

## **VOLUME 3 – TECHNICAL SPECIFICATIONS**

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# 1 Background Information

## 1.1 Programme Background

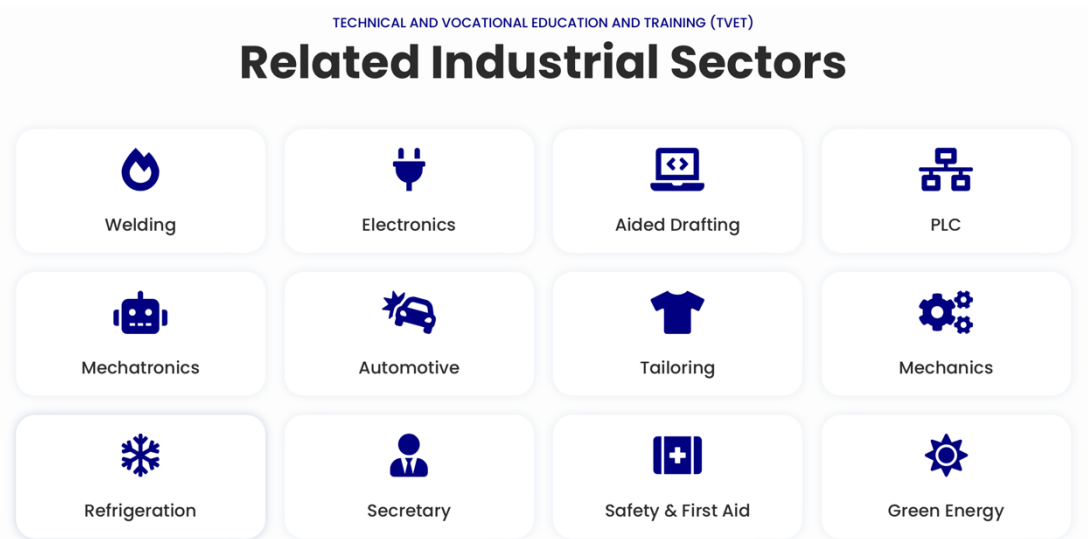
The Multi-Educational Programme for Employment Promotion in Migration-affected Areas (MEPEP) falls under the scope of the “Enhancing the Response to Migration Challenges in Egypt Programme (ERMCE, Ref. T05-EUTF-NOA-EG-01) which is funded by the European Union Emergency Trust Fund for stability and addressing the root causes of irregular migration and displaced persons in Africa.

The MEPEP Programme is aligned to the Operational framework of the EU TF North Africa Window (EUTF NAW), is implemented by the Italian Agency for Development Cooperation (AICS) in the frame of the Contribution Agreement T05-EUTF-NOA-EG-01-06 (T05.255), with a planned three-year duration.

The Programme aims at enhancing economic and equal opportunities, in particular for vulnerable groups by improving the quality of the Technical and Vocational Education and Training (TVET) system in Egypt.

The Programme will be implemented in Sharkeya Governorate as its target area in consultation with local authorities. Sharkeya –is indeed one of the Governorates in Egypt that boast the largest number of Egyptian youths who wish to leave Egypt and illegally migrate to other countries. Secondly, the 10th of Ramadan Industrial Zone resulted being the most relevant intervention area due to the presence of a dynamic Egyptian and non-Egyptian industrial force on which the creation of a high-level and market-oriented TVET Centre can have the major impact. This area hosts the 10th of Ramadan Training Centre belonging to MoTI’s Productivity and Vocational Training Department (PVDT) that will be the target of the activities. This Technical School was chosen during the formulation phase by AICS Cairo together with the local Authorities.

Twelve are the identified sectors of intervention, as below described:



The Italian Agency for Development Cooperation (AICS) - Cairo Office will work in close cooperation with the Ministry of Education and Technical Education (MoETE) and the Ministry of Industry and Trade (MoTI), namely the Productivity and Vocational Training Department (PVDT), as the main national entities mandated in the area of TVET.

## 1.2 Overall Objective

The overall objective of the Programme MEPEP - Multi-Educational Programme for Employment Promotion in Migration-Affected Areas of which this contract will be a part is as follows:

- fostering more inclusive social and economic environment and stability in the region (in line with the European Union Trust Fund - North of Africa Window Strategic Objective 4), by fostering employment and income generation through TVET (Technical and Vocational Education and Training) enhancement;
- improving the TVET system quality in the industrial field respectively in terms of teaching methodologies for teachers and trainers and skills acquisition for students and promoting job placement and creating synergies with the industrial stakeholders at the national and local level;
- enhancing economic and equal opportunities, in particular for vulnerable groups by improving the physical and technical infrastructure and the physical and technical equipment of the Technical and Vocational Education and Training system in Egypt. The 10th of Ramadan Vocational Training Centre belonging to Ministry of Trade and Industry's Productivity and Vocational Training Department is the target of the activities of the Programme.

### 1.3 Purpose of the Contract

The purpose of this contract is the refurbishment of the existing buildings and all the relevant classrooms, laboratories and workshops and the design and build a new building at the 10th of Ramadan Training Centre to transform it in a new modern Vocational Training Centre in Sharkeya Governorate taking in consideration the need for people with disabilities.

Regarding the new building, it has to be built as a modern ECO-System edifice that meets environmental friendly requirements.

The refurbishment of the existing buildings shall cover the following services:

- Civil/Architectural Works
- Electrical Works
- Mechanical Works

### 1.4 Site Layout

- 1 Classrooms and offices building
- 2 Workshops and classrooms building
- 3 Laboratories and classrooms building
- 4 New ECO-System building
- 5 Playground
- 6 Mosque
- 7 Utilities



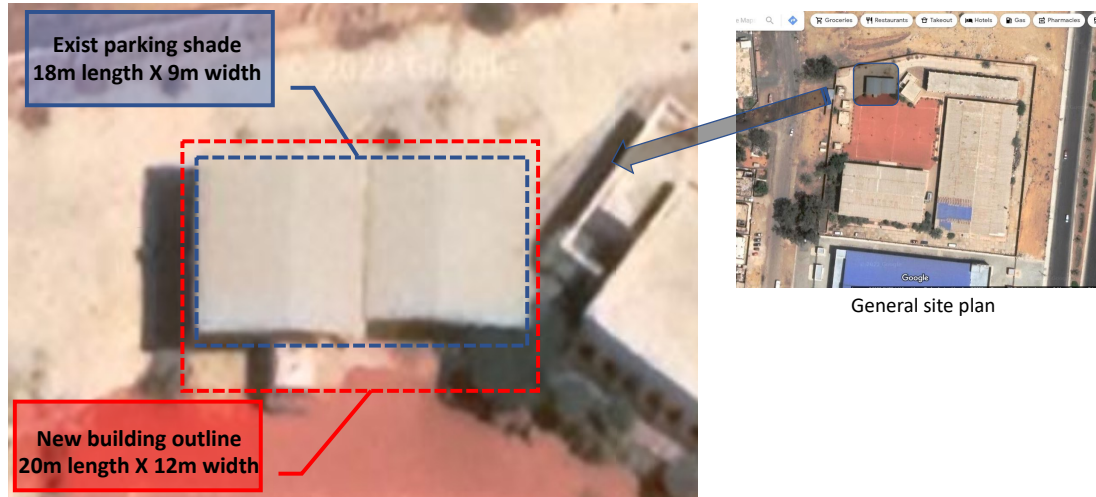
### 1.5 Description of the new ECO-System building

Peculiarity of the new ECO-System building is that several environmental friendly features must be adopted during its construction.

The new ECO-System building shall be located beside the mosque facing the playground area, with approximately built-up area of at least 350 sqm and at least 2 floors (ground + 1st floor + roof).

The footprint of the new building is about 240 sqm (20m length, 12m width) and it must consist of the following:

- 3 labs
- 1 office
- 1 classroom
- stair(s)
- elevator(s)
- WCs



## 1.6 ECO-System building environmental friendly features

Table below describes the minimum set of environmental friendly features to be adopted for designing and building the new ECO-System. Tenderers are encouraged to propose and implement more features.

Environmental friendly features	Description
<b>Architectural</b>	
Building orientation in site plan according to sun direction and air flow direction.	Apply green building rules in design processes to get large amount of natural lighting and fresh air thus reducing the usage of artificial lighting and air conditioning.
Designing the building windows on elevations, to get a suitable lighting amount to the internal spaces.	Apply green building rules in design processes to reduce the artificial lighting usage at day time.
Adopting double glass windows with a suitable heat isolation layers.	Reduce the amount of heat transferred into the building at day time.
Using ready made composite sections in exterior walls for more heat isolation.	Reduce the amount of heat transferred into the building at day time.

Planning a roof Garden.	Reduce the amount of heat transferred into the building from the roof surfaces.
<b>Electrical</b>	
All lighting fixtures shall comply with sustainability and energy saving by using highly efficient low-power LED lamps.	LED lamps reduce the power consumption by 25% from lighting loads.
Installing a PV on grid system.	Reduction in electrical power consumption and gain sustainability and green environment goals.
<b>Mechanical</b>	
Using treat graywater for toilets.	Collect and treat graywater and reuse it for toilets flush fixture leads to reduce the water consumption.

## 2 Scope of Work

### 2.1 General and Site

#### **Tender Phase:**

- A Pre-Concept Design shall be an integral part of the contractor Proposal. The contractor must submit a pre-concept design showing the outlines of his design and the execution plan of the works, along with an introduction of the ECO-System description and way of execution.

#### **The following items shall be part of the contractor scope of work:**

- The contractor is responsible and committed to review all tender documents, and to submit a stamped copy to the PMU before the beginning of the works;
- The contractor shall submit his concept design up to the detailed design with full Bill of Quantity for all project components to the supervisor for approval;
- The contractor is committed to submit for approvals to the Supervisor all workshop drawings, samples of all the materials or items needed to complete the project for submittal by the engineer in charge and from the supervision committee before starting the works;
- The contractor is committed to submit to PMU approved copy of the as-built drawings of all project components and to be approved by the consultant;
- The PMU can at anytime review and supervise the work progress and submit his comments at any time as deemed necessary for better completion of the works;
- The PMU can at anytime request Materials Test, and the contractor along his staff shall provide all the facilities needed.

#### 2.1.1 Civil Site Plan

The external corridors will be prepared and equipped in the public site to be suitable for the use of students as well as those with special needs.

Landscape
Supply and installation of interlock flooring 10x20x10 cm for pavement technocrete, samcrete or equally approved including all the under layer sand and 10 cm screed beneath. - For all the external pavements between buildings. - <b>Approx. quantity about 1500 m<sup>2</sup>.</b>
Per meter length, supply and installation of cement curb stone 15x30x50 cm for paving according to standard specs. - For all the external pavements between buildings. - <b>Approx. quantity about 2000 m<sup>2</sup>.</b>
Supply and apply artificial grass rolls for the playground, including removing the playground sand and using it in filling of the new constructed building, the grass rolls specs are: - height: uniformity and adequate height, varying between 30-37 mm - gauge: distance of the tufting lines, comes in 3/4 inch, 5/8 inch, 3/8 inch, and 3/16 inch also including the treatment and leveling of the underlay after removing sand and prepare it for installing the roll sheets and the curbs all over playground perimeter. - <b>Playground area 2000 sqm (40 x 50 m).</b>
Mobilization
Preparing site for all construction purposes, making sure of the safety of all the buldings users, preparing places of material storages with coordination with owner. <b>As refer in division no. 31 and 41 of the Engineering Technical Specification</b>
Landscape

Excution of all the landscape excavation, filling and finishing according to Egyptian specifications and industry assets.

**As refer in division no. 31 and 41 of the Engineering Technical Specification**

### 2.1.2 Electrical Site Works

Strengthening the intensity of illumination in site, by replacing or doing the necessary maintenance for the existing lighting fixtures and increasing the number of lighting fixtures as required according to lux level calculations respecting engineering illuminating society (IES) code or Egy code.

<b>Lighting System</b>
Repair, connect, test and put into operation approximated number 25 of outdoor lighting fixtures, complete with all lamps, capacitors, electronic ballasts, terminations, components, wires, fittings, outlet, boxes, conduits, ..., all accessories and all related ancillary works. See fig (01). See engineering technical specification item number (26 56 29).
Supply, install, connect, test and put into operation approximated 35 items of outdoor lighting fixtures, complete with all lamps, capacitors, electronic ballasts, terminations, components, wires, fittings, outlet, boxes, conduits, ...,ets all accessories and all related ancillary works. See fig (01). See engineering technical specification item number (26 56 29). Strengthening the intensity of illumination by doing the necessary maintenance for the existing lighting fixtures in the site, increasing the number of lighting fixtures as required, lighting system considering using high power efficient power LED lamps according to lux level calculations (IES) code or Egy.code. The installation of lighting fixtures shall be according to Egy.code.
<b>Panel board modifications</b> See engineering technical specification item number (26 24 16).

### 2.1.3 Mechanical Site Works

- Fire hose cabinet class 3 should be installed in general site according to NFPA 14
- The pump room should be replaced and install new one, the design and calculation according to NFPA 20
- All pipes and fittings for water tank should be replaced

<b>Fire Fighting</b>
Repairing, testing and commissioning of firefighting pump set according to NFPA-20 standards. - <b>Approx. 2 Items</b> See fig (01). See engineering technical specification item number (213113) and (213116)
Repairing, testing and commissioning of concret fire tank
Supply and installation and commissioning of a dry chemical powder fire extinguishres 6 Kg to secure the site - <b>Approx. 15 Items</b> See fig (02). See engineering technical specification item number (104416).



## 2.2 Building No 01

### 2.2.1 Civil Works (Architectural and Structural)

1. Renovation of the floor with high-quality floors more suitable for educational activities.
2. Complete repaint of interior and exterior walls.
3. Adding an elevator to the building to serve the disabled persons.
4. Renovation of toilets and equipping one of the bathrooms for people with disabilities.
5. Adding gypsum tiles to isolate the interior spaces from the heat of the weather.
6. Change all windows with a new quality that isolates external noise and weather heat.
7. Changing wooden doors for all classrooms and offices.
8. Renovation and maintenance of the external staircase for the upper floor for the convenience, security, and safety of users.
9. Dismantling of the existing top layers of roof corrugated sheets.
10. Erection of the new roof corrugated sheet layer.
11. Applying anti-corrosion protection on outside roof shed.
12. Welding of cantilever sheds.

