conduct setting out the work and prepare the minutes, together with architect and builder.

g) Check the temporary, auxiliary and safety and health at work, checking their correct implementation.

h) Conduct or arrange for testing and materials testing, installations and other work units as scheduled sampling frequencies in the control plan and carry out other checks are necessary to ensure the quality of construction in accordance with the project and applicable technical standards. The results inform promptly the builder, imparting, if applicable, the appropriate orders, if unresolved contingency take appropriate measures, informing the architect.

i) Perform measurements and approve work performed, as established relationships, the valued certifications and final settlement of the work.

j) Check the reception in the work of building products, ordering tests and performing accurate tests.

k) To direct the conduct of the work checking the stakeout, the materials, proper execution and disposal of construction elements and facilities, according to the project and with the instructions of the project manager.

l) Include in the order book and assists precise instructions.
m) To sign the act of redefinition or beginning of work and the final certificate of work, and to prepare and sign the partial certifications and final settlement of the units of work executed.

n) Collaborate with other agents in the preparation of the documentation of the work performed, providing the results of the monitoring executed.

Health and safety coordinator

The coordinator for safety and health during the execution of the work shall perform the following functions:

a) Coordinate the implementation of the general principles of prevention and safety.

b) Coordinate the work activities to ensure that contractor and, where appropriate, subcontractors and freelancers applied consistently and responsibly the principles of preventive action to be found in Article 15 of the Law on Prevention of Occupational Hazards during execution of the work.

c) Approve the safety and health plan developed by the contractor and, if applicable, amendments to the same.

d) Coordinate actions and control functions of the correct application of the methods of work.

e) Take the necessary measures to ensure that only authorized people can access the work. The Project Manager will assume this function when not required the appointment of coordinator.

Entities and Quality Control laboratories building

Article 8. Entities quality control of the building providing technical assistance in the verification of the quality of design, materials and execution of the work and its facilities in accordance with the project and the applicable regulations. The testing laboratories for quality control of the building providing technical assistance, by conducting tests or proof of service of materials, systems or facilities of a building work. The obligations of institutions and laboratories for quality control:

a) Provide technical assistance and deliver the results of its activity to the author's agent commission and, in any case, the director of the execution of the works.

b) Justify sufficient capacity of human and material resources necessary to perform the contracted work, where appropriate, through the relevant official accreditation granted by state government with jurisdiction in the matter.
B. Obligations and general rights of the constructor

Verification of the project documents

Article 9. Before beginning the works, the builder set out in writing that the documentation will be sufficient for understanding all of the contracted work, or otherwise seek clarification.

Health and safety plan

Article 10. The builder, in view of the implementation project containing, where appropriate, the health and safety study, will present the health and safety plan of the work to the approval of the surveyor or technical architect architects.

Quality Control project

Article 11. The builder will be available to the project quality control, if necessary for the work, which will specify the characteristics and requirements to be met by the materials and construction units, and the criteria for receipt of materials, as are guaranteed or not by labels and quality marks, tests, analyzes and tests to be performed, batch determination and other parameters defined in the project by the architect or surveyor of the architects.

Office work

Article 12. The builder will enable the work an office in which there will be a suitable table or board, which can be extended and plans available. This office will always have the contractor available to the Architect:

- The full implementation project, including additions of the architect.
- A building permit.
- The order book and assists.
- The safety and health plan and logbook, whether for work.
- The quality control project and record book, whether for work.
- The ordinance regulations and safety and health at work.
- Documentation of insurance underwritten by the manufacturer.
Representation of the contractor. Site Manager

Article 13. The manufacturer is obliged to notify the person designated property as his delegate in the work, which shall be considered masterpiece of the same, with full dedication and abilities to represent and take at any time such decisions are available to the contract. Will the builder functions as specified in Article 5. When the importance of the work required and it is claimed in the special conditions of voluntary nature, the contractor will delegate an optional top or intermediate level, as appropriate. The special conditions determined by the staff member or specialist builder is obliged to maintain at least the work, dedication and time commitment.

Failure to comply with this obligation, or, in general, the lack of adequate qualifications by staff depending on the nature of the work, empower the architect to order the cessation of work, without recourse whatsoever, until the deficiency is corrected.

Builder’s presence in the works

Article 14. The site manager, by itself or through its technicians, or managers will be present during the legal working day and accompany the surveyor or architect or technical architect in visitors to do the works, making itself available for practice examinations deemed necessary and by providing accurate data for checking measurements and assessments.

Non-expressed stated works

Article 15. It is the obligation of the contract as necessary to execute the construction and appearance of good works, even if not expressly specified in the project documents, provided that, without departing from the spirit and correct interpretation, as provided by the architect within the limits of possibilities that enable budgets for each unit of work and type of execution. In the absence of specification in the special conditions, be deemed reformed project requires consent of the owner, developer, any change that involves a price increase of piece rates by more than 20% of the total budget over 10%.

Interpretations, clarifications and modifications of project documents

Article 16. The manufacturer may require the surveyor or architect or technical architect, according to their respective mandates, instructions or clarifications as
may be required for the correct interpretation and implementation of schedule. When you try to clarify, interpret or modify provisions of the specifications or indications of plans or sketches, orders and instructions will be communicated in writing to the constructor precisely, the latter being forced to turn to return the originals or copies subscribing and sign the informed, that appear at the bottom of all orders, notices or instructions from both the technical architect and surveyor or architect. Any claim against the measures taken by them to make the builder sees fit, will direct it, within a period of just three days, who’s been rendered, which will give the builder a receipt, if it so requests.

Claims against the orders of the architectural

Article 17. Claims against the contractor wants to make an order or instruction emanating from the project management, you can only submit them through the architect, to the property, if the economic and according to the conditions stipulated in the relevant specifications. Technical Rules Against the architect or surveyor or technical architect, not admit any claim, the contractor can save his responsibility, if deemed appropriate by the architect addressed rationale, which may limit its response to the acknowledgment, which in any case shall be binding for such claims.

Challenge by contractor personnel appointed architect

Article 18. The builder may challenge for architects, surveyors or personnel for surveillance of these works, or ask the property by other physicians is designated for surveys and measurements. When you create harmed by the work of these proceed in accordance with the provisions of the preceding article, but not for this reason be interrupted or disturbed the progress.

Staff misconduct

Article 19. The architect, in cases of disobedience to his instructions, manifest incompetence or gross negligence that compromise or disrupt the progress of work, may require the contractor to work beyond the dependents or operators causing the disturbance.
Subcontractors

Article 20. The contractor may subcontract chapters or other construction units and industrial contractors, subject where appropriate, to the provisions of the special conditions and without prejudice to its obligations as general contractor for the work.
C. Civil responsibility of the agents involved in the project execution

Material damages

Article 21. The natural or legal persons involved in the process of building owners are liable to third-party purchasers and buildings or portions thereof, in case they are subject to division, the following damage caused to the building within the time specified, from the date of receipt of the work, without reservations or from the correction of these:

a) For 10 years, the damage caused to the building by faults or defects affecting the foundations, supports, beams, slabs, bearing walls or other structural elements, and which directly compromise the strength and the stability of the building.

b) For three years, the damage caused to the building by faults or defects of construction elements or facilities that cause breach of habitability requirements of Article 3 of the LOE. The builder also liable for damages for defective execution elements affecting termination or finished works within one year.

Liability

Article 22. Civil liability shall apply at a personal and individualized, both own acts or omissions, for acts or omissions of persons who are to be answered. However, when could individualize the cause of damage or duly attested the contributory negligence that might be required without the degree of involvement of each agent in damage, liability severally is required. In any case, the sponsor shall be jointly liable with the other agents involved to potential purchasers of the damage in the building caused by construction defects or flaws. Without prejudice to administrative intervention measures in each case come the responsibility of the promoter that is set in the LOE will be extended to natural or legal persons who, under the contract or his decisive intervention in the promotion, acting as such promoters in the form of cooperatives promoter or manager of a condominium or other similar arrangements. When the project has been contracted together with more than one designer, the same shall be jointly liable. Designers who hire calculations, studies, opinions or reports of other professionals, will be directly responsible for any damages that may result from its failure, incorrect or inaccurate, subject to the repetition that might have against their authors. The builder will report directly to the damage caused to the building by faults or defects resulting from inexperience, lack of professional or technical capacity, negligence or breach of duty attributed to site manager and other natural or legal
persons covered by their insurance. When the builder subcontracts with other natural or legal persons implementing specific parts of the work or facilities shall be directly liable for damages for defective materials of execution, subject to repetition that might arise. The project manager and the director of the execution of the work sign the Certificate of Completion will be responsible for the accuracy of this document. Whoever accepts the address of a work, whose design has not prepared himself, will assume the responsibilities arising from omissions, deficiencies or imperfections of the project, subject to the repetition that might correspond to the designer front. When construction management is hired jointly more than a technician, they jointly liable notwithstanding the appropriate distribution among them.

Liability for damages shall not be payable to the agents involved in the process of building, it is proved that those were caused by accident, acts of God, acts of third party or by the injured party for the damage itself. The responsibilities referred to this article are without prejudice to the seller reaching or parts of buildings built to the purchaser under the purchase agreement signed between them, to Articles 1484 and following of the Civil Code and other legislation applicable to the sale.
D. General prescriptions according to works, materials and auxiliary

Roads and access

Article 23. The builder will have their own access to the work, the enclosure or fencing and maintenance thereof during the execution of the work. The technical architect or surveyor may require modification or improvement.

Stakeout

Article 24. The builder works with start staking them into the ground, pointing the main references remain as partial basis for further reconsiderations. These works will be considered by the contractor and included in the bid. The manufacturer shall submit the approval stakeout surveyor or architect and once this has been agreed prepare minutes accompanied by a plan to be approved by the architect, builder's responsibility being the omission of this procedure.

Beginning of the work. Completion rate of work

Article 25. The builder will begin construction in the period determined in the special conditions, developing in the manner required for the partial periods within those identified in the corresponding works are executed and therefore, the total execution takes effect within the time required by the contract. Mandatory and writing, the contractor shall report to the surveyor or architect and technical architect of the start of work at least 3 days in advance.

Order of business

Article 26. In general, determining the order of business is hiring faculty, except those cases where, for reasons of technical, considered necessary by the variation the architects.

Other facilities or contractors

Article 27. In accordance with the project management required, the general contractor shall provide all reasonable facilities for carrying out the work entrusted to it all other contractors involved in the work. This is without prejudice to the financial compensation that may be required from contractors or use of
auxiliary power supplies or other items. In cases of dispute, both contractors will be to resolve the architects.

**Expansion project due to unexpected causes**

Article 28. When required by unforeseen reason or for any accident, expand the project, the work will not stop, continuing as instructed by the architect as formulated or processed the amended Bill. The manufacturer is required to perform with their personnel and materials as the direction of the works available for propping, shoring, demolition or other urgent work, anticipating the moment this service, the amount of which will be entered in a supplementary budget or paid directly, according to what is appropriate.

**Overtime due to major cause**

Article 29. If by reason of force majeure or beyond the control of the manufacturer, it could not start work, or had to suspend them, or he could not finish them in the time-bound, an extension will be granted provided to fulfill the contract, favorable report from the architect. For this, the manufacturer shall indicate in writing to the architect, the cause that prevents the execution or progress and thus delay would originate within the agreed, reasoning that the extension due for that cause requests.

**Responsibility of the architectural in the delay of work**

Article 30. The contractor shall not apologize for not meeting the deadlines stipulated works, citing as cause lack of plans or orders of the Project Manager, except in the case at their request in writing that he had not provided.

**General requirements about work executions**

Article 31. All work will be executed with strict adherence to the project, modifications thereof which have been previously approved and orders and instructions at your own risk and deliver written the architect or surveyor or technical architect to builder, within budgetary constraints and as specified in Article 15.
Documentation of hidden works

Article 32. Of all the jobs and work units that are to be hidden to the completion of the building, will rise to precise plans are perfectly defined, these documents are drawn up in triplicate, giving: one, the architect, the other, the surveyor, and the third, the contractor, signed by all three. These plans, which must be sufficiently dimensioned, are considered essential documents and unexceptionable for measurements.

Defective works

Article 33. The builder must use materials that meet the requirements in the general and special conditions of technical specifications and perform each and every one of the contracted work as specified in that document also. Therefore, and until final acceptance occurs the building, is responsible for the execution of the work that has engaged and the faults and defects that they may exist due to poor execution or poor quality of the materials used or devices placed without exonerated of responsibility which falls under the control surveyor or technical architect, nor the fact that these works have been valued in the partial certifications of work, which shall be extended and always paid to good account. As a result of the foregoing, when the surveyor or architect warn technical faults or defects in the work performed, or materials used or non-qualified appliances placed, either in the course of execution of work, or they completed and verified before final acceptance of the work, may provide that the defective parts are demolished and rebuilt in accordance with the contract, and all at the expense of the contract. If it considers not just the decision and refused to demolition and reconstruction ordinates, it raises the issue with the architect's work, who will resolve.

Hidden vices

Article 34. If the surveyor or technical architect had reason to believe in the existence of latent defects in construction works executed, shall have at any time, and before final acceptance, testing, destructive or not, it creates necessary to recognize involving defective work, realizing the fact the architect. The expenses incurred shall be borne by the manufacturer, provided that the defects actually exist, otherwise they will be in charge of the property.
Materials and devices. Their source

Article 35. The builder has provided free materials and devices of all kinds in the points as you see fit, except in cases where the particular specification establishes mandatory technical conditions a specific origin. Necessarily and prior to his employment or collection, the builder must submit to the surveyor or technical architect a complete list of materials and equipment to be used in specifying all the information about brands, quality, origin and suitability of each.

Submission of samples

Article 36. At the request of the architect, the builder will present samples of the materials provided with the notice provided for in the work schedule.

Unusable materials

Article 37. The manufacturer, at its expense, transported and placed, neatly grouped and in the right place, the materials from the excavations, demolitions, etc., not used in the work. Withdraw from it or will take to the dump, where was established in the special conditions in the work force. If you do not have anything on particular withdraw from it when ordered by the foreman or technical architect, but agreeing in advance with the builder his fair appraisal, taking into account the value of such materials and transportation costs.

Defective materials and devices

Article 38. When materials, facilities or equipment items were not of the quality required by these specifications or were not required to prepare it and, finally, when the lack of formal requirements that are recognized or established that they were not suitable for its object, architect or surveyor instances of technical architect, builder will order to replace them with others that meet the conditions or fill the object to which they are intended. If within 15 days of receiving the order to withdraw builder materials not in a position, has not been fulfilled, the property may make expenditures charged to the contract. If materials, facilities or equipment items are defective, but acceptable to the architect, but it will reduce the purchase price to determine that, unless the builder prefers to substitute other conditions.
Charges for tests and trials

Article 39. All costs incurred by the trials and tests of materials or elements involved in the execution of the works, shall be borne by the contract. Any test which has not been successful or not offer sufficient guarantees may begin again in charge of it.

Cleaning works

Article 40. It is the obligation of the manufacturer to keep clean the works and its surroundings, both material and leftover debris, to remove the temporary facilities that are not necessary, and adopt measures and carry out all work necessary for the work to provide good looks.

Works without prescription

Article 41. In the execution of works entering the construction works and for which there are no explicit requirements contained in this statement or other documentation of the project, the builder will follow, in the first instance to the instructions issued by the Architect works and, secondly, to the rules and practices of good construction.
E. Alien buildings and works reception

Certificate of Acceptance

Article 42. The reception of the work is the act by which the manufacturer, once this, delivers it to the developer and is acceptable to it. May be performed with or without reservations and must cover all phases of the work or complete and finished in the same, when agreed by the parties. The receipt shall be recorded in a report signed at least by the developer and the builder, and the same shall be recorded:

a) The parties involved.
b) The date of the final certificate of the entire work or complete and finished phase of it.
c) The final value of the actual execution of the work.
d) The statement of receipt of the work with or without reservation, specifying, where appropriate, they objectively, and the time frame to get the defects rectified. After eliminating the same, shall be recorded in a separate record, signed by the signatories to the reception.
e) The warranties, if any, will require the builder to ensure their responsibilities.
f) Contain the Certificate of Completion signed by the main contractor (architect) and the director of the execution of the work (architect) and supporting documentation for quality control done.

The Promoter may refuse receipt of the work on the grounds that it is not finished or that does not conform to the contract terms. In any case, the rejection must be motivated in writing in the minutes, which shall be the new deadline for making the reception.

Unless expressly agreed otherwise, the reception of the work will take place within 30 days of the date of termination, accredited by the final certificate of work; period is counted from the notification by writing to the promoter. The receipt shall be produced tacitly if within 30 days after the date indicated promoter had shown no reservations or motivated rejection in writing.