1. DEMOLITION WORKS
Demolition and removal of the existing floor tiles for all spaces in the first floor in the building, including all floor skirting and move it to the public dump. - Approx. quantity is 1,430 m <sup>2</sup> .
Demolition and removal of the existing floor tiles for all wet area spaces and move it to the public dump. - Approx. quantity is 50 m <sup>2</sup> .
Demolition and removal of the existing wall tiles for all wet area spaces and move it to the public dump. - Approx. quantity is 100 m <sup>2</sup> .
Per lump sum demolition and removal the existing aluminum partitions, including doors, and to be delivered to the owner's stores. - Approx. quantity about 10 units with different dimensions and types.
Demolition and removal of the existing WCs fixtures as toilets, sinks and urinals, ..., and to be delivered to the owner's stores. - Approx. quantity about 15 units with different dimensions and types.
Demolition and removal of the existing steel handrail for the external upstairs (the main building entrance), and to be delivered to the owner's stores. - Approx. quantity about 25 Linear meters with 1 meter height.
Demolition and removal of the existing gypsum board tiles including metal structure, and to delivered to the owner's stores. - Approx. quantity is 500 m <sup>2</sup> .
DISMANTLING OF CORRUGATED SHEETS
Removal of the existing top layer of corrugated sheets for the building roof and delivering it to the owner, making sure not effect the bottom layer, repair and close any opening in the bottom layer to avoid entry of insects and rodents. - Approx. quantity is 1500 m <sup>2</sup> . As refer in division no. 2 and 41 of the Engineering Technical Specification

Dismantling the existing lighting fixtures approximated 67 items and delivering it to the owner.
<b>2. Civil Works</b>
<b>Flooring</b>
Supply and install mosaic tiles (with marble breaks pieces) size 40 x 40 x 3 cm, from an approved sample before installation, provided that the thickness of the non-cement components is not less than 10 mm consisting of (5 part of the marble pebble Bchino + 2 part Boudreau welding + 3 part white cement) while the cement part consists of sand mortar and black cement in a ratio of 1:3 and is attached to a mortar of 300 kg cement / m3 sand and includes the price of washing and watering using appropriate stones or wax and so on and bearing on the item, including skirting 25cm height for required spaces. - Approx. quantity is 1,430 m <sup>2</sup> .
Supply and install ceramic tiles floor in all wet area, with a suitable dimensions and required approved colors. - Approx. quantity is 50 m <sup>2</sup> .
<b>Finishes</b>
Supply and install ceramic tiles for walls in all wet area, with a suitable dimensions and required approved colors. - Approx. quantity is 100 m <sup>2</sup> .
<b>Ceiling</b>
Supply and install false ceiling gypsum tiles 60x60 cm for whole spaces in the floor. - Approx. quantity is 1,480 m <sup>2</sup> .
<b>Doors and Windows</b>
Maintenance and renovation of the existing internal wooden door, the doors work include fix or replace the accessories and sub frames. And also painting/varnish the doors surface - Approx. quantity about 15 units with different dimensions and types.
Maintenance and renovation of the existing aluminum glass windows, the scope of work includes fix or replace the accessories and sub frames. Painting the aluminum with a new color - Approx. quantity about 50 units with different dimensions and types.
Supply and installation of fixed aluminum-glass partition, 8 mm tempered glass thick, with all needed accessories, including openings and doors. With the same colors as exists. - Approx. quantity about 10 units with different dimensions and types.
<b>Stairs</b>
Supply and installation of metal handrail for the exterior upstairs and the scope include fixation and duco paint - Approx. quantity about 25 linear meters with 1 meter height.
<b>Elevator</b>
Supply and make all necessary civil works for adding a new elevator adjacent to the building and serve from ground to first floor.
Supply, install, connect and test, lavatories for all wk. with the required numbers, trim and accessories complete including but not limited to flush valves, drains pipes, mixers, faucets, water supplies pipes, stop angle valves, ablation faucets, traps, connectors, adapters, ...etc. - Approx. quantity about 15 units with different dimensions and types.
Supply and build solid cemented block works 12 cm thick with mortar composed of 300 kg ordinary Portland cement for one cubic meter sand the rate includes necessary openings for electro-mechanical services and pvc or foam grout sleeves, including full line concrete R.C. or steel framing for doors. (for new walls required for adding a new wc in the director office) - Approx. quantity about 15 m <sup>2</sup> .

<p>Supply and installation of liquid bituminous moisture insulation for all wet areas inside the building with 200mm heights at corners from finishing level.  - Approx. quantity about 50 m<sup>2</sup>.</p>
<p>Supply and install mirrors 6 mm thick, chamfered edges to water closets areas complete with mechanical special hanger fixation.  - Approx. quantity about 3 parts with a different dimensions.</p>
<p><b>Finishes</b></p>
<p>Supply and apply internal walls paints, emulsion plastic washable paint for internal walls and ceiling including all approved procedure (one primer coat, two putty coats, one flat coat, one sipes putty coat as an enhancement coat and two final coats and or approved equal according to specs, and incl. all equipment needed such as tools and steel reach out or scaffolding systems, as required approved colors.  - Approx. quantity about 3000 m<sup>2</sup>.</p>
<p>Supply and apply of external paints cement base material or equivalent to the external facades according to the required color and mixed according to the colour of the material according to the percentage of mixing approved and present on the packages of the company's production to depend on the colour and type of surface of granular or rough or smooth including all equipment needed such as tools and steel reachout or scaffolding systems.  - Approx. quantity about 840 m<sup>2</sup>.</p>
<p>Maintenance and renovation of pink bricks for external facades, using sanding, cleaning by using a cleaning solution and water then spraying the solution on the wall using a spray or cleaning brush in addition to using a layer of waterproof sealer, including all equipment needed such as tools and steel reachout or scaffolding systems  - Approx. quantity about 3360 m<sup>2</sup>.</p>
<p>Supply and install internal signage of plexi with engraved colored text and logo as approved from owner.  - Approx. about 50 signage with 25 x 15 cm dimensions</p>
<p><b>Sandwich panel corrugated sheets</b></p>
<p>Supply and apply sandwich panel with minimum thickness of 5 cm heat proving type instead of the top layer of the corrugated sheet for the roof.  - Approx. quantity is 1500 m<sup>2</sup>.  <b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Rain gutters</b></p>
<p>Supply and install rain gutter around the building roof with every accessories need to finish the work according to Egyptian specifications and industry assets.  - Approx. quantity is 170m.  <b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Welding</b></p>
<p>Apply site re-weld (full rounded weld) on the welding of the cantilevers connection for the building shed around the building, the work should be done according to Egyptian specifications and industry assets.  - Approx. quantity is 28 CANTILIVER.  <b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Anti corrosion protection</b></p>
<p>Apply rust treatment for the outside shed around the building by suitable method according to Egyptian specifications and industry assets.  - Approx. quantity is 170 m<sup>2</sup>.  <b>As refer in division no. 5 of the Engineering Technical Specification</b></p>

## 2.2.2 Electrical Works

### Lighting

Strengthening the intensity of illumination in spaces, by replacing or doing the necessary maintenance for the existing lighting fixtures in the current spaces and increasing the number of lighting fixtures as required according to lux level calculations respecting engineering illuminating society (IES) code or Egy code.

### Power

Doing the necessary maintenance for sockets.

Feed electricity to all new equipment and machines from the existing network and do all required modifications accordingly.

Electrical Works
<b>Lighting system:</b>
Repair, connect, test and put into operation existing lighting fixtures approximated 25 items including lamps, fixture housing, wires, switches, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See fig (02). See engineering technical specification item number (26 51 13) and (26 05 19).
Supply, install, connect, test and put into operation lighting fixtures approximated 75 items including lamps, fixture housing, wires, switches, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See fig (02). See engineering technical specification item number (26 51 13) and (26 05 19). Strengthening the intensity of illumination by doing the necessary maintenance for the existing lighting fixtures in the current spaces, increasing the number of lighting fixtures as required and design the new architectural spaces lighting system considering using high power efficient power LED lamps according to lux level calculations (IES) code or Egy.code. - The installation of lighting fixtures shall be according to Egy.code.B61
<b>Power system:</b>
Repair, connect, test and put into operation existing sockets approximated 20 items including : sockets, wires, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. See fig (02). See engineering technical specification item number (26 27 26) and (26 05 19).
Supply, install, connect, test and put into operation sockets approximated 35 items including : sockets,wires,terminations,fittings,outlet, boxes,conduits, ..., with all accessories and all related ancillary works. See fig (02). See engineering technical specification item number (26 27 26) and (26 05 19) .
Supplying and installing electrical system power circuit for machines (fans, air conditions, ...): outlets, disconnect switches, cables, drives, distribution panel(s), control panel(s), ..., with all accessories and all related ancillary works. See fig (02). See engineering technical specification item number (26 27 26) and (26 05 19) and (26 27 28). <ul style="list-style-type: none"><li>- Socket shall be German standard 10/16A DIN (2P +E).</li><li>- Industrial type switched sockets shall be used in electrical/mechanical plant rooms tunnels, workshops etc. and shall be of all rigid metal construction for surface mounting.</li><li>- Three phase sockets shall be 3 poles + neutral + earth 16 Amp.</li><li>- Unless otherwise indicated made of rigid metal construction. Sockets shall be supplied complete with plugs. The installation of sockets shall be according to Egyptian code.</li></ul>
<b>Panel board modifications</b>
See engineering technical specification item number (26 24 16).
<b>Elevator Works:</b>

Use: passenger lift

Quantity: 1 capacity: 450 kg, rated load (4 persons), Speed:1 m/s Motor start per hour: 180 Ride comfort: class(B), Stops: 2 stops

Doors: 2 landing doors, control system: VVVF drive, machine type: gearless traction drive machine location: machine room less. All finishes shall be approved by the interior/arch consultant. The item including the electrical works: outlets, disconnect switches, cables, conduits, fitting, drives, distribution panel(s), control panel(s), ..., with all accessories and all related ancillary works.

### 2.2.3 Mechanical Works

#### **HVAC**

- Educational classes have worn out fans so they should be replaced and install split air conditioning system according to ASHARAE Code or EGY Code.
- Director room need to install split air conditioning system according to ASHARAE Code or EGY Code.

#### **Fire Fighting works**

- Fire extinguishers are distributed in the corridor of educational classrooms area according to NFPA 10.
- Install fire search system for the existing electrical panels and do all required security according to NFPA 12.

#### **Plumbing Work**

- All fixtures should be replaced and renovated which include WCs, lavatories, urinals, drain trenches, ..., according to IPC and ASPE codes.
- Cold and hot water pipes for toilets should be replaced using PPR pipes.
- Design and calculations according to IPC, ASPE codes.
- Drain pipes should be replaced and renewed by UPVC pipes according ASPE codes.

<b>Mechanical Work</b>
Supply, installation, testing, commissioning, handing over and guarantee of the mechanical system equipment and related components. The number in bill of quantity is approximated
Supply and installation split air conditioners for the director room, approximated 1 items See fig (02). See engineering technical specification item number (23 81 26).
Demolition and removal of the existing air conditioning system and install a concealed air conditioning system for the CAD lab approximated 2 items See fig (02). See engineering technical specification item number (23 82 19).
Supply and installation and commissioning of fire extinguishers to secure the corridor, approximated 3 items See fig (02). See engineering technical specification item number (104416).
Supply and installation of a fire search system to secure the electrical panel existing in this building, approximated 1 Items See fig (02). See engineering technical specification item number (212113.13).
Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for all classrooms. Approximated number of 18 item.

## 2.3 Building No 02

### 2.3.1 Civil Works (Architectural and Structural)

1. Renovation of the floor with high-quality floors more suitable for educational activities.
2. Complete repaint of interior and exterior walls.
3. Preparing all entrances and internal corridors for the disabled persons.
4. Developing the bathroom attached to the ready-made garment workshop and making new toilets for students.
5. Renovation of the interior floors in proportion to the activities of the internal workshops.
6. Adding gypsum tiles to isolate the interior spaces from the heat of the weather
7. Change all windows with a new quality that isolates external noise and weather heat.
8. Renovation and maintenance of metal doors for all workshops and entrances.
9. Addition of a multi-purpose hall inside the building.
10. Dismantling of the existing top layers of roof corrugated sheets.
11. Erection of the new Roof corrugated sheet layer.
12. Applying Anti-corrosion Protection on outside roof shed.
13. Welding of cantilever sheds.
14. Curring exsisting slab on grade.

#### 1. DEMOLITION WORKS

Demolition and removal of the existing floor tiles for the workshops below inside the building, including all floor skirting and move them to the public dump. Workshops list:

- CNC workshop
- Refrigeration and air conditioning workshop.
- Tailoring workshops - upper floor
- Approx. quantity is 1,430 m<sup>2</sup>.

Demolition and removal of the existing floor tiles for wet area spaces and move them to the public dump.

- WC attached to the Tailoring workshop.
- Approx. quantity is 10 m<sup>2</sup>.

Demolition and removal of the existing wall tiles for wet area spaces and move them to the public dump.

- WC attached to the Tailoring workshop.
- Approx. quantity is 20 m<sup>2</sup>.

Demolition and removal of the existing brick wall with any thick and move them to the public dump

- walls in workshop no.14 to be ready to new WCs.
- Approx. quantity is 30 m<sup>2</sup>.

Demolition and removal of the existing aluminum partitions, and deliver them to the owner's stores.

- all partitions in the Tailoring workshop - upper one.
- Approx. quantity is 75m<sup>2</sup>

Demolition and removal of the existing WCs toilets, sinks and urinals and deliver them to the owner's stores.

- WC attached to the Tailoring workshop.
- Approx. quantity is 5 parts.

<p>Demolition and removal of the existing wooden doors, and deliver them to the owner's stores.</p> <ul style="list-style-type: none"> <li>- wooden doors in different places.</li> <li>- <b>Approx. quantity is 10 doors.</b></li> </ul>
<p>Demolition and removal of the existing gypsum board tiles including metal structure, and deliver them to the owner's stores.</p> <ul style="list-style-type: none"> <li>- Tailoring workshop.</li> <li>- Refrigeration and air conditioning workshop.</li> <li>- CNC workshop.</li> <li>- <b>Approx. quantity is 500 m<sup>2</sup>.</b></li> </ul>
<b>DISMANTLING OF CORRUGATED SHEETS</b>
<p>Removal of the existing top layer of corrugated sheets for the building roof and delivering it to the owner, making sure not effect the bottom layer, repair and close any opening in the bottom layer to avoid entry of insects and rodents.</p> <ul style="list-style-type: none"> <li>- <b>Approx. quantity is 3500 m<sup>2</sup>.</b></li> </ul> <p><b>As refer in deivison no. 2 e 41 of the Engineering Technical Specification</b></p>
<p>Dismantling of the existing lighting fixtures and deliver them to the owner.</p> <ul style="list-style-type: none"> <li>- <b>Approx. 55 items</b></li> </ul>
<b>Civil works</b>
<b>Flooring</b>
<p>Supply and installation of mosaico tiles for the need of surfaces with an Egyptian pebble size 30*30*3 cm, from an approved sample before installation, provided that the thickness of the non-cement components is not less than 10 mm consisting of (5 part of the marble pebble Bchino + 2 part Boudreau welding + 3 part white cement) while the cement part consists of sand mortar and black cement in a ratio of 1:3 and is attached to a mortar of 300 kg cement / m<sup>3</sup> sand and includes the price of washing and watering using appropriate stones or wax and so on and bearing On the item, including skirting 25cm height for required spaces..</p> <ul style="list-style-type: none"> <li>- All first floor labs and corridor.</li> <li>- <b>Approx. quantity is 610m<sup>2</sup>.</b></li> </ul>
<p>Supply and installation of ceramic tiles floor in all wet area, with a suitable dimensions and colours to be approved.</p> <ul style="list-style-type: none"> <li>- WC attached to Tailoring workshop.</li> <li>- new WC space.</li> <li>- <b>Approx. quantity is 50 m<sup>2</sup>.</b></li> </ul>
<b>Finishes</b>
<p>Supply and installation of ceramic tiles for walls in all wet area, with a suitable dimensions and colours to be approved.</p> <ul style="list-style-type: none"> <li>- WC attached to Tailoring workshop.</li> <li>- new WC space.</li> <li>- <b>Approx. quantity is 150 m<sup>2</sup>.</b></li> </ul>
<b>Ceiling</b>
<p>Supply and installation of false ceiling gypsum tiles 60x60 cm for whole spaces in the floor.</p> <ul style="list-style-type: none"> <li>- Tailoring workshop.</li> <li>- Tailoring workshops (upper 2 workshops)</li> <li>- Refrigeration and air conditioning workshop.</li> <li>- CNC workshop.</li> <li>- New classrooms in metal carpentry, automotive and metal sheets workshops (3 classrooms)</li> <li>- <b>Approx. quantity is 650 m<sup>2</sup>.</b></li> </ul>



<b>Doors and Windows</b>
<p>Maintenance and renovation of the existing <b>Metal Glass Windows</b>, the scope of work includes fix or replace the accessories and sub frames. In addition, the painting of the metal by new color with Duco Paint</p> <ul style="list-style-type: none"> <li>- for all exterior windows on elevations.</li> <li>- <b>Approx. quantity is 90 units with different dimensions and types.</b></li> </ul>
<p>Maintenance and renovation of the existing <b>Aluminum Glass Windows</b>, the scope of work includes fix or replace the accessories and sub frames. In addition, the painting of the aluminum by new color</p> <ul style="list-style-type: none"> <li>- windows in the ready-made garment workshop (upper 2 workshops).</li> <li>- <b>Approx. quantity 25 units with different dimensions and types.</b></li> </ul>
<p>Supply and installation of fixed Aluminum-glass partition, 10mm glass thick, with all needed accessories.</p> <ul style="list-style-type: none"> <li>- all partitions in the Tailoring workshop - upper floor (according to the spaces division proposed)</li> <li>- <b>Approx. quantity is 150m<sup>2</sup>.</b></li> </ul>
<p>Supply, install, connect and test, lavatories for all wc with the required numbers, trim and accessories complete including but not limited to flush valves, drains pipes, mixers, faucets, water supplies pipes, stop angle valves, ablation faucets, traps, connectors, adapters, etc.</p> <ul style="list-style-type: none"> <li>- WC attached to the Tailoring workshop.</li> <li>- new WCs.</li> <li>- <b>Approx. quantity is 15 units.</b></li> </ul>
<b>Doors and Windows</b>
<p>Supply and installation of electrostatic coated hinged metal door, with the same dimensions as exists, including all accessories needed and sub frames.</p> <ul style="list-style-type: none"> <li>- one new door in the workshop no.09 (new hall)</li> <li>- dimension as the exist doors in elevation.</li> </ul>
<p>Supply and installation of internal wooden door double leaf 100cm width 220cm height, the doors including all accessories needed and sub frames.</p> <ul style="list-style-type: none"> <li>- <b>Approx. quantity about 10 units with different dimensions and types.</b></li> </ul>
<p>Maintenance and renovation of the existing <b>Metal door</b>, the doors work include fix or replace the accessories and sub frames. In addition, the painting by Duco new paint</p> <ul style="list-style-type: none"> <li>- All exists indoor and outdoor units in whole building.</li> <li>- <b>Approx. quantity is 30 unit with different dimensions and types.</b></li> </ul>
<b>Finishes</b>
<p>Supply and installation of liquid bituminous moisture insulation for all wet areas inside the building with 200mm heights at corners from finishing level.</p> <ul style="list-style-type: none"> <li>- WC attached to Tailoring workshop.</li> <li>- new WCs.</li> <li>- <b>Approx. quantity about 50 m<sup>2</sup>.</b></li> </ul>
<p>Supply and installations of mirrors 6 mm thick, chamfered edges to water closets areas complete with mechanical special hanger fixation</p> <ul style="list-style-type: none"> <li>- in all WCs.</li> <li>- <b>Approx. quantity is 15m<sup>2</sup>.</b></li> </ul>
<b>Finishes</b>
<p>Supply and apply emulsion plastic washable paint for internal walls and ceiling, including all equipment needed such as tools and steel reachout or scaffolding systems. Colours shall be approved.</p> <ul style="list-style-type: none"> <li>- as exists spaces.</li> <li>- <b>Approx. quantity is 1200 m<sup>2</sup>.</b></li> </ul>

<p>Supply and apply of external paints cement base material or equivalent to the external facades according to the required color and mixed according to the color of the material according to the percentage of mixing approved and present on the packages of the company's production to depend on the color and type of surface of granular or rough or smooth including all equipment's needed such as tools and steel reachout or scaffolding systems</p> <p>- as exists spaces.</p> <p>- <b>Approx. quantity is 866 m<sup>2</sup>.</b></p>
<p>Maintenance and renovation of pink bricks for external facades, using sanding, cleaning by using a cleaning solution and water then spraying the solution on the wall using a spray or cleaning brush in addition to using a layer of waterproof sealer, including all equipment's needed such as tools and steel reachout or scaffolding systems</p> <p>- <b>Approx. quantity about 3464 m2.</b></p>
<p>Supply and installation of internal signage of Plexi with engraved colored text and logo as approved from owner.</p> <p>- <b>Approx. about 40 signage with 30 x 20 cm dimentions</b></p>
<p>Supply and build solid cemented block works 25 cm thick. with mortar composed of 300 kg ordinary Portland cement for one cubic meter sand the rate includes necessary openings for electro-mechanical services and pvc or foam grout sleeves, including full line concrete R.C. or steel framing for doors, according standard specs</p> <p>- For making the new WCs internal partition.</p> <p>- <b>Approx. quantity is 25 m<sup>2</sup>.</b></p>
<p><b>Sandwich panel corrugated sheets</b></p>
<p>Supply and apply sandwich panel with minimum thickness of 5 cm heat proving type instead of the top layer of the corrugated sheet for the roof.</p> <p>- <b>Approx. quantity is 3500 m<sup>2</sup>.</b></p> <p><b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Rain Gutters</b></p>
<p>Supply and installation of rain gutter around the building roof with every accessories need to finish the work according to Egyptian specifications and industry assets.</p> <p>- <b>Approx. quantity is 250m.</b></p> <p><b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Welding</b></p>
<p>Apply site re-weld (full rounded weld) on the welding of the cantilevers connection for the building shed around the building, the work should done according to Egyptian specifications and industry assets.</p> <p>- <b>Approx. quantity is 38 CANTILIVER.</b></p> <p><b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Anti corrosion protection</b></p>
<p>Apply rust treatment for the outside shed around the building by suitable method according to Egyptian specifications and industry assets.</p> <p>- <b>Approx. quantity is 250 m2.</b></p> <p><b>As refer in division no. 5 of the Engineering Technical Specification</b></p>
<p><b>Slab on Grade</b></p>
<p>Inject curring material for crackes in the top surface of the slab on grade, fill the place of removed trenches, all materials used should be from approved firms, work should be done according to Egyptian specifications and industry assets.</p> <p>As shown in fig. (16)</p> <p>- <b>Approx. quantity is 2500 m<sup>2</sup>.</b></p> <p><b>As refer in division no. 3 of the Engineering Technical Specification</b></p>

## 2.3.2 Electrical

### Lighting

Strengthening the intensity of illumination in spaces, by replacing or doing the necessary maintenance for the existing lighting fixtures in the current spaces and increasing the number of lighting fixtures as required according to lux level calculations respecting engineering illuminating society (IES) code or Egy code.

Design the new architectural spaces lighting system considering using high power efficient power LED lamps, according to (IES) code or Egy code.

### Power

Doing the necessary maintenance for sockets.

Feed electricity to all new equipment and machines from the existing network and do all required modifications accordingly.

Electrical Works
<b>Lighting system:</b>
Repair, connect, test and put into operation existing lighting fixtures approx. 90 items including lamps, fixture housing, wires, switches, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See fig (03 and 04). See engineering technical specification item number (26 51 13) and (26 05 19).
Supply, install, connect, test and put into operation lighting fixtures approx. 170 items including lamps, fixture housing, wires, switches, terminations, fittings, outlet, boxes, conduits, cable trays ..., with all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See fig (03 and 04). See engineering technical specification item number (26 51 13) and (26 05 19) and (26 05 36).
Strengthening the intensity of illumination by doing the necessary maintenance for the existing lighting fixtures in the current spaces, increasing the number of lighting fixtures as required and design the new architectural spaces lighting system considering using high power efficient power LED lamps according to lux level calculations (IES) code or Egy.code. The installation of lighting fixtures shall be according to Egy.code.
<b>Power system:</b>
Repair, connect, test and put into operation existing sockets approx. 80 items including : sockets,wires, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. See fig (03 and 04). See engineering technical specification item number (26 27 26) and (26 05 19).
Supply, install, connect, test and put into operation sockets approx. 70 items including : sockets, wires, terminations, fittings, outlet, boxes, conduits, cable trays ..., with all accessories and all related ancillary works. See fig (03 and 04). See engineering technical specification item number (26 27 26) and (26 05 19) and (26 05 36).
Supply and installation of electrical system power circuit for machines (fans, air conditions,...): outlets, disconnect switches, cables, drives, distribution panel(s), control panel(s), cable trays ..., with all accessories and all related ancillary works. - Socket shall be German standard 10/16A DIN (2P+E). - Industrial type switched sockets shall be used in Electrical/Mechanical plant rooms tunnels, workshops etc. and shall be of all rigid metal construction for surface mounting. - Three phase sockets shall be 3 poles + neutral + earth 16 Amp. Unless otherwise indicated made of rigid metal construction. Sockets shall be supplied complete with plugs. The installation of sockets shall be according to Egy.code See fig (03 and 04). See engineering technical specification item number (26 27 26) and (26 05 19) and (26 27 28) and (26 05 36).

### 2.3.3 Mechanical Works

#### **HVAC**

- A central exhaust system to be made by using centrifugal fan and the rate of air is 9 ACH, for supply fresh air install wall mounted axial fan and the rate of air change is 6 ACH according to ASHRAE 62.1 for (welding and lathing workshop)
- Install wall mounted axial fans for (automotive, mechanics work shop) and the rate of air change is 6 ACH according to ASHRAE 62.1
- Install concealed air conditioning system for workshops which have false ceiling. According to ASHRAE Code and EGY Code.

#### **Fire Fighting works**

- Install fire extinguishers distributed in workshops. According to NFPA 10
- Install fire search system for the existing electrical panels and do all required security according to NFPA 12.

#### **Plumbing Work**

- All fixtures should be replaced and renovated which include WCs, lavatories, urinals, drain trenches, ..., according to IPC and ASPE codes
- Cold and hot water pipes for toilets should be replaced using PPR Pipes
- The design and calculations according to IPC, ASPE Codes
- Drain pipes should be replaced and renewed by UPVC Pipes according ASPE Codes

<b>Mechanical Work</b>
Supply, installation, testing, commissioning, handing over and guarantee of the mechanical system equipment and related components. The number in bill of quantity is approximated
Demolition and removal of the existing ceiling fans and install axial fresh air fan wall mounted for automotive workshop. - <b>Approx. 3 Items</b> See fig (03). See engineering technical specification item number (23 34 13).
Demolition and removal of the existing ceiling fans and install axial fresh air fan wall mounted for mechanics workshop. - <b>Approx. 3 Items</b> See fig (03). See engineering technical specification item number (23 34 13).
Supply and installation and commissioning of central exhaust and fresh air fan for lathing work shop. - <b>Approx. 2 Items</b> See fig (03). See engineering technical specification item number (2334163).
Supply and installation and commissioning of fire extinguishers for automotive workshop - <b>Approx. 3 Items</b> See fig(03). See engineering technical specification item number (104416).
Supply and installation and commissioning of fire extinguishers for Refrigeration and air conditioning workshop. - <b>Approx. 3 Items</b> See fig (03). See engineering technical specification item number (104416).
Supply and installation and commissioning of fire extinguishers for lathing workshop - <b>Approx. 3 Items</b> See fig(03). See engineering technical specification item number (104416).