Provisional acceptance

Article 43. This will be done with the intervention of the property, the builder, architect and surveyor or technical architect. It will also call the remaining technical, if any, have intervened in the address partial aspects in specialized units.
Practiced a thorough appreciation of the works, shall be a record with as many copies as involved and signed by all of them. From this date shall begin the warranty period, if the work would be in condition to be admitted. Then technicians will extend the project management certificate of final completion.

When works are not in condition to be received, shall be recorded in the minutes and give appropriate instructions to the builder to remedy the defects, setting a deadline for remedying them, which expired, there will be a new recognition to proceed with the provisional acceptance of the work. If the builder has not completed, may declare the contract avoided with loss of the deposit.

Final documentation

Article 44. The architect, contractor and assisted by technicians who have participated in the work, drafted the final documentation of the works, to be provided to the property. Such documentation shall be attached to the minutes of receipt, identifying the relationship of the agents who spoke during the building process, as well as instructions on use and maintenance of the building and its facilities, in accordance with the regulations that applicable. This documentation will be the book of the building, which has been commissioned by the developer and will be delivered to end users of the building. In turn such documentation is divided into:

Final measurement and provisional liquidation of work

Article 45. Provisionally received works, is immediately by the surveyor or architect technician to your final measurement, need assistance with the builder or his representative. It will extend the timely certification triplicate, approved by the architect with his signature, will serve for the payment for the property of the resulting balance unless the amount withheld as a deposit (as defined in Article 6 of the Act).

Warranty period

Article 46. The warranty period shall be stipulated in the special conditions and in any case not be less than 9 months (1 year contract with the government).
Conservation of works received provisionally

Article 47. The cost of maintenance during the warranty period between provisional and definitive receptions, borne by the contractor. If the building was occupied or used before final acceptance, childcare, cleaning and repairs caused by use borne by the owner and repair of defects or defects of work on site, will be in charge of hiring.

Final acceptance

Article 48. The final acceptance will be verified after the warranty period has elapsed equally and with the same formalities as the provisional, from which date the obligation ceases builder to repair damage charge those inherent to the normal maintenance of buildings and shall only remaining all liabilities that may overtake you on construction services.

Extension of the warranty period

Article 49. If the granting recognition to final acceptance of the work, not FOUND it in proper condition, that final acceptance will be deferred and will mark the constructor chief architect deadlines and ways in which purpose the necessary works and, if not done among those, the contract may be terminated with forfeiture of the bond.

Receipts of work which was hired terminate

Article 50. In the event of termination of the contract, the contractor shall be obliged to withdraw, in the period specified in the special conditions, machinery, aids, facilities, etc., Solve subcontracts had concluded and leave the work able to be resumed by another company.

The finished works and completely provisionally be received with the procedures established in this specification. After the warranty period will definitely be in accordance with this specification.

For certain works and not, but acceptable to the chief architect, will be a single and final reception.
F. Mutual compensations

Compensation due to delay in completion time

Article 79. Compensation for delay in completion shall be established per thousand of the total amount of contracted work for each calendar day of delay, calculated from the day of termination fixed work schedule, except as provided in the specifications including of this project. The amounts deducted and withheld resulting under bail.

Delayed payments by the owner

Article 80. If the owner fails to pay for the works carried out within the month following the agreed deadline corresponding contractor shall also have the right to receive payment of 5% per year (or the specifications defined in particular), in concept of default interest, during the time period of the delay and the amount of the said certification.

If you have two months elapsed from the end of the period of one month without made such payment, the contractor shall be entitled to terminate the contract, proceeding to the relevant settlement of the works executed and materials collected, provided they meet the predefined conditions and that their number does not exceed that necessary for the completion of the contracted work or awarded.

Notwithstanding the above, it will reject any request for termination of the contract based on the delay of payments, when the contractor warrants that on the date of such request has invested in work or materials collected admissible the budget for the period performance having stated in the contract.
2.2. Economic requirements

A. General principle

Article 51. All those involved in the construction process are entitled to receive promptly the amounts due for the correct action, under the terms of their contracts. The property, the contractor and, if necessary, technicians can interact adequate safeguards required to timely compliance with its payment obligations.

B. Deposits

Article 52. The contractor shall furnish a bond under any of the following procedures as stipulated:

   a) Prior deposit in cash, securities or bank guarantees amounting to between 4% and 10% of the total contract price.
   b) By withholding certifications or partial prepayments in equal proportion. The application rate for the deposit or retention shall be the special conditions.

Deposit at public auction

Article 53. In the event that the work is awarded by public auction, the provisional deposit to take part in it will be specified in the notice of the same and the amount is usually, and unless stipulated differently in the special conditions prevailing on the work of at least 4%, of the total contract budget.

The contractor who has been awarded the execution of a work or service for the same, shall deposit at the point and time set in the notice of auction, or determined in the special conditions of the project, the final deposit that point and, failing that, the amount will be 10% of the amount by which the award is made to the forms specified in the preceding paragraph.

The period prescribed in the preceding paragraph, unless express condition established in the special conditions, shall not exceed 30 calendar days from the date you receive notice of the award, and within it the contractor must submit a letter of payment or receipt confirming lodgment of the bond referred to the same paragraph.

Failure to comply with this requirement will result in the award is declared void, and the winner will forfeit the deposit that would have made provisional to take part in the auction.
Execution of work under deposit charges

Article 54. If the contractor refuses to do on your own complete the work necessary for the work under the conditions employed, the chief architect, on behalf of the owner, the running order to a third party, or may be incurred directly by management, paying their deposited with the bond amount, without prejudice to any action that the owner is entitled, in the event that the amount of the bond would not cover the amount of the expenses incurred in the work units that were not in receipt.

Return of deposits

Article 55. The deposit will be returned to the contractor retained a maximum period of 30 days after signing the minutes of final acceptance of the work. The property may require the contractor to prove the liquidation and settlement of debts caused by the execution of the work, such as salaries, supplies, subcontracts, etc.

Return of deposits in case of execution of partial receptions

Article 56. If the property, with the agreement of the chief architect, agreed to make partial receipts, the contractor is entitled to be returned to the portion of the bond.
C. Prices

Composition of unit prices

Article 57. The calculation of the prices of the various units of work is the result of adding the direct costs, indirect costs, overhead and profit industry.

a) Direct costs
   - Labor, with their bonuses and social security charges and, directly involved in the execution of the work unit.
   - The materials, the resulting prices on site, which are integrated into the unit in question or are necessary for execution.
   - The equipment and technical systems for safety and health protection and prevention of occupational accidents and diseases.
   - Staff costs, fuel, energy, etc., that may occur by the actuation or operation of machinery and equipment used in the execution of the work unit.
   - The cost of depreciation and maintenance of equipment, facilities, systems and equipment mentioned above.

b) Indirect costs. The costs of setting up offices on site, communications, construction of warehouses, workshops, and temporary pavilions for workers, laboratories, insurance, etc., the technical and administrative staff assigned exclusively to the work and contingencies. All such costs shall be encoded as a percentage of direct costs.

c) Overheads. Corporate overhead, interest expense, taxes and administration fees, legally established. Be encoded as a percentage of the sum of the direct and indirect costs (in contracts for public works of this percentage is between 13% and 17%).

d) Industrial profits. The contractor's industrial profit is set at 6% of the sum of the above items to the administration works.

e) Material execution price. Price is called the material execution result by the sum of the previous concepts except industrial benefit.

f) Contracts price. The contract price is the sum of direct costs, indirect costs, and overhead and profit industry. VAT is charged on this amount (contract price) but not part of the price.

Contract prices. Amount of contract

Article 58. In the event that the work done in a building or work are attached either hire them at the risk, the term contract price that matters the total cost of the work unit, i.e., the exercise price of material, plus the% on the latter price for
profit industrial contractor. The benefit is usually estimated at 6%, except in the special conditions establish a different one.

Contradictory prices

Article 59. Prices will occur only when the property contradictory by the architect decides to introduce quality units or changes in any of the previews, or as needed face unforeseen circumstances.

The contractor shall be required to make changes.

Failing agreement, the price will be settled contradictorily between the architect and the contractor before the execution of the works and the period determined by the special conditions. If the dispute remains will come first, the most similar concept in the price table project, and secondly the bank frequently used prices locally.

The existing contradictories will refer to the unit prices of the contract date.

Claim of increasing prices

Article 60. If the contractor before signing the contract had not made timely claim or observation may not under any circumstances claim error or omission increased the prices set in the table for the budget as a basis for the implementation of the works.

Traditional methods of measuring or applying prices

Article 61. In any case, the contractor may invoke the customs of the country in the implementation of the price or how to measure units of work performed, is expected to be first, the general conditions and secondly techniques Instead, the individual specification techniques.

Review of the contracted prices

Article 62. When works are contracted at risk, not admissible price revision while not increasing extent, in the amount of units remaining to be performed in
accordance with the schedule, an amount greater than 3% of the total contract budget.

Variations in the event of rising above this percentage make the corresponding review in accordance with the formula set out in the special conditions, the contractor receiving the difference arising over the CPI by more than 3%.

There will be no revision of prices of units may fall outside the deadlines specified in the bid schedule.

Materials collection

Article 63. The contractor is required to execute the stockpiles of construction materials and equipment from the property order in writing. The materials collected, once paid by the owner are the sole property of it, of his care and the contractor will be responsible conservation.
D. Works by administration

Administration

Article 64. Management works are called by those in which the steps that are necessary for the realization leads directly the owner, either personally or through a representative or by mean of a constructor. Works by administration are classified in two ways:

a) Works by direct administration.

b) Works for delegated administration or indirect.

Works by direct administration

Article 65. It works by direct administration called those in which the owner itself or through a representative, you can be the architect director, specifically authorized for this purpose, leading directly to the steps necessary for the execution of the work, acquiring the materials, hiring transport to work and, ultimately becoming directly involved in all the operations necessary for the staff and workers employed by him to do it, in these works the constructor, if any, or in charge of its implementation, is Own a mere dependent, either as an employee or as a freelancer hired him for it, that is who gathers itself, hence the split personality of owner and contractor.

Works for delegated administration or indirect

Article 66. Means for delegated administration work or you agree indirect owner and a builder for it, on behalf of itself and as a delegate, make efforts and work are required, and be agreed. They are therefore peculiar features works by delegated administration or indirectly the following:

1) by the owner, the obligation to pay directly, or through the constructor, all costs associated with the implementation of the agreed work, the owner reserves the right to be able to order, either by itself or through the principal architect in representation, order and progress, the choice of materials and equipment in the work are to be employed and, in short, all the elements that make precise to regulate the conduct of agreed tasks.

2) For the builder, the obligation to keep the practice of business management, providing expertise constructive, accurate aids and, in short, everything that, in keeping with its mandate, required for the execution of work, realizing why the landlord a Preset% on the total amount of the costs incurred and paid by the builder.
Liquidation of works by administration

Article 67. For settlement of jobs running for delegated administration or indirectly govern the standards established for such purposes in the particular conditions of an economic force in the work, in their absence, the management accounts presented to the builder owner, in relation to assessed to be accompanied and grouped in the order that the following documents are expressed all shaped by the surveyor or architect technician:

a) The original invoices for materials purchased for the work and the appropriate documentation to justify the deposit or use of such materials in the work.

b) The payroll of wages paid, adjusted as provided in the legislation, specifying the number of hours worked in the work by the operators of each trade category, accompanying. those payrolls numerical relationship managers, supervisors, team leaders, officials and helpers of each trade, specialized laborers and loose, timekeepers, guards, etc., who have worked in the work during the period of time corresponding to the payrolls presented.

c) The original invoices transport of materials made in the work or removal of debris.

d) Receipts from licenses, taxes and other charges inherent in the work paid or whose management was involved in the constructor, since payment is always the owner.

The sum of all expenses related to the work itself in the handling or the manufacturer has intervened payment will be applied in the absence of special agreement, 15%, meaning that at this rate are including aids and preventive security accident, overheads arising constructor work performed by management and the industrial profit from it.

Ticket to builder account executive administration

Article 68. Unless otherwise agreed, the builder fertilizers delegated administration accounts the owner made monthly as work performed parts approved by the owner or his delegated representative. Regardless, the technical architect or surveyor shall, with equal frequency, measurement of work done; value it under the approved budget. These evaluations will not impact the constructor for fertilizers, unless otherwise been agreed contractually.
Rules for the purchase of materials and devices

Article 69. But the powers in these works by delegated administration reserves the owner for the purchase of materials and equipment, if the constructor is authorized to manage and purchase, shall submit to the owner, or on behalf of the chief architect, prices and samples of materials and equipment provided, need prior approval before purchase.

About the constructor in low-performance of workers

Article 70. If the work executed monthly parties that were required to be submitted by the builder architect director, it emerges that the returns to labor, in all or some of the units of work performed, were markedly lower than normal yields generally accepted for units of the same or similar work, it shall notify the manufacturer, in order to make it precise efforts to increase production in the amount specified by the architect director. If this notification made to the builder, in the following months, the yields do not reach the standard, the owner is entitled to recoup the difference, reducing the amount of 15% that expressed by concepts correspond pay it before the constructor in the settlements fortnightly that should mandatorily be done. If both parties do not reach an agreement regarding the returns to labor, the case shall be submitted to arbitration.

Constructor responsibilities

Article 71. When performing works by administration, the manufacturer is liable for construction defects that may have jobs or units and executed by him for accidents or damage that may occur to workers or third parties for not taking measures accurate than current legislation sets. Instead, and unless otherwise stated in Article 70 above shall not be responsible for the bad result that could give materials and equipment chosen according to the rules set out in that Article. Under the previously recorded, the builder is required to make on your own defective work and also answer any accidents or damages expressed in the previous paragraph.
E. Assessment and tickets of the work

Payment methods of the works

Article 72. According to the method chosen for the procurement of works, and unless the particular specification establishes mandatory economic conditions otherwise, the payment of the work shall be as follows:

1) Fixed rate or lump sum total. He paid the amount previously set as the basis for the award, less applicable in the amount of the low made by the contractor.

2) Fixed rate or a flat rate per unit of work. This price per unit of output is unchanged and is fixed in advance, varying only the number of units executed. Previous measurement and applied to the total number of units of work performed, the invariable price stipulated in advance for each, provided in advance for each of them, shall be paid to the contractor the amount of covered work performed and finalized accordance with and subject to the documents comprising the project, which will provide the basis for measuring and assessing the various units.

3) Both variable piece rates. According to the conditions to be performed and the materials used in various execution in accordance with the orders of the chief architect. Be paid to the contractor on the same conditions as above.

4) On receipt of wages and lists of materials, in the manner authorized by these specifications determines overall economic conditions.

5) For hours of work performed under the conditions specified in the contract.

Relations and certificates rated

Article 73. In each of the times or dates fixed in the contract or in the terms and conditions that govern the work, the contractor will be valued relationship works completed in the time allowed, as measured by the quantity surveyor to be practiced.

We executed by the contractor in the prescribed conditions, be assessed by applying the measurement result general cubic surface, linear, weighted or corresponding numeral for each unit of output, the prices quoted in the budget for each of them, bearing in mind well established in the present general conditions.
regarding economic improvement or replacement of equipment and ancillary works and special, etc..

The contractor, who may witness the measurements necessary to extend this relationship shall be provided by the master builder of data for the valued relationships, accompanying a consignment note, in order that, within 10 days from the date of receipt of such notice, the contractor can examine them and return them signed with their agreement or do otherwise, comments or complaints as appropriate. Within 10 days of its receipt, the chief architect accepts or rejects the claims of the contractor if any, reporting to the same resolution, it may, in the second case, go to the owner against the decision of the chief architect in the form referred to in the specifications and optional general legal conditions.

Based on the valued relationships indicated in the previous paragraph, issue the chief architect certification of work performed. Of the amount is deducted as a percentage that the construction of the security is preset.

The material collected on site on the express and written by the owner, certified up to 90% of the amount; at the prices stated in the project documents, without affect the% of hires.

The certificates will be sent to the owner, within the month following the period to which they relate, and shall be authentic and deliveries to good account, subject to corrections and changes resulting from the final settlement, assuming no such certifications either approval or reception of works comprising.

Valued relations contain only the work performed in the period to which the assessment applies. In the event that the principal architect so requires, the certifications will extend to the origin.