<p>Supply and installation and commissioning of a fire search system to secure the electrical panel that exists in CNC workshop</p> <p>- Approx. 1 Items</p> <p>See fig (03). See engineering technical specification item number (212113.13).</p>
<p>Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for automotive workshop. Approximated number of 10 new fans.</p>
<p>Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for mechanical workshop. Approximated number of 8 new fans.</p>
<p>Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for sheet metal workshop. Approximated number of 8 new fans.</p>
<p>Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for the tailoring workshop. Approximated number of 12 new fans.</p>

## 2.4 Building No 03

### 2.4.1 Architectural Works

1. Renovation of the floor with high-quality floors more suitable for educational activities.
2. Complete repaint of interior and exterior walls.
3. Preparing all entrances and internal corridors for the disabled persons.
4. Developing the exist bathroom and make a new bath for the disabled persons.
5. Renovation of the interior floors in proportion to the activities of the internal labs.
6. Adding gypsum tiles to isolate the interior spaces from the heat of the weather
7. Change all windows with a new quality that isolates external noise and weather heat.
8. Adding an elevator to the building to serve the disabled persons.
9. Renovation and maintenance of the external staircase for the upper floor for the convenience, security, and safety of users.
10. Renovation and maintenance of metal doors for all workshops and entrances.
11. Re-insulation the building roof to resist heat and moisture.

#### 1. DEMOLITION WORKS

Demolition and removal of the existing floor tiles for all roof space.

- as exists spaces.

- Approx. quantity is 675 m<sup>2</sup>.

Demolition and removal of the existing floor tiles for whole first floor spaces in the building, including all floor skirting and move them to the public dump.

- as exists spaces.

- Approx. quantity is 610 m<sup>2</sup>.

Demolition and removal of the existing floor tiles for all wet area spaces

- Exist WCs.

- Exist Buffet.

- Approx. quantity is 25 m<sup>2</sup>.

Demolition and removal of the existing wall tiles for all wet area spaces

- Exist WCs.

- Exist Buffet.

- Approx. quantity is 75 m<sup>2</sup>.

Demolition and removal of the existing aluminum partitions, to be delivered to the owner's stores.

- already installed in the 2 small classroom at the beginning of the corridor.

- Approx. quantity is 4 units with different dimensions and types.

Demolition and removal of the existing WCs toilets, sinks and urinals, to be delivered to the owner's stores.

- WCs beside the main building upstairs.

- Approx. quantity is 8 parts.

Demolition and removal of the existing wooden doors, to be delivered to the owner's stores.

- WC and buffet doors only.

- Approx. quantity is 2 parts.

Demolition and removal of the existing moister/heat isolation layers if founded in the building roof.

- Located in the building roof.

- Approx. quantity is 610m<sup>2</sup>.

Dismantling the existing lighting fixtures and delivering it to the owner.

- Approx. 10 items

#### Civil works

<b>Flooring</b>
<p>Supply and installation of mosaic tiles (with marble breaks pieces) size 40x40x3 cm, from an approved sample before installation, provided that the thickness of the non-cement components is not less than 10 mm consisting of (5 part of the marble pebble Bchino + 2 part Boudreau welding + 3 part white cement) while the cement part consists of sand mortar and black cement in a ratio of 1:3 and is attached to a mortar of 300 kg cement / m3 sand and includes the price of washing and watering using appropriate stones or wax and so on and bearing On the item, including skirting 25cm height for required spaces..</p> <p>- All first floor labs and corridor.</p> <p>- Approx. quantity is 610m<sup>2</sup>.</p>
<p>Supply and installation of ceramic tiles floor in all wet area, with a suitable dimensions, and required approved colors.</p> <p>- WC and New WC which be instead of exist buffet.</p> <p>- Approx. quantity is 25m<sup>2</sup>.</p>
<b>Finishes</b>
<p>Supply and installation of ceramic tiles for walls in all wet area, with a suitable dimensions and required approved colors.</p> <p>- WC and New WC which be instead of exist buffet.</p> <p>- Approx. quantity is 75m<sup>2</sup>.</p>
<p>Supply and installation of a steel ladder for the roof with an electrostatic paints.</p> <p>- Instead of existing one but with standard dimensions and respecting safety standards.</p> <p>- Approx. weight is 100 KG.</p>
<p>Supply and installation of liquid bituminous moisture insulation for all wet areas in the fist floor with 200mm heights at corners from finishing level.</p> <p>- WCs.</p> <p>- Approx. quantity about 25 m<sup>2</sup>.</p>
<p>Supply and installation of liquid bituminous moisture insulation for whole roof area, with 200mm heights at corners from finishing level.</p> <p>- all roof.</p> <p>- Approx. quantity about 660 m<sup>2</sup>.</p>
<p>Supply and installation of thermal isolation layer made from compressed blue foam 5cm thk. extruded type density 36 kg/m3 arvy foam or equally as standards.</p> <p>- all roof.</p> <p>- Approx. quantity about 660 m<sup>2</sup>.</p>
<b>Windows</b>
<p>Maintenance and renovation of the exisiting Aluminum Glass Windows, the scope of work includes fix or replace the accessories and sub frames. In addition, the painting of the aluminum by new color</p> <p>- for all exterior and interior windows on elevations (first floor only).</p> <p>- Approx. quantity is 47 units with different dimensions and types.</p>
<b>Elevator</b>
<p>Supply and implementation of all necessary civil works for adding a new elevator adjacent to the building serving from ground to first floor.</p>
<p>Supply, install, connect and test, lavatories for all wc with the required numbers, trim and accessories complete including but not limited to flush valves, drains pipes, mixers, faucets, water supplies pipes, stop angle valves, abluion faucets, traps, connectors, adapters, ...etc.</p> <p>- exist wc and the new one.</p> <p>- Approx. quantity is 12 parts.</p>
<p>Supply and install mirrors 6 mm thick, chamfered edges to water closets areas complete with mechanical special hanger fixation.</p> <p>- in all WCs.</p> <p>- Approx. quantity is 8m<sup>2</sup>.</p>

<b>Doors and Windows</b>
<p>Maintenance and renovation of the existing Metal door, the doors work include fix or replace the accessories and sub frames. In addition, the painting by Duco new paint</p> <ul style="list-style-type: none"> <li>- All exists doors.</li> <li>- Approx. quantity is 4 unit with different dimensions and types.</li> </ul>
<b>Finishes</b>
<p>Supply and apply emulsion plastic washable paint for internal walls and ceiling, including all equipment needed such as tools and steel reach out or scaffolding systems, as required approved colors.</p> <ul style="list-style-type: none"> <li>- as exists spaces.</li> <li>- Approx. quantity is 1200 m<sup>2</sup>.</li> </ul>
<p>Supply and apply of external paints cement base material or equivalent to the external facades according to the required color and mixed according to the color of the material according to the percentage of mixing approved and present on the packages of the company's production to depend on the color and type of surface of granular or rough or smooth including all equipment needed such as tools and steel reachout or scaffolding systems</p> <ul style="list-style-type: none"> <li>- as exists spaces.</li> <li>- Approx. quantity is 255 m<sup>2</sup>.</li> </ul>
<p>Maintenance and renovation of pink bricks for external facades, using sanding, cleaning by using a cleaning solution and water then spraying the solution on the wall using a spray or cleaning brush in addition to using a layer of waterproof sealer, including all equipment needed such as tools and steel reachout or scaffolding systems</p> <ul style="list-style-type: none"> <li>- Approx. quantity about 1021 m<sup>2</sup>.</li> </ul>
<p>Supply and installation of internal signage of Plexi with engraved colored text and logo as approved from owner.</p> <ul style="list-style-type: none"> <li>- Approx. about 50 signage with 25 x 15 cm dimentions</li> </ul>
<p>Supply and installation of cement floor tiles for roof, with a suitable dimensions including skirting and any required additions.</p> <ul style="list-style-type: none"> <li>- as exists spaces.</li> <li>- Approx. quantity is 660 m<sup>2</sup>.</li> </ul>
<p>Make the necessary modification for the main entrance stairs to add a suitable ramp for disables, including all needed changes and additions.</p>
<b>Ceiling</b>
<p>Supply and installation of false ceiling gypsum tiles 60x60 cm for whole spaces in the floor.</p> <ul style="list-style-type: none"> <li>- Approx. quantity is 660 m<sup>2</sup>.</li> </ul>
<b>Doors and Windows</b>
<p>Supply and installation of internal wooden door double leaf 100cm width 220cm height, the doors including all accessories needed and sub frames.</p> <ul style="list-style-type: none"> <li>- For WC and new Handicapped WC only.</li> <li>- Approx. quantity is 2 units with the same dimensions and types.</li> </ul>



## 2.4.2 Electrical Works

### **Lighting**

Strengthening the intensity of illumination in spaces, by replacing or doing the necessary maintenance for the existing lighting fixtures in the current spaces and increasing the number of lighting fixtures as required according to lux level calculations respecting engineering illuminating society (IES) code or Egy code.

Design the new architectural spaces lighting system considering using high power efficient power LED lamps, according to (IES) code or Egy code

### **Power**

Doing the necessary maintenance for sockets.

Feed electricity to all new equipment and machines from the existing network and do all required modifications accordingly.

<b>Electrical Works</b>
<b>Lighting system:</b>
Repair, connect, test and put into operation existing lighting fixtures approximated 25 items including lamps, fixture housing, wires, switches, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See fig (05). See engineering technical specification item number (26 51 13) and (26 05 19).
Supply, install, connect, test and put into operation lighting fixtures approximated 20 items including lamps, fixture housing, wires, switches, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See fig (05). See engineering technical specification item number (26 51 13) and (26 05 19).
Strengthening the intensity of illumination by doing the necessary maintenance for the existing lighting fixtures in the current spaces, increasing the number of lighting fixtures as required and design the new architectural spaces lighting system considering using high power efficient power LED lamps according to lux level calculations (IES) code or Egy.code. The installation of lighting fixtures shall be according to Egy.code.
<b>Power system:</b>
Repair, connect, test and put into operation existing sockets approximated 25 items including: sockets, wires, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works Egyptian. See fig (05). See engineering technical specification item number (26 27 26) and (26 05 19).
Supply, install, connect, test and put into operation sockets approximated 30 items including: sockets, wires, terminations, fittings, outlet, boxes, conduits, ..., with all accessories and all related ancillary works Egyptian. See fig(05). See engineering technical specification item number (26 27 26) and (26 05 19).
Supplying and installing electrical system power circuit for machines (fans, air conditions, ...ets): outlets, disconnect switches, cables, drives, distribution panel(s), control panel(s), ..., with all accessories and all related ancillary works. - Socket shall be German standard 10/16A DIN (2P +E). - Industrial type switched sockets shall be used in Electrical Mechanical plant rooms tunnels, workshops etc. and shall be of all rigid metal construction for surface mounting. - Three phase sockets shall be 3 poles + neutral + earth 16 Amp. Unless otherwise indicated made of rigid metal construction. - Sockets shall be supplied complete with plugs. - The installation of sockets shall be according to Egy.code See fig (05). See engineering technical specification item number (26 27 26) and (26 05 19) and (26 27 28).
<b>Panel board modifications:</b>

See engineering technical specification item number (26 24 16).

**Elevator**

Use: passenger lift Quantity: 1

capacity: 450 kg, rated load (4 persons), Speed:1 m/s Motor start per hour: 180 Ride comfort: class(B), Stops: 2 stops, Doors: 2 landing doors, control system: VVVF drive,

Machine type: gearless traction drive machine location: machine room less.

All finishes shall be approved by the interior/arch consultant.

The item including the electrical works: outlets, disconnect switches, cables, conduits, fitting, drives, distribution panel(s), control panel(s), ..., with all accessories and all related ancillary works.

### 2.4.3 Mechanical Works

#### HVAC

- Install split air conditioning system to the laboratories according to ASHARAE Code

#### Fire Fighting works

- Install fire hose cabinet class 3 for the corridor between educational labs according to NFPA 14
- Educational laboratories have electric panels so we should made fire search system by using co2 according to NFPA 12
- Install fire extinguishers distributed in workshops. According to NFPA 10

#### Plumbing Work

- All fixtures should be replaced and renovated which include (WC, Lavatory, Urinal, drain trenches) according to IPC and ASPE codes
- Cold and hot water pipes for toilets should be replaced using PPR Pipes
- The design and calculations according to IPC, ASPE Codes
- Drain pipes should be replaced and renewed by UPVC Pipes according ASPE Codes

Mechanical Work
Supply, installation, testing, commissioning, handing over and guarantee of the mechanical system equipment and related components. The number in bill of quantaty is approximated
Supply and installation and commissioning of split air conditioning system for electronic lab - Approx. 2 Items See fig (05). See engineering technical specification item number (23 81 26).
Supply and installation and commissioning of split air conditioning system for control lab - Approx. 2 Items See fig (05). See engineering technical specification item number (23 81 26).
Supply and installation and commissioning of split air conditiong system for electric1 lab - Approx. 2 Items See fig (05). See engineering technical specification item number (23 81 26).
Supply and installation and commissioning of split air conditiong system for electric2 lab - Approx. 2 Items See fig (05). See engineering technical specification item number (23 81 26).
Supply and installation and commissioning of ceiling fans for the classrooms. - Approx. 6 Items See fig (05). See engineering technical specification item number (23 81 26).
Supply, installation, testing and hand over of electrostatic painted fire hose cabinet (class 3) - Approx. 1 Items See fig (05). See engineering technical specification item number (211200).
Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for the labs. Approximated number of 6 new fans per each lab.
Removal of old/existing fans (if any), supply, install and commissioning of new ceiling fans for the classrooms. Approximated number of 2 new fans per each classroom.

## 2.5 Building No 04 (NEW BUILDING)

### 2.5.1 Civil Works (Architectural and Structural)

Construction of a new building with a 350 sqm built-up area, containing the following:

1. 3 study laboratories with different specializations.
2. 1 office for teachers and 1 classroom.
3. WC and Buffet.
4. All floors of the building are suitable for educational activities.
5. All external windows block noise and external heat.
6. All elements of vertical and horizontal movement are equipped for the disabled persons.
7. A lift for the disabled persons.
8. insulation the building roof to resist heat and moisture.
9. Dismantling of the existing car parking shed.
10. Construction of the new building.

<b>Building Permits</b>
<p>The contractor shall when required be responsible of managing/issuing any building permits that may be required for the construction of the new building.</p> <p>This shall include but not limited to any cost related to reimbursement of issuing any building permits, along with any related cost to manage, execute, and issue any building permit required, till receiving the final approval.</p>
<b>DEMOLITION WORKS</b>
Dismantling of existing car park shed
<p>Removal of car parking shed, delivering it to the owner, demolition of underground parts and foundations and transferring the excavation output to public dumps. Work should be done according to Egyptian specifications and industry assets.</p> <p>Approx. quantity is 250m.</p> <p>As refer in division no. 2 and 41 of the Engineering Technical Specification</p>
<b>Civil works</b>
<b>Flooring</b>
<p>Supply and installation of mosaic tiles (with marble breaks pieces) size 40x40x3 cm, from an approved sample before installation, provided that the thickness of the non-cement components is not less than 10 mm consisting of (5 part of the marble pebble Behino + 2 part Boudreau welding + 3 part white cement) while the cement part consists of sand mortar and black cement in a ratio of 1:3 and is attached to a mortar of 300 kg cement / m3 sand and includes the price of washing and watering using appropriate stones or wax and so on and bearing on the item, including skirting 25cm height for required spaces..</p> <p>- For labs, Corridors and public areas.</p> <p>- Approx. quantity is 240m<sup>2</sup>.</p>
<p>Supply and installation of ceramic tiles floor in all wet area, with a suitable dimensions, and required approved colors.</p> <p>- For Wcs and buffet.</p> <p>- Approx. quantity is 50m<sup>2</sup>.</p>
<p>Supply and installation of ceramic tiles for walls in all wet area, with a suitable dimensions and required approved colors.</p> <p>- WC and new WC which be instead of exist buffet.</p> <p>- Approx. quantity is 125m<sup>2</sup>.</p>
<p>Supply and install of a steel ladder for the roof with an electrostatic paints.</p> <p>- Approx. weight is 100 KG.</p>

<p>Supply and installation of liquid bituminous moisture insulation for all wet areas in the first floor with 200mm heights at corners from finishing level.</p> <ul style="list-style-type: none"> <li>- WCs.</li> <li>- Approx. quantity about 50 m<sup>2</sup>.</li> </ul>
<p>Supply and installation of liquid bituminous moisture insulation for whole roof area, with 200mm heights at corners from finishing level.</p> <ul style="list-style-type: none"> <li>- all roof.</li> <li>- Approx. quantity about 175 m<sup>2</sup>.</li> </ul>
<p>Supply and installation of thermal isolation layer made from compressed blue foam 5cm thk. extruded type density 36 kg/m<sup>3</sup> or equally as standards.</p> <ul style="list-style-type: none"> <li>- all roof.</li> <li>- Approx. quantity about 175 m<sup>2</sup>.</li> </ul>
<b>Doors and Windows</b>
<p>Supply and installation of electrostatic coated sliding aluminum glass window, including all accessories needed and sub frames.</p> <ul style="list-style-type: none"> <li>- for all exterior and interior windows on elevations.</li> <li>- Approx. quantity is 24 units with different dimensions and types.</li> </ul>
<p>Supply, install, connect and test, lavatories for all wc with the required numbers, trim and accessories complete including but not limited to flush valves, drains pipes, mixers, faucets, water supplies pipes, stop angle valves, ablution faucets, traps, connectors, adapters, ...etc.</p> <ul style="list-style-type: none"> <li>- Approx. quantity is 12 parts.</li> </ul>
<p>Supply and installation of mirrors 6 mm thick, chamfered edges to water closets areas complete with mechanical special hanger fixation.</p> <ul style="list-style-type: none"> <li>- in all WCs.</li> <li>- Approx. quantity is 8m<sup>2</sup>.</li> </ul>
<b>Doors and Windows</b>
<p>Per lump sum supply and install electrostatic coated hinged metal door, for the main building entrance, including all accessories needed and sub frames.</p> <ul style="list-style-type: none"> <li>- one door only.</li> <li>- dimension about 2.20 height, 2.40 width.</li> </ul>
<b>Finishes</b>
<p>Supply and apply emulsion plastic washable paint for internal walls and ceiling, including all equipment needed such as tools and steel reach out or scaffolding systems, as required approved colors.</p> <ul style="list-style-type: none"> <li>- All interior spaces.</li> <li>- Approx. quantity is 1200 m<sup>2</sup>.</li> </ul>
<p>Supply and apply emulsion plastic washable paint for external walls and ceiling including all equipment needed such as tools and steel reach out or scaffolding systems, as required approved colors.</p> <ul style="list-style-type: none"> <li>- as exists spaces.</li> <li>- Approx. quantity is 450 m<sup>2</sup>.</li> </ul>
<p>Supply and installation of internal signage of Plexi with engraved colored text and logo as approved from owner.</p> <ul style="list-style-type: none"> <li>- Approx. about 15 signage with 25 x 15 cm dimensions</li> </ul>
<p>Supply and installation of cement floor tiles for roof, with a suitable dimensions including skirting and any required additions.</p> <ul style="list-style-type: none"> <li>- as exists spaces.</li> <li>- Approx. quantity is 175 m<sup>2</sup>.</li> </ul>

Make necessary items for the main entrance stairs and ramps, including all needed items and materials (marble, handrail, etc..).
<b>Ceiling</b>
Supply and installation of false ceiling gypsum tiles 60x60 cm for whole spaces in the floor. - Approx. quantity is 300 m <sup>2</sup> .
<b>Doors and Windows</b>
Supply and installation of internal wooden door double leaf 100cm width 220cm height, the doors including all accessories needed and sub frames. - For labs, offices, WCs and buffet. - Approx. quantity is 8 units with the same dimensions and types.
Supply and installation of internal wooden door single leaf 90cm width 220cm height, the doors including all accessories needed and sub frames. - Internal WCs doors. - Approx. quantity is 4 units with the same dimensions and types.
Supply and build solid cemented block works 25 cm thick. with mortar composed of 300 kg ordinary Portland cement for one cubic meter sand the rate includes necessary openings for electro-mechanical services and pvc or foam grout sleeves, including full line concrete R.C. or steel framing for doors, according standard specs - For making the external partition. - Approx. quantity is 700 m <sup>2</sup> .
Supply and build solid cemented block works 12 cm thick. with mortar composed of 300 kg ordinary Portland cement for one cubic meter sand the rate includes necessary openings for electro-mechanical services and pvc or foam grout sleeves, including full line concrete R.C. or steel framing for doors, according to standard specs. - For making the internal partition. - Approx. quantity is 400 m <sup>2</sup> .
Supply and apply cemented mortar plastering for external walls and ceiling containing 300 kg cement per m3 all with levelling separate and continuous pads and level included all accessories such as corner beads and metal lath on connection between partitions according to specs, as required and approved rate shall include scaffolding system needed. - For all the external walls. - Approx. quantity is 450 m <sup>2</sup> .
Supply and apply cemented mortar plastering for internal walls and ceiling containing 300 kg cement per m3 all with levelling separate and continuous pads and level included all accessories such as corner beads and metal lath on connection between partitions according to specs, as required and approved. - For all the external walls. - Approx. quantity is 1200 m <sup>2</sup> .
Supply and installation of granite Verdi for stairs riser 2 cm thick. and tread to be 4 cm thick. including 4 nonslipping grooves for tread and galvanized steel u-shape splitter between cladding and plaster according to standard specs. - For all the internal upstairs, and external in front of the building. - Approx. quantity is enough for 3 floors with 1.40m stairs width. (from ground to roof)
Supply and installation of electrostatic metal handrail with all needed accessories. - For all the internal upstairs, and external in front of the building. - Approx. quantity is enough for 3 floors with 1.00m height. (from ground to roof)
<b>Geotechnical investigation</b>

Making mechanical boreholes with (SPT at 1m depth intervals) the depth, numbers of boreholes should be determine by soil consultant office.

- Approx. quantity is minimum 2 boreholes.

**As refer in division no. 31 of the Engineering Technical Specification**

#### **Soil leveling**

Per lump sum reaching construction level and make sure of the safety of the around buildings according to Egyptian specifications.

- Approx. quantity is 500m<sup>3</sup>.

**As refer in division no. 31 of the Engineering Technical Specification**

#### **Plain Concrete Casting**

Supply and apply plain concrete for foundation of building with minimum cubic strength of 180 kg/cm<sup>2</sup>, according to Egyptian specifications and industry assets.

- Approx. quantity is 30m<sup>3</sup>.

**As refer in division no. 3 of the Engineering Technical Specification**

#### **Reinforced Concrete Casting**

Supply and apply reinforced concrete for all building skeleton with minimum cubic strength of 250 kg/cm<sup>2</sup>, according to Egyptian specifications and industry assets.

- Approx. quantity is 200m<sup>3</sup>.

**As refer in division no.3 of the Engineering Technical Specification**

#### **Insulation Works**

Supply and paint bitumen layers on underground concrete and masonry surfaces. The number of layers, type determine by soil report and the work should be done according to Egyptian specifications and industry assets.

- Approx. quantity is 150m<sup>2</sup>.

**As refer in division no. 7 of the Engineering Technical Specification**

## 2.5.2 Electrical Works

### **Lighting**

Design the new architectural spaces lighting system considering using high power efficient power LED lamps, according to (IES) code or Egy code.

### **Power**

Feed electricity to all equipment and machines from the existing network and do all required modifications accordingly.

### **PV System (on grid type)**

Electrical Works
<p><b>Main distribution Boards:</b> Supply, install, connect, test and put into operation the main low voltage distribution board, 2mm thickness, complete with all protective devices, with all CBs, measuring instruments, terminal blocks, busbars, Termination of incoming cables, normal main circuit breaker and outgoing bus duct including cable glands, labels, tags, terminations, components, accessories and all related ancillary works as specified. See engineering technical specification item number (26 24 16).</p>
<p>The Contractor shall submit the Main Distribution Boards (MDB) according to the latest requirements of the Egyptian distribution Company (EDC) for approval before manufacturing, Any additional requirements shall be considered without any extra cost to the Contract even if these requirements are not clearly mentioned. EDC shall witness the factory testing for the MDB and approved before shipment to site.</p>
<p><b>Distribution Boards:</b> Supply, install, connect, test and put into operation approximated 6 items of distribution panel boards, 2mm thickness, complete with all protective devices, with all CBs, measuring instruments, terminal blocks, busbars, contactors, push buttons, termination of incoming and outgoing cables including cable glands, tags, components, accessories and all related ancillary works required to complete installation and operation. See engineering technical specification item number (26 24 16).</p>
<p>Low voltage cable (multi/single core cables insulated 0.6/1 KV): Supply, install, connect, test and put into operation (multi or single) core copper conductors 0.6 / 1 KV, XLPE insulated and PVC sheathed low voltage cables, complete with all terminations, cable supports, saddles, cable glands, tags, fittings, accessories and all related ancillary works required to complete installation and operation, the item shall include all excavation back filling work road crossing, cable tray, duct bank, UPVC conduits and all requirement for establishing work and all related ancillary works required to complete installation and operation. See engineering technical specification item number (26 05 19).</p>
<p>Lighting system: Supply, install, connect, test and put into operation indoor lighting fixtures approximated 150 items, complete with all lamps, capacitors, electronic ballasts, terminations, components, wires, switches, fittings, outlet, boxes, conduits, ..., all accessories and all related ancillary works. The contractor shall submit the lux calculations for building spaces according to Egy.code or IES code. See engineering technical specification item number (26 51 13) and (26 05 19).</p>
<p>Design the new architectural spaces lighting system using high power efficient power LED lamps according to lux level calculations (IES) code or Egy.code. The installation of lighting fixtures shall be according to Egy.code.</p>
<p><b>Power System:</b></p>
<p>Supply, install, connect, test and put into operation sockets approximated number 140 items, complete with all fittings, terminations, wires, outlet boxes, conduits, ..., all accessories and all related ancillary works required to complete installation and operation. See engineering technical specification item number (26 27 26) and (26 05 19).</p>
<p>Supplying and installing electrical system power circuit for machines (fans, air conditions,...): outlets, disconnect switches, cables, drives, distribution panel(s), control panel(s), ..., with all accessories and all related ancillary works. - Socket shall be German standard 10/16A DIN (2P+E).</p>



- Industrial type switched sockets shall be used in Electrical/Mechanical plant rooms tunnels, workshops etc. and shall be of all rigid metal construction for surface mounting.  
- Three phase sockets shall be 3 poles + neutral + earth 16 Amp. Unless otherwise indicated made of rigid metal construction.  
- Sockets shall be supplied complete with plugs.  
The installation of sockets shall be according to Egy.code  
See engineering technical specification item number (26 27 26) and (26 05 19) and (26 27 28).

**Low Voltage Cable Tray and Cable Ladder :**

Supplying, installing, empty race way connecting, testing and commissioning empty raceway hot galvanized perforated type cable trays, cable tray covers in wet location and intersection with MEP services including all fitting supporting materials and associated works.  
See engineering technical specification item number (26 05 36).

**PV system :**

Supplying, installing, testing and commissioning of a complete PV system (on grid type) for lighting loads only (4 KW) including PV panels, cables, wires and all necessary accessories including inverter and connection to main building panel.