**Improvement of free-executed works**

Article 74. When the contractor, even with permission of the architect director, employ more careful preparation materials or larger than shown in the project or replaces a factory class with another that had assigned higher price with larger or execute any part of the work, or, in general, in this and no ask for it, any other change that is beneficial to trial the principal architect, is not entitled, however, rather than the payment of which may correspond to the case that had built the work with strict adherence to the planned and contracted or awarded.
Payment of budgeted works with raised certificate

Article 75. Unless the provisions in the special conditions of an economic, effective in the work, the payment of lump starting budgeted work shall be performed in accordance with the relevant procedure including stated below:

a) If there are contract prices for equal work units, starting budgeted by raised, will be made following measurement and application of the established price.

b) If there are contract prices for similar work units are established contradictory prices starting units with raised, net of the related contract.

c) If there are no units contracted prices for the same or similar work, the game raised be paid in full to the contractor, except for that in the budget of the work to express the amount of such departure must be justified, in which case the tell the principal architect and contractor prior to its execution, the procedure followed to take the account, it will actually be management, assessing the materials and wages to prices listed in the approved budget or, alternatively, to that prior to the implementation agreed by both parties, increasing the total amount to the percentage fixed in the special conditions in general expenses and profit of the contractor industry.

Depletion payments and other non-contracted special works

Article 76. When it was necessary to carry outs, injections and other works of any kind of special and ordinary nature, that for not being hired are not borne by the contractor, and if you do not hire them in the third person, the contractor will be required to perform and to meet expenses of any nature incurred, which will be paid separately by the owner of the contract. Besides monthly reimburse these costs to the contractor shall be paid together with them as a percentage of the total amount, if any, specified in the special conditions.

Payments

Article 77. Payments will be made by the owner at the time previously established, and its amount is precisely the work certifications formed by architect director, under which those are verified.
Payment of works performed during warranty period

Article 78. Performed provisional acceptance and if during the warranty period any work has been performed, to be credited shall be as follows:

1) If the work going on in the project were specified, and no cause had not been made by the contractor in due time, and the chief architect demanded its implementation during the warranty period, will be valued at the prices listed subscribers in the budget and in accordance with the provisions of the particular specifications or failing in general, in the event that these prices are lower than those applicable at the time of its completion, otherwise, the latter shall apply.

2) If you have performed work necessary to repair damage caused by the use of the building, because that was used during that period by the owner, will be assessed and paid to the prices of the day, previously agreed.

3) If you have carried out work to repair damage caused by deficiency of the construction or the quality of the materials, nothing will be paid by them to the contractor.
Chapter 3. Particular requirements

3.1. General

3.1.1. Description

This section of the work includes the design, fabrication, testing, cleaning and packaging, shipment, final assembly and installation of custom field assembled air handling units under the direct supervision of the unit manufacturer.

The details outlined and component manufacturers named in this specification may not be deviated from in the air handling unit manufacturer's preparation of the bid, even where techniques are required which are not considered standard by the manufacturer. The construction as described in this specification is considered essential, and any deviation from this specification must be specifically identified and bid as a Voluntary Alternate (add or deduct), but only after complying with the specification defined as the Base Bid.

The air handling unit manufacturer shall assume all responsibility to assure equipment installation including field assembly of individual equipment components as required.

Install equipment complete ready for duct, pipe, control and electrical connections as described by this Section and other specification sections. Coordinate installation of equipment with equipment manufacturer.

The manufacturer shall confirm rigging and installation limitations and shall design, package and ship based on these limitations.

3.1.2. Quality assurance

All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified or as denoted on the drawings and schedule.

Equipment furnished under this specification shall be in accordance with the following industry, association and government codes and standards, as applicable to their design, fabrication, and assembly and testing.

a) AMCA 99 Standards
b) ARI 430 Central Station Air Handling Units
c) NFPA 70 National Electric Code
d) NFPA 90A Standard for the Installation of Air Conditioning and Ventilating System
Fans shall be rated in accordance with AMCA Standard 210 for performance and AMCA Standard 301 for sound and shall bear the AMCA seal. Motor shall meet requirements of NEMA, IEEE, ANSI, and NEC standard. Coils shall be rated in accordance with ARI Standard 410 and bear the ARI seal.

Equipment within unit shall be UL listed where applicable.

Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torque, and fan has been test run under observation.

The manufacturer shall submit a unit assembly plan prior to beginning unit fabrication. The assembly plan shall temporary unit / ventilation requirements; detail each step of the construction process, effects on related trades, required utilities and a timeline for unit completion.

The manufacturer shall provide a full time on site construction supervisor during the entire unit assembly process. The supervisor shall manage the unit assembly and provide a lead contact for project meetings, owner / engineer / construction manager relations and answer questions from associated trades.

Unit manufacturer shall be responsible for conducting all specified field tests. Manufacturer shall provide testing equipment and instrumentation as needed for testing.

3.1.3. Submittals

WITH THE QUOTATION

Provide the following detailed information on the equipment proposed Unit manufacturer shall itemize all deviations from the specified requirements. If not so indicated, unit manufacturer will be required to furnish at no cost to the owner:

1) Information requested in the RFQ, including equipment data sheets, schedules and sketches.
2) Equipment drawings showing dimensions, weights (shipping & operating), configuration, major component locations, access door locations, duct connection sizes and locations, and shipping split locations.
3) Materials of construction for housing and major components.
4) Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details and field connection details.

5) Submit step by step assembly instructions as part of the unit submittals. The assembly instructions shall detail each step of the assembly process along with the required field issues needed to maintain unit quality.

6) Submit, as part of the submittals, a unit assembly plan which details the order in which the panels and components will be assembled based on this particular project. Generic assembly plans are not acceptable. Assembly plan must be project specific.

**AFTER PURCHASE**

Make submittals in accordance with requirements of conditions of purchase. Submittals shall show Buyer’s purchase order number, equipment number and project number. Information shall include, as applicable, but not be limited to the following:

1) Information submitted with quotation, revised and expanded as required; including airborne and transmitted sound power levels by octave band for unit.
2) Fan manufacturer and performance curves with the operating points clearly indicated. Motor sizes and types.
3) Coil selections with sizes rows, fin spacing, face velocity, air & fluid temperatures, flow rates, air & fluid pressure drops, and connection sizes.
4) Proposed filters indicating size, efficiency, and pressure drop.
5) (If applicable) Electrical data, wiring diagrams, and accessory panel layouts. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
6) (If applicable) Factory testing procedures for review and acceptance.

**AFTER RECEIPT OF APPROVED DRAWINGS**

Submit manuals with detailed description of installation, operation, and maintenance, including the following:

1) All approved “Certified for Construction” drawings.
2) Written recommendations for field storage, both indoors and outdoors.
3) Installation requirements including assembly instructions, lifting requirements and adjustments.

4) Manufacturer’s literature describing each piece of equipment including operation instructions with step by step preparation of starting, shutdown, and draining and maintenance instructions including lubrication.

3.1.4. Product cleaning, delivery, storage and handling

Thoroughly clean equipment, components and subassemblies of water, dirt, debris, weld splatter, grease, oil and other foreign matter prior to shipment.

The manufacturer shall design base sections, components and component crating to allow rigging in via the space available. Coordination of component size limitations shall be the responsibility of the equipment manufacturer.

Components shall be crated to minimize construction space requirements. Construction space is limited and the manufacturer shall design the unit crating to respect this limitation. Specifically, the manufacturer shall crate wall sections and necessary wall assembly components in individual crates allowing for assembly from one crate at a time.

Units delivered with scratched, dented, or dirty surfaces or damage of any type shall be restored to “as new” condition as directed by the Architect, Engineer, Owner at no cost to Owner.

If equipment is to be stored before use, shipping protection provided by the unit manufacturer shall remain on the unit until the unit is installed. Manufacturer shall submit written recommendations for field storage.

Provide non-corrosive nameplate permanently attached to the equipment containing the following information:

1) Manufacturer’s project/serial number
2) Plant name and location
3) Customer equipment number
4) Date of manufacture
3.1.5. Warranty

All equipment, materials, and workmanship shall be warranted for (12) months from startup or (18) months from shipment, whichever period expires first. During the warranty period, the manufacturer shall repair or replace, at no additional cost to the Owner, any equipment, material, or workmanship in which defects may develop.

Warranty is for parts only; labor to remove or reinstall parts is the responsibility of others.

Unit casing and structural base shall be warranted against corrosion or failure under normal operating conditions for a period of forty (40) years from the date of unit delivery.

3.2. Products

3.2.1. Manufacturers

Provide air handling units as manufactured by: Air Enterprises (add others; consult AE for preferences)

Alternate pricing based on pre-approved manufacturers will be considered if the following performance requirements and construction techniques are adhered to in all respects. Any substitutions shall be approved by the Architect, Engineer, and Owner in writing ten (10) days prior to bid.

The unit manufacturer shall have been manufacturing custom built-up air handling units for a minimum of 20 years.

3.2.2. Custom built-up Air Handling Units

Custom built-up units shall be of the configuration, capacity and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured.