**Elevator :**

Use: passenger lift Quantity: 1  
capacity: 450 kg, rated load (4 persons), Speed:1 m/s Motor start per hour: 180 Ride comfort: class(B) , Stops: 2  
stops  
Doors : 2 landing doors, control system: VVVF drive, machine type: gearless traction drive machine location: machine room less. All finishes shall be approved by the interior/arch consultant. The item including the electrical works: outlets,disconnect switches,cables,conduits,fitting, drives,distribution panel(s),control panel(s), ...,ets, with all accessories and all related ancillary works.

### 2.5.3 Mechanical Works

#### HVAC

- Install split air conditioning system to the laboratories according to ASHARAE Code

#### Fire Fighting works

- Install fire hose cabinet class 3 for the corridor between educational labs according to NFPA 14
- Educational laboratories have electric panels so a fire search system by using co2 according to NFPA 12 must be installed
- Install fire extinguishers distributed in workshops. According to NFPA 10

#### Plumbing Work

- All fixtures should be replaced and renovated which include WCs, lavatories, urinals, drain trenches according to IPC and ASPE codes
- Cold and hot water pipes for toilets should be replaced using PPR Pipes
- The design and calculations according to IPC, ASPE Codes
- Drain pipes should be replaced and renewed by UPVC Pipes according ASPE Codes.

Supply, installation, testing, commissioning, handing over and guarantee of the mechanical system equipment and related components. The number in bill of quantity is approximated
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Supply and installation and commissioning of split air conditioning system for electronic lab
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- Approx. 2 Items.

See engineering technical specification item number (23 81 26).

Supply and install and commissioning of split air conditioning system for plc lab
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- Approx. 2 Items.

See engineering technical specification item number (23 81 26).

Supply and installation and commissioning of split air conditioning system for green energy lab.
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- Approx. 2 Items.

See engineering technical specification item number (23 81 26).

Supply and installation and commissioning of split air condition system for safety and first aid rooms.
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- Approx. 2 Items .

See engineering technical specification item number (23 81 26).

Supply, install, test and hand over of electrostatic painted fire hose cabinet (class 3).
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- Approx. 1 Items.

See engineering technical specification item number (211200).

### 3 WORKS PROCEDURES

This section describes the works procedures, instructions, and directions for the contractor for certain items of this contract which need to be clearly described.

This section is compatible and aligned with the SoW and Specifications of this Tender, and any conflict should be addressed and discussed with the consultant

**This section shall give instructions to the following items**

- Steel Structural of Building No. 2
- Workshops Concrete Floors (All Existing Buildings)
- Elevations Paint
- Aluminum Windows Renovation
- Metal Doors Renovation
- Wooden Doors Renovation
- Stairs Metal Handrail

**IMPORTANT NOTE**

Any items other than the ones discussed within this section and need to be clarified, the contractor should send RFI (Request For Information) to the Consultant to be described and discussed.

### 3.1.1 Steel Structural Works Procedures (Building No. 2)

#### - **Acronyms**

- PE: Production Engineer
- QCE: Quality Control Engineer.
- WPS: Welding Procedure Specification
- QHSEMS: Quality, Health, Safety and Environmental Management System
- SPP: Senior Production Planning
- MAX: NSF own data base to follow-up work orders from creation to final release
- HAZ: Heat Affected Zone
- NDT: Non-Destructive Test

#### - **Procedure**

##### **Submittals**

The Contractor shall submit the following to the Engineer, in accordance with the Special Provisions:

- Detailed plan and schedule clearly illustrating the method and sequence by which the Contractor proposes to dismantle and remove the existing timber or steel structures (in whole or in part), including a description of the measures that will be implemented to meet the environmental requirements. The demolition procedure shall include detailed design notes and Shop Drawings that are sealed, signed and dated by a Professional Engineer.

##### **Work Order Creation**

The SPP Engineer shall create work orders on MAX and distribute it among fabrication bays in accordance to load chart and bays capabilities (labours qualifications, capacity of cranes...etc.).

##### **Material Preparation**

- The responsible Preparation Engineer shall receive materials issued from the stores for preparation.
- Technical office shall prepare nesting plans for cutting plate material and rolled steel sections.
- The nesting plans reformatted to be compatible with the cutting machines' programs through the Preparation Engineer then it will be issued to the Machine Operators through the Foreman.
- **The Sequence of preparation is as follow:**
  - **Cutting**
    - a) The cutting process includes the cutting of raw material into the required sizes on the shop drawings in accordance to the fitted program
    - b) The machine operator shall select the right pick which proper to dimension and thickness of the plate.
    - c) The machine operator shall check and adapt the pressure of gas mixture in accordance to machine parameters to guarantee good quality of cut.
    - d) All safety regulations shall be applied before starting and during the cut process.
  - The marked cut material may be Rolled or Drilled or Bended if required as per project requirements.
- Inspection by QCE shall be carried out on the prepared material as detailed in clause 3.6.

- The Preparation Engineer shall move the work order of the prepared material to the assigned assembly bay for assembly and he shall move the work order on MAX to step 1000 to state that preparation has been accomplished.

### **Assembly**

- **Fit-up**
  - o The responsible PE for assembly shall receive the prepared material from the Preparation Engineer and work order from production planning.
  - o After making sure that ID of material provided is the matching the ID with the Work Order, he shall give orders to start assembly in accordance with controlled drawings issued to his by document control
  - o Assembly shall be carried out by qualified fitters and qualified tack Welders under the supervision of a Foreman who will report to the PE.
- **Grinding**
  - o The PE shall ensure the correct preparation of weld joints and good cleanliness.
  - o The PE shall ensure that grinder has been trained on how to do the pre-use inspection of grinding machine
  - o The PE shall ensure that the only trained persons are allowed to change the disk on a grinding machine
  - o The grinder shall ensure that the steel is to be placed on a level area in order to prevent any possible damage to the cutting disc
  - o Employees to stand properly and grinder shall ensure that sparks go past them and not straight into them
- In case of queries, PE will raise a Technical Query (NSF-REC-T002) to the technical office who will return it back with recommended action.
- QCE will be informed by a copy of the Technical Query so that he can take any changes from the drawings into consideration during inspection.
- QCE will check the assembly after the PE in accordance with clause 3.6 to allow commencement of welding.

### **3.1.2 Workshops Concrete Floors (All Existing Buildings)**

As the existing concert floor needs to be renovated, the contractor should stick to the below directions:

- To protect the fixed/non removable machines the contractor should surround every machine base by marble base (6 cm Height x 4 cm thickness) with gray local marble
- As we will neglect the existing drain system, the contractor should close the existing pipes by concert and treatment material, it should also be reinforced (If needed) because of the heavy loads
- A concrete layer should be applied above the surface with the appropriate thickness and appropriate expansions treatments.
- The final surface finish should be treated by Concrete floor grinding and polish machine
- Concrete paint stripes used to determine the safety and machines borders and circulation

### **3.1.3 Elevations Paint (All Existing Buildings)**

As the Elevations are from tiles cladding, so the painting will be limited for some areas as the followings:

- The Area surrounding the Windows (20 CM offset of window border)
- The Area surrounding the Doors (20 CM offset of Door two sides and 40 cm above)
- The exposed concrete beams
- All the Areas which have no cladding

The Paint will be colored Premixed rough putty for external walls, and the color should match with the context theme (window colors, breaks cladding color, etc.)

### **3.1.4 Aluminum Windows Renovation (All Existing Buildings)**

As the Windows will be renovated, so the contractor should consider the followings:

- Fix and replace all the accessories which enhance the windows efficiency
- Repair the damaged glass but with the same tone of the existing one
- The aluminum frames should be painted by new color (matching the context) , the paint should be in aluminum paint work shop so the contractor should disassemble the windows to be transported to/from the painting workshop

### **3.1.5 Metal Doors Renovation (All Existing Buildings)**

As the Doors will be renovated, so the contractor should consider the followings:

- Fix and replace all the accessories which enhance the doors efficiency
- The Metal frame and door leaf should be painted by new color (matching the context) , the paint should be in painting workshop (whether in site or in painting workshop), but in all cases the door should be uninstalled from frame and disassemble the accessories to be perfectly painted, then assemble new sufficient accessories

### **3.1.6 Wooden Doors Renovation (All Existing Buildings)**

As the Doors will be renovated, so the contractor should consider the followings:

- Fix and replace all the accessories which enhance the doors efficiency
- A new layer of 8 mm Board should be fixed (in both sides) for renovation and perfectly painting doors
- The Wooden frame and door leaf should be painted by new color (matching the context) , the paint should be in painting workshop (whether in site or in painting workshop), but in all cases the door should be uninstalled from frame and disassemble the accessories to be perfectly painted, then assemble new sufficient accessories

### **3.1.7 Stairs Metal Handrails (All Existing Buildings)**

As the Handrails will be renovated, so the contractor should consider the followings:

- Galvanized steel stripes with appropriate thickness to be welded and fixed together for the handrails

- Before painting the handrails, it should be grinded and smoothened well
- The paint should be water and sun resistance
- The handrail up stand base of should be cladded with local granite

## 4 Engineering Technical Specifications

The Technical Specifications shall be read clearly inline with the Scope of Work of this contract.

### 4.1 Structural Specifications

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#### 4.1.1.1 DIVISION 2

#### SITE CONSTRUCTION

024100	DISMANTLING AND SALVAGE OF EXISTING STRUCTURES
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#### DIVISIONS 3

#### CONCRETE

033000	Cast-In-Place Concrete
035440	Cement-Based Screeds

#### Divisions 05

#### Metals

051200	Structural Steel
053100	Steel Decking
055000	Metal Fabrications
055213	Pipe and Tube Railings
057000	<u>Decorative Formed Metal</u>

#### 4.1.1.2

#### DIVISION 7 - THERMAL AND MOISTURE PROTECTION

071340	Polyethylene Sheet
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312000	Earth Moving
315000	Excavation Support and Protection

#### Division 41

#### Material Processing And Handling Equipment

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## **DIVISIONS 2**

### **SITE CONSTRUCTION**

#### **1.0 DESCRIPTION**

The Work shall consist of:

- 1- Dismantling and removing (in whole or in part) the existing structure together with salvaging, cleaning, handling and storing of all usable or valuable parts and materials, and disposing of nonsalvageable materials and debris;
- 2- Design, supply, fabrication, installation, maintenance and removal of demolition catch platforms;  
Backfilling of cavities created; and  
Site restoration.  
Cofferdams and shoring (if required) shall be completed in accordance with the Specifications for Temporary Works.

#### **2.0 REFERENCES AND RELATED SPECIFICATIONS**

All reference standards and related specifications shall be current issue or the latest revision at the date of tender advertisement.

##### **2.1 References**

##### **2.2 Related Specifications**

- Specifications for Supplying and Placing Backfill
- Specifications for Temporary Works

#### **3.0 SUBMITTALS**

The Contractor shall submit the following to the Engineer, in accordance with the Special Provisions:

1. A detailed plan and schedule clearly illustrating the method and sequence by which the Contractor proposes to dismantle and remove the existing timber or steel structures (in whole or in part), including a description of the measures that will be implemented to meet the environmental requirements. The demolition procedure shall include detailed design notes and Shop Drawings that are sealed, signed and dated by a Professional Engineer licensed to practice in the Province of Manitoba necessary to describe the following:
  - (a) Access roads, Site Work Roads, work bridges and working platforms in accordance with the Specifications for Temporary Works.
  - (b) Type and capacity of equipment.
  - (c) Sequence of operation, including position of equipment.
  - (d) Proposed method of traffic accommodation and protection of the travelling public, when required.
  - (e) Design of demolition catch platforms.
  - (f) Description of the measures that will be implemented to meet the requirements of Environmental Management Procedures, including all monitoring and reporting requirements.
  - (g) Details and schedule of site restoration.
  - (h) Measures to be taken to protect adjacent structures, adjacent grades and portions of existing structure to remain.
2. Upon completion of the Work, a letter bearing the seal of the Registered Professional Engineer certifying that he has carried out a personal inspection of the Work and the method of demolition and removal, including any temporary works and the measures to meet the environmental requirements, have been completed in accordance with his sealed plans and procedures.

3. A description of the quantity and location for the demolition waste that will be recycled and reused

#### **4.0 CONSTRUCTION METHODS**

##### **4.1 Closing To Traffic**

The Contractor shall not close any portion of the existing rail line or roadways to traffic or begin the

dismantling and removal operations without prior written approval from the Engineer. The approval will not be given until all required traffic control devices have been erected and the requirements of the traffic control plan have been met to the satisfaction of the Engineer.

##### **4.2 Dismantling and Salvaging**

###### **1. General**

The Contractor shall be fully responsible for ensuring safety in areas underlying and adjacent to the construction site. The Contractor will be responsible for any loss or damage caused as a result of his actions. The Contractor shall prevent movement, settlement or damage to adjacent structures, grades or portions of existing structures to remain. If the safety of the structure being removed, or adjacent structures or grades appear to be in danger, the Contractor shall cease operations and notify the Engineer immediately.

All bridge components, in whole or in part, that have been deemed non-salvable by the Engineer, shall not be reused in any other bridge or structure in the future, and shall be disposed of off-site.

The Contractor shall obtain and pay for all licenses and permits, and shall comply with all Municipal, Provincial and Federal regulations related to demolition and disposal of these materials.

###### **2. Dismantling and Salvaging**

The existing structure shall be dismantled and removed in a careful and workmanlike manner and the use of equipment or facilities that might damage portions of the structure to be salvaged shall not be permitted. Bolts, screws, pins and nails shall be removed in such a manner as to avoid splitting and breaking of the timbers. Salvable material shall be cleaned, sorted and stored as to size and length for purposes of checking and preparing lists. Salvable timber shall be trimmed to usable lengths as directed by the Engineer. Piles shall be cut off neatly at the proposed or existing ground line, as directed by the Engineer. When in water, the piles shall be cut off at the existing stream bed. All lumber such as decking shall be strapped in bundles of approximately 1 m<sup>3</sup>. The length of the salvaged stringers shall be clearly marked with yellow paint on both ends of every stringer.

###### **3. Salvable Materials**

Material having salvage value shall be carefully handled to avoid damage and shall be piled neatly at a location adjacent to the work. A detailed list of salvable material shall be prepared by the Contractor and provided to the Engineer.

The Contractor shall load and haul the salvaged material to the Beausejour Bridge Yard, unless otherwise specified in the Special Provisions.

Salvable material is the property of the Minister and the Contractor will be held responsible for all material not accounted for. The salvable material shall not be used by the Contractor for any of his construction operations.

###### **4 Demolition Catch Platform**

The demolition catch platform shall be designed and constructed as required to catch and retain all products of demolition, from falling onto roadway surfaces, railway right-of-way surfaces or open water during the Contractor's operations.

The demolition catch platform shall be designed and constructed so that the minimum vertical clearances over roadways and railways, as shown on the Drawings, are provided. The platform shall include, but not necessarily be limited to deck edge platforms and other catch platforms as required to collect and contain all products of demolition and all other debris.

**4.3 Removal and Disposal of Non-Salvable Materials** Any debris that falls off the structures onto the underlying ground, roadway or railway right-of-way shall be immediately cleaned up by the Contractor.

The Contractor shall remove all non-salvable materials and debris from the site as soon as possible. All material shall be deemed non-salvable unless noted otherwise on the Drawings or Special Provisions. Demolition debris shall become the property of the Contractor and shall be properly disposed of at an approved location, in accordance with the applicable Provincial and Municipal Regulations and Acts. Storage of non-salvable materials and debris will not be allowed on site without the written approval of the Engineer.

The Contractor shall recycle and reuse as much of the non-salvable materials and demolition debris as is reasonably practical.

#### **4.4 Backfilling of Cavities**

The Contractor shall backfill all cavities created by the dismantling and removal operations with suitable material approved by the Engineer and in accordance with the Drawings and the Specifications for Supplying and Placing Backfill.

#### **4.5 Site Restoration**

The Contractor shall restore the site to the profile and grade as shown on the Drawings and to the approval.

### **5.0 QUALITY MANAGEMENT**

The Contractor shall allow the Engineer unhindered access to the demolition areas and shall assist the Engineer in carrying out inspections, including provision of access platforms.

Upon completion of dismantling and removal (in whole or in part), a final inspection will be made by the Engineer.

### **6.0 METHOD OF MEASUREMENT**

Dismantling and salvage of existing structures will be paid for on a lump sum basis, and no measurement will be taken for this work.

### **7.0 BASIS OF PAYMENT**

Dismantling and salvage of existing structures will be paid for at the Contract Lump Sum Price for "Dismantling and Salvaging Existing Structures", measured as specified herein, and will be payment in full for performing all operations herein described and all other items incidental to the Work

## **DIVISIONS 3**

### **SECTION 033000 CAST-IN-PLACE CONCRETE**

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## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

Drawings and General Provisions of the Contract, including Contract Conditions and Division-1 Specification Sections, apply to work of this Section.

#### 1.2 SUMMARY

This section covers the specifications for cast-in-situ structural concrete work re-quired by the Contract including formwork, reinforcement, mix design, placement procedures and finishes, for the following:

- Footings.
- Foundation walls.
- Slabs-on-grade.
- Suspended slabs.
- Concrete toppings.
- Building frame members.
- Core walls.

#### 1.3 REFERENCE STANDARDS

Concrete works shall be performed in strict accordance with the Specifications, Draw-ings and the stipulations of the latest editions of the Egyptian Standard Specifications (ES), and the specifications of the American Society for Testing and Materials (ASTM) and the designations of the American Association of State Highway and Transporta-tion Officials (AASHTO) as referenced to throughout the section.

#### **Egyptian Code of Practice**

Egyptian Code of Practice for Design and Construction of Reinforced Concrete, ECP 203-2018.

#### **Egyptian Standard Specifications**

ES No.

262	Steel Bars for Concrete Reinforcement
534	Metal Scaffolding
583	Sulphate Resisting Portland Cement
917	Standard Tests for Approval of Welds
1109	Concrete Aggregates from Natural Sources
1618	Fabric of Welded Steel Bars for Reinforced Concrete
1658	Methods of Testing Concrete
1899	Part 1: Accelerating Admixtures, Retarding Admixtures and Water Re- ducing Admixtures

4756 Portland Cement (Ordinary and Rapid-Hardening)

**American Concrete Institute**

ACI NO.

Recommended Practice for Measuring Mixing, Transporting and Placing Concrete

318 Building Code Requirements for Reinforced-Concrete

350R Concrete Sanitary Engineering Structures.

**American Society for Testing and Materials**

ASTM No.

A 497 Specifications for Welded Deformed Steel Wire Fabric for Concrete Reinforcement

C 31 Practice for Making and Curing Concrete Test Specimens in the Field

C 40 Test Method for Organic Impurities in Fine Aggregates for Concrete

C 94 Specification for Ready Mixed Concrete

C 150 Standard Specification for Portland Cement

C 171 Specification for Sheet Materials for Curing Concrete

C 172 Practice for Sampling Freshly Mixed Concrete

C 309 Liquid Membrane-Forming Compounds for Curing Concrete

C 494 Specification for Chemical Admixtures for Concrete

C 1059 Specification for Latex Agents for Bonding Fresh to Hardened Concrete

American Association of State Highway and Transportation Officials

**AASHTO No.**

M-182 Burlap Cloth Made from Jute or Kenaf

T-96 Standard Method of Test for Abrasion

In the event of conflict between various codes and standards, the most stringent shall apply.

1.4 RELATED SECTIONS

The following specification sections includes requirements which relate to this section:

1. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.

## 1.5 SUBMITTALS

Submit the following in accordance with Conditions of the Contract and Division-1 Specification Sections:

**Product Data:** For proprietary materials and items, including reinforcement and forming accessories, waterstops, admixtures, patching compounds, joint systems, curing compounds, dryshake finish materials, joint sealants and others as requested by the Engineer.

**Shop Drawings:** For fabrication, bending and placement of concrete reinforcement. Details for reinforced concrete shall show, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement, special reinforcement required for openings through concrete structures, etc.

Shop drawings for formwork, prepared by an approved structural consulting engineer for fabrication and erection of forms for specific finished concrete surfaces as indicated. Show general construction of forms including jointing, special form joint or reveals, location and pattern of form, tie placement and other items which affect exposed concrete visually.

Engineer's review is for general structural and architectural applications and features only. Design of formwork for structural stability and efficiency is the Contractor's responsibility.

**Concrete Mix:** mixing, transporting, and placing equipment and procedures.

**Shop Drawing:** For concrete construction joint locations, sequence of pouring and method of curing.

**Samples:** Of all materials to be used in the Works as specified and as otherwise requested by the Engineer including names, sources and descriptions.

**Laboratory Test Reports:** For concrete materials, mix and mix design tests as specified.

**Material Certificates:** In lieu of or in addition to material laboratory test reports when permitted or requested by the Engineer. Material certificates shall indicate the date of manufacture and shall be signed by the manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

**Daily Reports:** Indicating all information related to concrete and reinforced concrete work.

## 1.6 QUALITY ASSURANCE

Materials and installed work may require testing and retesting at any time during the progress of the Works. Tests, including retesting of rejected materials or installed work, shall be done at the Contractor's expense.

**Concrete Testing Services:** A testing laboratory to perform material evaluation tests, design concrete mixes and progress concrete testing shall be founded on Site by the Contractor.

**Pre-execution Conference:** At least 15 days prior to submittal of design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing and certifications. Request that representatives of each entity directly concerned with all concrete and reinforced concrete attend this conference including, but not be limited to, the following:

Contractor's superintendent.

Laboratory responsible for concrete design mixes.

Laboratory responsible for field quality control.  
Ready-mix concrete producer.  
Concrete subcontractor.  
Primary admixture manufacturers.

## 1.7 DELIVERY, STORAGE AND HANDLING

Cement shall be delivered to Site in sealed bags bearing the manufacturer's name and the type of cement. Bulk cement delivered directly from factory in special container trucks and stored in steel, elevated weather-tight silos is acceptable.

Cement shall be fully protected during handling and transport from adverse weather conditions, moisture and over stacking.

Cement shall be stored in piles not more than ten bags high in perfectly dry weather-proof sheds, clear from the ground on planks or other damp-proofing supports. Free passages, minimum one meter wide, shall be left between stored bags and sidewalls of buildings (if any) so that each bag shall be visible.

Each consignment of cement shall be stored apart from earlier ones, and consignments shall be used in the order they were delivered. Any consignment which has become lumped caked or otherwise adversely affected shall be removed from Site immediately.

Steel Reinforcement: Deliver and handle steel reinforcement in a manner to prevent bending and damage. Store according to grade, length, and diameter.

## PART 2 PRODUCTS

### 2.1 CEMENT

Unless otherwise indicated on Drawings and Geotechnical report recommendations, type of cement used shall be ordinary Portland cement to ES No. 4756 and ASTM C 150 Type I for above-grade castings. For below-grade castings, cement type shall be ordinary Portland cement to ES No. 4756 and ASTM C 150 type I unless otherwise indicated on Geotechnical report recommendations and Drawings.

Use one brand of cement throughout the project. The source of supply of cement shall be subject to the Engineer's approval. The date of manufacture must be recorded. Follow-up tests shall be performed by an approved testing laboratory and the Contractor shall at all times furnish test certificates and proof that the required standard specification has been complied with.

Cement used in concrete work shall be less than six months old from date of manufacture.

### 2.2 AGGREGATES

Aggregates shall not contain harmful materials which may reduce the strength or durability of concrete nor materials which may attack the reinforcement. Mixed coarse and fine aggregates together shall not contain more than 0.05% (by weight) chloride ions.

Coarse Aggregate: Coarse aggregate shall be gravel or crushed stone or a combination thereof meeting the requirements of ECP 203-2018, ASTM C33 standard.



Gravel or crushed stone shall be durable particles of uniform quality throughout. Each of the materials shall have a wear of not more than 40% when tested according to AASHTO Method T-96 Standard Method of Test for Abrasion.

Coarse aggregates shall not contain more than 0.04% (by weight) chloride ions.

Coarse aggregate shall be free from salt, mica, alkali, organic matter or other deleterious material either free or as adherent coating on particles. It shall not contain more than 3% by weight of clay lumps, not more than 1.0% by weight of shale, not more than 5.0% by weight laminated, friable, flat, chip-like, thin or elongated particles. The loss by decantation when tested by approved methods shall not exceed 1%.

Quality test on the fine and coarse aggregate material shall be complied with C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates.

The nominal maximum size of aggregate shall be governed by the type of structure element in which concrete to be cast.

Fine Aggregate: Furnish natural siliceous sands from approved pits, free from Opaline, Felspar, mica, fool's gold, siliceous magnesium, limestone or other deleterious or reactive substances. Fine aggregate shall be clean, hard, durable, and well graded meeting the requirements of ECP 203-2018, ASTM C33 standard.

Fine aggregates shall not contain more than 0.06% (by weight) of chloride ions.

Fine aggregate shall also be free from salt or alkali and shall not contain more than 3% by weight of clay lumps. When subjected to the color test for organic impurities (ASTM C 40), it shall not show a color darker than the standard. When tested by approved methods, it shall conform to the grading and percentage passing each sieve by weight. The material removed by the Standard Test of Decantation shall not exceed 4%.

All specified quality testing on the aggregate material shall be carried out by an independent testing agency approved by the Engineer.

Coarse and Fine Aggregate: Shall comply with ES No. 1109, ASTM C33, BS EN 12620, having absorption as measured in accordance with BS 812 not greater than 2%.

Fine, Coarse and All-in Aggregates: Used for concrete shall comply with the requirements of their corresponding Egyptian Standard Specifications.

The Grading of Aggregates: Shall be such as to produce concrete of the specified proportions that will work readily into position without segregation and without the use of excessive water content. The grading limits for sand, gravel, or all-in aggregates given in Table 1 and Table 2 may serve as a guide for this purpose. It shall be the Contractor's responsibility to design and work out concrete mixes to attain the specified strengths.

Table 1

Grading Requirements for Coarse Aggregate

Sieve Size mm	Percentage by mass passing BS Sieves for Nominal Sizes						
	Graded Aggregate			Single-sized Aggregate			
	40 mm to 5 mm	20 mm to 5 mm	14 mm to 5 mm	40 mm	20 mm	14 mm	10 mm
50.0	100	-	-	100	-	-	-

37.5	90-100	100	-	85-100	100	-	-
20.0	35-70	90-100	-	0-25	85-100	100	-
14.0	-	-	90-100	-	-	85-100	100
10.0	10-40	30-60	50-85	0-5	0-25	0-50	85-100
5.0	0-5	0-10	0-10	-	0-5	0-10	0-25
2.36	-	-	-	-	-	-	0-5

Table 2  
Grading Requirements for Fine Aggregate

Sieve Size	Percentage by Mass Passing BS Sieve			
	Overall Limits	Additional Limits for Grading		
		C	M	F
10.00 mm	100	-	-	-
5.00 mm	80-100	-	-	-
2.36 mm	60-100	60-100	65-100	80-100
1.18 mm	30-100	30-90	45-100	70-100

600 microns	15-100	15-54	25-80	55-100
300 microns	5-70	5-40	15-18	5-70
150 microns	0-15*	-	-	-

Increased to 20% for crushed stone fines except when they are used for heavy floors.

Note: Fine aggregate not complying with Table 2 may also be used provided that such materials produce concrete of the required quality.

**Maximum Nominal Size of Coarse Aggregate:** The maximum nominal size of coarse aggregate shall be as large as possible within the limits specified in the code of practice or as shown on Drawings but in no case greater than 1/5 of the narrowest dimension of the member, and shall be less than 1/3 of the depth of slab, provided that concrete can be placed without difficulty so as to surround all reinforcement thoroughly and to fill corners of forms.

The grading of aggregates shall be controlled by furnishing coarse aggregate in one size for 10 mm maximum size and in two sizes for aggregate of 25 mm maximum size.