The units shall be constructed for (select) indoor / outdoor installation. (If outdoor chosen) Outdoor units to be provided with weatherproofing (roofing, guttering, etc.) as defined herein. The units shall be factory built, field assembled. The construction shall be a factory designed, factory fabricated, field assembled. The unit manufacturer shall be completely responsible for the unit installation.
The units shall consist of: (develop appropriate listing) intake sections for return and outside air, mixing section with dampers for outside air, return air and exhaust air, pre-filter section, final filter section, heating coil section, cooling coil section, humidifier section, supply and return fan sections, diffuser section, and discharge section.

Unit shall employ aluminum material (panels, bases, supports, sating, etc.) to reduce overall unit weight and minimize facility maintenance requirements.

Provide saving between internal components and unit casing to prevent air bypass. Saving material shall match unit interior. All seams or voids between saving, components and unit casing shall be caulked and sealed airtight.

Provide hygienic unit design with interior suitable for washing down. The use of support members framed within the unit casing which will allow for trapping of debris between the supports and casing will not be allowed. Unit insulation must be completely encapsulated.

The unit sizes shown on drawings are established based on unit performance, structural, and access requirements and are not to be altered.

3.2.3. Unit base

The unit shall be constructed on an all-aluminum or stainless steel structural base. The base shall be designed to distribute loads properly to a suitable mounting surface and be braced to support internal components without sagging, pulsating or oil canning.

The unit base shall be provided with sloped sumps in areas as indicated on the drawings. Sumps to be welded and guaranteed waterproof to serve as a drain pan to prevent building water damage from the unit. Sump to be double-sloped (min. ¼” per foot) towards units drains to positively remove condensate from the unit.

The base floor shall be minimum 3/16” thick aluminum plate welded at all joints and to structural members. Floor material shall have smooth / safety-tread surface. The base floor shall be designed for a minimum live load of 100 pounds per square foot throughout the unit. The base floor is to be supported with adequate stiffening members to prevent oil canning. Caulking, gaskets and mechanical fasteners to guarantee seals and water tightness of joints will not be acceptable.
Base shipping splits shall be provided as needed based on unit rigging limitations. Shipping splits shall be designed with a raised flange for connecting of base sections. The raised flange shall allow the base sections to be bolted together and maintain a minimum of 2” deep slump. Base joining methods that require field welding are not acceptable.

The perimeter support members shall be properly sized to support all major components and the housing during rigging, handling and operation of the unit.

The underneath side of the base pan and base perimeter shall be insulated with minimum 2” thick 1.5-pcf high density polyisocyanurate foam insulation to form a vapor barrier. (optional – outdoor units) Vapor barrier is then protected by a 0.040” thick aluminum sheet attached to the bottom of the base.

Each section of the unit base shall contain a minimum 1” NPT drain to facilitate system wash down, maintenance and condensate removal. Areas in the base where potential standing water cannot be removed through drains or weep holes are not acceptable. Clean out drains shall be provided with removable caps of non-corrosive material.

All equipment within air handling unit shall be provided with a minimum 2" high base to raise equipment off unit floor for housekeeping. Equipment mounted directly on unit floor is unacceptable.

Supply air openings to be framed with 2” high water dam continuously welded to the pan to allow proper duct connections and to prevent moisture from entering the openings. Framed openings shall be provided with removable aluminum or 304 stainless steel grating designed and fabricated for a live load of 100 pounds per square foot. Galvanized or painted steel grating will not be accepted.

All unit base service openings shall be framed with a minimum 2” high water dam continuously welded to the floor. All pipe and electric conduit chases with openings to building or elements shall be covered with thin gage aluminum or 304 stainless steel. Penetrations by contractors shall be sealed by the respective contractor.

Fastening to floor plate or joining of unit sections to be accomplished by bolting through casketed joints above the floor line or continuously welding. Fasteners which penetrate base floor plate are not acceptable.

Unit to be provided with properly located permanent lifting plates or removable lifting lugs for each section to adequately allow rigging of the unit sections in place.
3.2.4. Unit casing

Air handling unit casing shall be built up from the unit base or floor with panels. The unit manufacturer shall be the manufacturer of the panel system. Panels shall be load bearing and capable of forming the enclosure without additional structural members. Panels shall be joined together with independent joining member and fastened with closed end aluminum rivets or stainless steel fasteners. Plated fasteners will not be accepted.

Panel joints and seams shall be sealed with FDA approved sealant. Other sealing methods or materials must be approved by the Architect/Engineer/Owner in writing before application.

All panels shall be double wall all-aluminum construction with minimum 0.040" exterior and interior skin thicknesses. Interior finish to be smooth, mill finish; exterior finish to be a low-reflective textured mill finish. Each panel shall contain an integral frame or be properly supported by a structural framing system. Panel shall have continuous tight seal at the interior and exterior skins completely encapsulating the insulation.

The minimum panel thickness shall be 2-1/2" thick with 3-pcf high density (select) fiber / polyisocyanurate foam insulation. The panel R value shall be a minimum of 12 or greater.

Thickness of the panel skin, core density, rib structural frame spacing shall be regulated to eliminate panel pulsation and restrict the maximum deflection to 1/200 of any span at design load of 1-1/2 times the design positive or negative pressure plus snow and wind loading.

Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. Leakage to be guaranteed at no more than 1/2% of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater.

All casing walls shall be of panel construction, including but not limited to the fan discharge walls, mixing section walls and divider wall to the access corridor.

Any equipment flashing, internal partitions or other attachments to the casing shall be made in such a way as to ensure a permanent leak-tight connection. Attachments that are bolted, screwed, or welded to or through the casing creating air bypass, air leakage or rust propagation areas are not acceptable.

All ductwork penetrations through unit enclosure shall be provided with framed openings of size and arrangement as indicated on drawing. (optional)Openings to
be provided with flanged duct connections of same material as casing interior extending a minimum of 4” from surface of unit casing.

Pipe and conduit penetrations through the unit casings shall be provided by the unit manufacturer and be properly sealed prior to leaving the factory. Penetrations sealed by simply caulking around extension are not acceptable.

Provide minimum 24” wide access doors for access to all internal components. Access doors shall be installed to open against the greatest pressure relative to air pressure on each side of access door.

Removable access panels shall be provided as indicated on the drawings for service and maintenance. Access panels shall be of the same construction as panels described above. Removable access panels shall be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels. Air tight integrity must be maintained.

3.2.5. Outside air direction

Outside air shall be admitted and exhaust air shall be discharged through storm-proof, extruded aluminum or stainless steel louvers, minimum 3-1/2” deep with aluminum or stainless steel bird screen and aluminum or stainless steel weather hoods. Weather hood exterior to match the finish of the unit casing.

Louver shall have AMCA certified air performance and water penetration ratings.

Louver to be provided with a low-leakage outside air damper. Dampers shall be as specified below and shall be furnished and installed by the unit manufacturer.

Outside air intake shall be sized for a maximum of 450 fpm. Exhaust air discharge shall be sized for a maximum of 750 fpm.

3.2.6. Mixing section

Complete with framed openings with low-leakage outside and return air dampers. Dampers shall be as specified below and shall be furnished and installed by the unit manufacturer.

Mixing section shall be designed for controlled mixing in that the proximity, relation, and air velocity for each respective damper shall be such that volume swings and stratification will be eliminated.
Outside air damper banks incorporating minimum outside air to be provided with an independent damper with independent control for minimum outside air. Minimum outside air provided by controlling outside air damper bank to a minimum position will not be acceptable.

3.2.7. Dampers

Dampers shall be low leakage, opposed blade design capable of withstanding 8” wg differential pressure at 2,000 fpm approach velocity. Leakage rate not to exceed 6 CFM per ft.$^2$ at 4” wg differential pressure and 2,000 fpm approach velocity.

Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and flexible synthetic blade edge seals.

Damper actuators to be mounted by unit manufacturer. Damper actuator to be Johnson Controls - model D3153 or equal. Actuators for dampers with modulating control to be provided with pilot positioners.

3.2.8. Supply and return fan sections

Provide fans, motors and drives of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications.

Fan sections shall be complete with DWDI, arrangement 3, centrifugal fans as per the following:

1) Fan housing shall be heavy gauge construction with spun inlet cones. Housings shall be suitably braced to prevent vibration or pulsation. Scroll housing shall be connected to side plates with a high quality air tight seal; seam shall be continuously welded as required for application. Bearing supports shall be rigid and shall provide a firm foundation for the shaft and bearings. Bearings supported from the fan housing will not be acceptable.

2) Fan wheels shall be non-overloading, airfoil type. Impellers shall be statically and dynamically balanced to a level of G6.3 (per ANSI 2-19) or better. Hubs shall be straight bored, keyed and set screwed to the shaft. Shafts are to be solid steel sized for first critical speed of at least 1.25 times the maximum speed for the class for class I and II fans and 1.42 times the maximum speed for class for class III and IV fans.
3) Bearings are to be heavy duty, grease lubricated, anti-friction, self-aligning, pillow block type and selected for minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum class RPM. All bearings shall be equipped with regreaseable Zerk fittings and lubrication lines extended to accessible location on fan housing for easy access for lubrication.

4) Fan shall be provided with heavy gauge wire inlet screens, housing access door, and scroll drain as required. In the event inlet vanes are provided, fan will not require inlet screens.

5) Fan shall be cleaned, prime coated and provided with two coats of enamel final coat.

6) Each fan shall be test run at their operating speed or at the maximum RPM for the particular fan's construction class prior to shipment. The fans are to be balanced and records maintained of the readings in the axial, vertical, and horizontal direction on each of the fan's bearings. Final peak velocity measurements shall not exceed 0.1 in/sec.

7) (Optional) Fans shall be designed with split housing to allow for field disassembly & re-assembly.

Motors shall be 1750 RPM, 460V/3ph/60Hz as per the following:

1) Motor shall be premium efficient, (select) ODP / TEFC enclosure.

2) Motor shall be of HP as listed on schedule and be selected for a minimum of 10% over calculated BHP. The motor service factor shall be a minimum of 1.15. (Substitute for arr. 4 direct-drive)Motor shall be of HP listed on schedule; selected to provide adequate torque throughout entire range of fan operation and not exceed nameplate HP when fan operates at synchronous motor speed.

3) Motor shall be designed for continuous duty operation, NEMA Design B with class F insulation.

The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.

Motors shall be “Inverter Ready” per NEMA Std. MG1 part 31.4.4.2 and labeled as such.

Provide stainless steel nameplate indicating the following:

a) NEMA efficiency index nominal efficient (MB1-12.53BO).
b) AFBMA bearing numbers.
c) Lubrication instructions.
The entire fan assembly shall be provided with a minimum of 18" clearance on all unattached sides for proper service access. Fan inlets to be provided with a minimum clearance distance equal to 75% of the wheel diameter.

The unit manufacturer shall provide flexible connection between fan and fan wall. Fan assembly shall be provided with thrust arrestors as required to prevent damage to the flex connection. Flex connection material shall be flame retardant fabric suitable for intended use meeting the requirements of NFPA 90A.

3.2.9. Air flow measurement

Provide as indicated on the accompanying plans, airflow measurement provision and transmitters for the purpose of continuously monitoring unit airflow volume.

The airflow measurement system shall consist of a piezometric flow ring incorporated into the inlet of the fans. Ring shall consist of a minimum of four orifice ports strategically located in the throat of the fan inlet; orifice taps to be piped with tubing in a continuous ring. Tubing to be extended to accessible location for connection to flow transmitter.

Piezometric ring to be provided integral with the fan construction.

3.2.10. Filter sections

Provide all pre-filters and final filters of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications. Filters to be selected for a maximum face velocity of 500 fpm.

Filters shall have nominal rating of 500 fpm. Each cell shall be 24" x 24", or 12" x 24". Initial pressure drop shall not exceed that indicated. Media shall be approved and listed as Underwriters Laboratories Class 2 when tested according to UL Standard 900 and as described below:

1) **Pre-filters**: 2" thick MERV 7 efficiency (per ASHRAE Test Standard 52.2-2007), and MERV 12 (per ASHRAE Test Standard 52.2-2007), rigid disposable filters.

2) **Final Filters**: 12" rigid type, MERV 15 (per ASHRAE Test Standard 52.2-2007), rigid disposable filters.

3) **HEPA Filters**: 99.97% (when tested with 0.3 micron thermally generated particulates) high capacity HEPA filters tested and certified.
Filters shall be upstream removable. Side access is not acceptable. Pre-filter sections shall be complete with holding frames capable of holding pre-filters with high efficiency filters. Pre-filters shall be capable of being removed and installed without affecting seal of the high efficiency filter.

Filter frames upstream of cooling coils or humidifiers shall be galvanized steel construction; stainless steel or aluminum construction required for locations downstream of cooling coils or humidifiers. Frames to be provided with closed cell neoprene gasketing and all associated clips required to hold filter cells.

Filter holding frames shall be installed and individually sealed to prevent leakage around frames. Filter banks shall be reinforced with vertical stiffeners to assure rigidity. Unit manufacturer shall provide flashing between filter banks and unit casings to prevent air leakage or bypass around the frames. Installation techniques, sealing methods, and structural reinforcement eliminate unfiltered air bypass and assure system cleanliness based on filter efficiencies specified.

Unit manufacturer shall provide and install a Dwyer series 2000 magnehelic gauge complete with stainless steel static pressure tips and accessories for indicating the operating pressure drop of each filter bank. Indicating range of gauge shall be selected at two times the final resistance of the filter bank.

Unit manufacturer shall provide xxx (x) sets of pre-filter media and xxx (x) sets of final filter media, (optional) and one (1) set of HEPA filter media with the unit for installation by others.

A filter removal ladder and access platform shall be provided. The platform and ladder shall be designed to fit in the space available and shall allow simple access to all of the elevated filters. The platform and ladder shall be on a slide rail to allow for safe movement while on the platform. Provide platform’s and ladders as necessary to access all filters without having to move the platform & ladder between sections. The platform and ladder shall be constructed of an aluminum ladder and stainless steel platform.

3.2.11. Cooling coil section (chilled water)

Provide chilled water cooling coils of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications. Coils to be selected with maximum face velocity of 500 fpm; maximum head pressure loss of 20 ft.
Chilled water coils shall have minimum 0.025" thick, 5/8" diameter, copper tubes, 0.0075" (select) aluminum / copper fins, nonferrous headers with min. 1/2" dia. MPT drain and vent connections. Coil casings shall be minimum 16 gauge 304 stainless steel. Coil fin spacing shall not exceed 10 fpi.

Coils shall be circuited to provide the required performance; the use of internal restrictive devices, or turbulators, to obtain turbulent flow will not be acceptable.

Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.

Coils shall be individually supported by a stainless steel rack system. This rack shall allow any one (1) coil to be removed though the unit casing, normal to the direction of air flow, without disturbing any other coil. Coils stacked one on top of the other will not be accepted.

Each coil shall include a sloped, positive-draining stainless steel condensate pan assembly. Drain pan to be constructed from minimum 18 gauge 304 stainless steel material. Coils shall set above the condensate pan for ease of removal. Intermediate condensate drain pan shall be minimum 1-1/2” deep; extending at least 3” upstream and at least 12” downstream of the coil face. Each drain pan shall be individually piped down to the bottom pan; lower drain pan to be provided with a drain connection of sufficient size to remove condensate extended to the unit exterior for connection by others.

Where necessary to prevent moisture carryover, each coil shall have aluminum or stainless steel moisture eliminators provided on the downstream side. Cooling coils condensate pans shall be designed and manufactured to incorporate future eliminators without any field modification.

Supply and return connections are to be extended and sealed through the casing wall; drain and vent connections shall be terminated internally. (optional) piped with ball valves and hose bibs for the drain.

Provide removable access panels in the unit casing on each side of the unit for ease of coil removal.

3.2.12. Heating coil section (hot water)

Provide hot water heating coils of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications. Coils to be selected with maximum face velocity of 550 fpm; maximum head pressure loss of 15 ft.
Coils shall have minimum 0.020" thick, 5/8" diameter, copper tubes, 0.0075" (select) aluminum / copper fins, nonferrous headers with min. 1/2" dia. MPT drain and vent connections, and aluminum coil casing. Coil casings shall be minimum 16 gauge galvanized steel; aluminum or stainless steel casings required for coils located downstream of cooling coils or humidifiers. Coil fin spacing shall not exceed 10 fpi.

Coils shall be circuited to provide the required performance; the use of internal restrictive devices, or turbulators, to obtain turbulent flow will not be acceptable.

Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.

Coils shall be individually supported by an all-aluminum rack system. This rack shall allow any one (1) coil to be removed through the unit casing without disturbing any other coil.

Supply and return connections are to be extended and sealed through the casing wall; drain and vent connections shall be terminated internally. (optional) piped with ball valves and hose bibs for the drain.

3.2.13. Humidifiers

Provide panel type, steam dispersion humidifier designed for short absorption distribution of size, arrangement, and capacity as required for air handling system indicated on drawings and as stated in these specifications. Multiple dispersion tube type distribution will not be acceptable. Humidifier panel to be selected with maximum face velocity of 650fpm.

Absorption distance shall not exceed 24" at desired conditions. Air handling manufacturer shall be responsible for proper absorption distance for steam between humidifier and downstream components.

Dispersion panel to be provided with stainless steel casings. Panel to be mounted on a stainless steel support structure with stainless flashing between humidifier and casing walls to prevent air bypass.

Steam supply and condensate return connections are to be extended and sealed through the casing wall. The condensate connections shall be a minimum of 18" above the unit base to allow for proper trapping; if required, condensate trap to be installed by AHU manufacturer internal to unit.
Humidifier is to be provided with pneumatic or electric operator with pilot positioned, F&T traps as required and Y-type strainer for steam supply line.

3.2.14. Sound attenuators (silencers)

Sound attenuators sections shall be complete with individual battens the full height and full width of the section in order to provide uniform leaving air velocities and lower pressure drops. Modularized sound attenuator assemblies with horizontal air restrictions are not acceptable.

The battens shall be of aluminum construction; filled with a fibrous inert core. Each batten shall consist of a solid aerodynamically styled nose piece with parallel perforated walls. Core material is to be covered with a tight weave cloth to prevent out-migration of fiber materials into the airstream; covering shall be porous material not diminishing the attenuating properties of the attenuators. Unit manufacturer shall guarantee lining cloth provided prevents out-migration of fibers.

The attenuator manufacturer shall have published literature documented by independent test laboratories for acoustic performance of the sound attenuators.

Custom air handling unit inlet and outlet airborne sound power levels and radiated sound pressure levels shall be guaranteed to meet the specified sound levels and shall be the responsibility of the unit manufacturer.

3.2.15. Unit discharge (extractors)

Discharge section with exit velocities exceeding 2000 fpm shall be complete with aerodynamically designed framed discharge openings or spun bellmouth fittings in order to reduce overall system static pressures.

Bellmouth fittings shall have minimum radius equal to 20% of the diameter (round or oval) or shortest side (rectangular) to provide optimum performance. Bellmouths with radius less than 2” are not acceptable. Bellmouth to be mounted flush with unit interior edge to minimize exit loss.

Openings shall conform to the size and configuration of the ductwork where shown.
Smoke dampers shall be furnished and installed by the unit manufacturer for supply air (and return air) openings as shown on the drawings. Dampers shall be as specified below:

1) Dampers shall be parallel blade design capable of withstanding 8” wg differential pressure at 2,000 fpm approach velocity. Damper shall meet requirements of Leakage Class II.
2) Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and flexible synthetic blade edge seals to keep leakage to a minimum.
3) Damper linkage to be concealed in frame channel outside of the airstream. Dampers shall be provided with extended shaft for connection to actuators.
4) Damper actuators to be mounted by unit manufacturer. Provide a minimum of one pneumatic damper actuator per 16 ft² maximum damper area. Damper actuator to be Johnson Controls - model D3153 or equal. Actuators for dampers with modulating control to be provided with pilot positioners.
5) Smoke dampers and operators shall be qualified under UL555S to a minimum elevated temperature of 250°F.

Provide a 3KW 3/60/460V electric unit heater with wall mounted thermostat for maintaining a minimum of 50°F temperature during winter operation. Provide factory mounted and wired heater, disconnect switch and thermostat. Provide ventilation for removing heat of variable speed drives and other devices within the vestibule.

The service corridor shall provide for floor supporting of field piping installations. The support structure shall include a means for pipe hangers to be attached to supporting members. The support members shall be three feet on center and sized to support a uniform piping load of 250 lbs./ft.
3.3. Execution

3.3.1. Installation of Air Handling Units

Unit manufacturer shall be responsible for the complete installation of the air handling unit. The unit manufacturer shall coordinate with other trade contractors, all necessary requirements to assure proper air handling unit installation.

Unit manufacturer shall coordinate exact quantity and locations on casing penetrations. All penetrations shall be sealed.

The unit manufacturer shall coordinate unit shipping and installation schedule with mechanical contractor.

Mechanical contractor shall make all final ductwork and piping connections required for a complete operating system.

Unit manufacturer shall provide all conduit, fixtures, motor wiring and lighting within unit.

The temperature controls contractor shall install temperature controls and panel, including, control wiring, etc., required for a complete and operating control system. Electrical contractor shall make final connections to the temperature control panel after the unit is installed.

Coordination: Coordinate with other work, including ductwork, piping, and controls as necessary to interface installation of air handling units with other work.

Access: Provide access space around air handling units for service as indicated and/or required, but in no case less than that recommended by manufacturer.

Drain Piping: Provide trapped copper drain line for indoor air handling units from each drain pan connection and run drain line to nearest floor drain or floor sink. Trap shall be constructed with depth as indicated on the drawings to provide proper coil drainage.

Piping Connections: Refer to Division-15 Section "Hydronic Piping" and/or "Steam and Condensate Piping". Provide piping, valves, accessories, gages, supports, and flexible connectors as indicated.

Duct Connections: Refer to Division-15 Specification Sections containing ductwork and accessories. Provide ductwork, accessories, and flexible connections as indicated.

Grounding: Provide positive equipment ground for air handling unit components.
3.3.2. Field quality control

FIELD UNIT TESTING: Unit manufacturer shall provide tests to insure structural integrity, as well as compliance with this specification.

Fan Vibration Testing: The unit fan assembly including the base, spring isolators and fans shall be operated at the design RPM and a complete vibration spectrum shall be conducted. Such tests shall be performed on a completely assembled unit including all components. Readings shall be taken in the horizontal, vertical, and axial direction at each fan and motor bearing. This test shall be conducted at the factory before shipping and in the field.

Basin Leakage Testing: The basin shall be tested for leakage. The base sections shall be filled with 2” of water for 24 hours. Any leaks shall be repaired and the basin re-tested.

Coil Pressure Tests: The heating and cooling coils, as well as any other piping included with the air handling units shall be pressure tested at 150 PSI for minimum of 1 hour.

Electrical System Tests: The entire electrical system shall be functionally checked including motors, lights, utility outlets, etc. for proper operation.

Unit Performance Test: Unit manufacturer shall demonstrate that the actual performance matches scheduled unit performance by testing and operating unit at the design conditions; simulating external static pressure (providing for dirty filters and wet coils). Test shall include measurements of CFM, BHP and RPM at design TSP.

Casing Leakage Test: The casing leakage test shall verify that unit casing leakage is less than 1/2% of design air flow at 1-1/2 times the design static pressure. The unit shall be sealed; pressure sections shall be put under positive pressure and suction sections shall be put under negative pressure. The leakage shall be measured in each section using a calibrated orifice plate. The total casing leakage (positive plus negative) shall be considered the sum of the positive and negative leakage.

Failure to pass leakage test will subject the AHU manufacturer to penalties based on the total summation of energy cost for the additional casing leakage above 1/2% extended thru a 10-year operating period up to a maximum of 5% of the air handling unit value.

Sound Test: The assembled air handling unit shall be field tested for sound power at the unit inlet and outlet; and sound pressure level at a three (3) foot
distance from the unit casing. The sound power level shall be verified through actual measurements and calculations in accordance with AMCA Standards 300 and 301. During test, unit shall be isolated from background noise and vibration or tested during periods when background noise and vibration are at a minimum.

Field testing shall assure the Owner and Engineer that any potential system performance concerns are addressed before owner acceptance. Any unit modifications necessary as a result of field testing not meeting specified performance levels shall be done by the unit manufacturer at no additional cost to the owner prior to unit acceptance.

The Owners representative/Engineer shall have the option to witness all tests. The manufacturer shall notify the Owners representative/Engineer two weeks prior to the scheduled tests.

A formal written report including test results shall be submitted to the Owner / Engineer.

3.3.3. Start-up and owner orientation

Equipment start-up and owner maintenance orientation shall be the responsibility of the unit manufacturer in order to activate equipment warranty and assure that the Owner and his facility personnel are comfortable and familiar with equipment maintenance. Manufacturer shall include a minimum of two (2) man days and one (1) trip for start-up and owner maintenance training and orientation.

The air handling unit manufacturer shall be responsible for proper operation and shall be required to meet the scheduled capacities and specified performance for this equipment.