In no case shall maximum size of coarse aggregate exceed  $\frac{3}{4}$  of the minimum clear spacing between bars or between reinforcing bars and forms.

For general purpose, a maximum size of 25 mm shall be satisfactory.

### 2.3 MIXING WATER

Mixing water for concrete shall be drinking water (potable water) or water of chemical composition acceptable for drinking (except for bacteriological limits) and be clean and free from organic impurities, industrial, contamination oils, salts and any other substances that may be harmful to cement or steel reinforcement.

The mixing water shall meet the requirements of the Egyptian code of practice for design and construction of reinforced concrete ECP 203-2018

### 2.4 STEEL REINFORCING BARS

Reinforcement shall be as shown on Drawings and shall comply with the requirements of the Egyptian Standard Specifications ES No. 262 for:

High Yield Deformed Bars: According to the Egyptian standard specifications no. 262 with a minimum proof stress of 400 MPa, grade B400DWR according to ECP203-2018 table 2-8.

Mill Certificates: shall be submitted for each consignment of reinforcing steel. This mill certificates shall state the place of manufacturing, chemical composition, manufacture prequalification, physical properties and manufacture test reports.

Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for the properties that are declared by the manufacture Specimens shall be selected by the representative of testing laboratory under the supervision of the Engineer from batches received on Site. Specimen periodical sampling and testing shall be directed by Engineer.

### 2.5 TIE WIRE

Tie wire shall be annealed steel. Except where otherwise required, tie wire shall be minimum 1.2 mm diameter.

### 2.6 FORM RELEASE AGENT

Commercially formulated form release agent that shall not bond with stains or adversely affect concrete surface. Formulate form release agent with rust inhibitor for steel form facing materials.

### 2.7 CURING MATERIALS

Water: Shall be as specified in Clause 2.3.

Liquid Membrane-Forming Curing Compound: Clear liquid membrane-forming curing compound complying with ASTM C 309, Type 1, Class B. Moisture loss shall not be more than 0.55 kg/m<sup>2</sup> when applied at a rate of 0.210 liter/m<sup>2</sup>.

Use membrane-curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

## 2.8 SUPPORTS FOR REINFORCEMENT

Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars in place and which may be in contact with forms, plain concrete footings or mud slabs, shall have their legs or ends plastic protected or they shall be rust-proofed or galvanized.

## 2.9 FORMWORK

Form for concrete work can be of timber, plywood or metal, lumber or wrought formwork shall be used where shown on Drawings or directed by Engineer.

Furnish form in largest practicable size to minimize number of joints. Lumbers shall be dressed on two edges for tight fit. Provide forms with sufficient wall thickness to resist plastic cement loads without deformation.

## 2.10 ADMIXTURES

Admixtures may be used, with the written approval of the Engineer, in concrete for special reasons such as waterproofing, retarding initial setting time, improve workability, reduce amount of water, etc. Use admixtures strictly in accordance with manufacturer's instructions.

Admixtures shall be of no harmful effect with regard to concrete or steel. The maximum limit shall be given as a ratio of the weight of cement. Concrete containing admixtures shall at least resist 90% of the compression, bending and bond between steel and concrete stresses of the corresponding value for concrete prepared without admixtures provided that such concrete shall satisfy the specified characteristic concrete strength as specified in Table 4.

Use admixtures that contain no more than 2% chloride ions of the admixture weight or 0.03% of the cement weight complying to BS No. 8110 and compatible with other admixtures and cementitious materials, do not use admixture containing calcium chloride.

Water-Reducing Admixture: Shall comply with ASTM C 494, Type A.

High-Range Water-Reducing Admixture (Super Plasticizer): Shall comply with ASTM C 494, Type F or Type G.

Water Reducing and Retarding Admixture: Shall comply with ASTM C 494, Type D.

Bonding Agents: Work as adhesive or sealing agent, can be based on polyvinyl acetate copolymer or viscous and shall produce 2 component product based on modified epoxy resin, according to manufacturer and shall be applied directly to wet surface to bond fresh to old concrete or to repair crack in concrete.

## 2.11 CONCRETE MIXES

Designed mixes shall be used throughout the Works, unless otherwise shown on Drawings and Bill of Materials. Standard concrete mixes can be used, if specifically called for and noted on Drawings.

## 2.12 DESIGNED MIXES

General: The Contractor shall design concrete mixes ECP 203-2018 and in compliance with ACI 211.1 and ACI 301 standards to satisfy the strength requirements of various classes of concrete to be used in the Works.

Concrete mix design shall start as soon as practical after the award of the Contract, and well in advance of any scheduled concreting work to allow adequate time for the design and testing of concrete cubes as defined hereinafter. No concreting shall be commenced before the satisfactory completion of design and testing of the designed mix samples.

Quantities of cement, fine and coarse aggregate shall be measured by weight.

Approved designed mixes shall be maintained throughout the duration of the Contract.

Mix designs shall satisfy the specified characteristic concrete strength requirements given in Table 4. In order to allow for unavoidable variations, the mix shall be de-signed in accordance to ECP 203-2018 conditions and limits as mentioned in Clause (2-2-4-2).

Concrete mix may be provisionally accepted on basis of 7-day results, when these satisfy the requirements for 28-day results, and strengths shall not be less than eighty percent of those required at 28-days.

Concrete grades required for this project shall be as shown in Table 4.

Trial Mixes: Before commencement of work, trial mixes shall be prepared under full-scale conditions and tested in accordance with ES 1658, Methods of Testing Concrete.

Trial mixes and all required testing on fresh and hardened concrete shall be conducted by an independent and approved testing agency, approved by the Engineer.

Representative samples of materials to be used shall be taken and a trial mix using the proposed proportions shall be made on each of three different days produced by the same plant and under the same supervision. The workability of each of these three trial mixes shall be determined. The proposed mix proportions shall be accepted if the average strength of the three trial mixes is not less than the characteristic strength plus 30 kg/cm<sup>2</sup>. Further trial mixes shall be made if any of the cube results in any set is less than the specified characteristic concrete strength or if the difference between the highest result and the lowest result in any of the sets exceeds 20% of the overall average of the set.

Cube Tests for Control Purposes: Works cube tests shall be made on concrete samples during the progress of the works. Concrete for test specimens shall be taken at the point of deposit. A minimum of nine (9) cubes 150 mm shall be taken for each day's pour or each 100 m<sup>3</sup> of concrete poured whichever is smaller. Separate samples shall be taken for each structural element if poured separately. From each sample three (3) cubes shall be tested after 7 days, three (3) after 28 days and three (3) kept as spares.

If the number of cubes test is less than 20 cubes, the result of any cube test shall not be less than the required characteristic strength, and the difference between the highest and the lowest results shall not exceed 25% of the average of all results.

If the number of cubes test is more than 20 cubes, the number of results less than the required characteristic strength shall not exceed one (1) for every 20 results, and the difference between the highest and the lowest results shall not exceed 25% of the average of all the results.

**Table 4**  
**Non-Air Entrained Concrete Grades**

<b>Grade</b>	<b>Maximum Aggregate Size</b>	<b>Characteristic Strength after 28 Days</b>	<b>Target Slump (mm)</b>	<b>Uses</b>
		<b>2</b>		

	(mm)	(kg/cm )		
A	19	600	50	Columns , shear Walls ,retaining walls and founda- tions
B	19	450	50	Slabs ,beams ,stairs , para- pets...etc
C	25	250	75	Concrete for Slab on grade only
D	25	200	75	Plain concrete

When the result of the 7-day test is unsatisfactory, the Contractor may elect to re-move and replace the defective concrete without waiting for the 28-day test. If the result of the 28-day test is unsatisfactory, all concreting shall be stopped. The Contractor shall then; test concrete of the suspected portions of the structure in such a manner as may be appropriate to the particular conditions or parts of the works.

Should tests prove that concrete is unsatisfactory then the condemned concrete shall be cut out, removed and replaced by the Contractor.

When works cube tests show concrete strengths consistently higher than those specified, the contractor may reduce the number of tests to be made to the minimum required by the Referenced Standards.

Minimum Water Cement Ratio should be complied with Egyptian Code of Practice for Design and Construction of Reinforced Concrete, ECP 203-2018.

For Pumpable concrete, slump values shall be achieved using chemical admixtures approved by the Engineer.

Pumpable concrete slump values shall be not less than 125 mm and not more than 200 mm according to ECP 203.

## 2.13 QUALITY CONTROL

**Supervision:** Employ a competent person and permanently keep him on Site until the completion of concreting work. His first duty shall be to supervise all stages in preparation and placing of concrete. He shall be responsible for supervising all tests of materials, molding and testing of concrete cubes and maintaining and calibrating all mixing and measuring plant.

**Aggregates:** Separate storage bins with adequate provision for drainage shall be provided for each size of aggregate used (40-20 mm, 30-20 mm, 25-20 mm, 20-10 mm, 10-5 mm, and 5 mm down).

The grading of coarse and fine aggregates shall be determined at least once a week to check whether the grading are similar to those of the samples used in trial mixes.

**Batching and Mixing Plant:** Concrete shall be machine mixed by appropriate drum-type batch machine mixer.

If centralized batching plant is planned for use by the Contractor, concrete shall be mixed dry, transported in transit mixers to place of work where water is to be added and final mixing is to be carried. If haulage distances are very short, mixing can take place at the batching plant and concrete transported in agitators or transit mixers.

About 10% of water required for the batch shall enter the drum in advance of cement and aggregates. Remainder of water shall be added gradually while the drum is in action so that required quantity is in the drum by the end of the first quarter of mixing time. Concrete shall be mixed until a mixture of uniform color and consistency is obtained and mixing shall continue for at least 1.5 minutes after all water has been added. In no circumstances shall mixing time be less than that recommended by the manufacturer of the mixer. Should mixing be determined by a certain number of revolutions of the drum, then adequate means and meters shall be provided to check number of revolutions before the discharge of each batch mix.

The amount of concrete mixed in any one batch shall not exceed the rated capacity of the mixer. The whole of the batch is to be evacuated before loading the drum with a fresh batch. On cessation of work, including all delays exceeding 20 minutes, the mixers and all handling plant shall be washed with clean water and any deposits of old concrete in drums shall be cleaned out by rotating clean aggregate and water in the drum, or by other appropriate means, before any fresh concrete is mixed. Mixers shall be properly maintained and all worn out blades shall be replaced with new ones or built-up by welding.

Concrete shall not be remixed if mixing water has been added to it for more than twenty (20) minutes. No additions to concrete shall be permitted once mixed.

If concreting work is done by using ready mixed concrete it shall conform to ASTM C 94 and concrete shall be mixed dry, transported in transit mixers to place of work where water is to be added and final mixing is to be carried. If haulage distances are very short, mixing can take place at the batching plant and concrete transported in agitators or transit mixers.

Provide batch ticket for each batch discharged and used in the work, indicating project identification, name and number, date, time, mix type, mix quantity, and amount of water added.

In special cases for concrete-work of non-important items concrete may be mixed at each place of work with a batch mixer of an approved type fitted with a water-measuring device.

Control of Water Content: Water/cement ratio shall be controlled at values determined in trial mixes. Appropriate allowances shall be made for water contained by the aggregates. Provisions shall be made to determine the moisture content of aggregates. Tests shall be performed at least once a day for fine aggregate but less frequently for coarse aggregate. Further tests shall be made whenever there is a noticeable difference in moisture content of any of the aggregates.

Workability: Workability shall be controlled by direct measurement of water content, making allowance for water contained by fine and coarse aggregates. Slump test shall be used as a guide for workability.

## 2.14

### STANDARD MIXES

All design mixes should be subjected for the Engineer approval.

## PART 3 EXECUTION

### 3.1 CONCRETE

Transporting: Concrete shall be handled from the place of mixing to the place of final deposit as rapidly as practicable by methods that will prevent segregation or contamination of the ingredients.

It shall be deposited as nearly as practicable in its final position to avoid re-handling or flowing.

Advance Notice: Give sufficient advance notice to the Engineer and anyone who has the right to attend the casting of concrete before starting to place concrete in any unit to permit the inspection of forms, reinforcing steel placement, and preparation for casting. No concrete shall be placed in any unit, prior to the proper completion of formwork and placement of reinforcing steel and the Engineer's written acceptance of such works.

Daylight: Unless the getting all necessary permits for working at dark, concrete mixing, placing and finishing shall be done in daylight hours only. Placement shall not commence when it is evident that the work cannot be completed before dark unless adequate provisions are made to lighten the entire site of all operations.

Weather Conditions: Concrete placement shall not be permitted when impending weather conditions may result in rainfall or low temperature which will impair the quality of finished work. In case rainfall should occur after placing operations have started, the Contractor shall provide ample covering to protect the work.

Placing: Before placing concrete, inspect and complete formwork installation, reinforcing steel, etc... Notify other crafts to permit installation of their work and cooperate with other trades in setting such work. Forms shall be thoroughly cleaned of all dirt, shavings, loose stones etc., and shall be well soaked with water. No standing water shall be present inside forms when concreting.

Concrete shall be placed in its final position before setting has commenced and shall not be subsequently disturbed. Concrete shall be placed in layers not exceeding 500 mm depth to ensure proper compaction and vibration, or in layers of such thickness that no concrete shall be placed on concrete that has hardened sufficiently to cause the formation of seams of weakness. Place each layer while underlying one is still plastic. Concrete shall not be freely dropped more than 1.5 m without the use of tremies.

Concreting shall be carried out continuously up to construction joints designated by the approved shop drawings. A detailed record shall be kept by the Contractor for all concreting operations reflecting date, time, shade, air temperature, relative humidity, and weather conditions for every part of the Works.

Construction Joints: Locate and install construction joints as indicated in shop drawings. Contact surfaces of hardened concrete shall be thoroughly hacked, swept clean, wetted, and covered with a coat of neat cement mortar grout freshly mixed and placed immediately before receiving fresh concrete. Construction joints shall be at right angles to the general direction of the member and provided with joggles where possible. Additional reinforcement shall be placed at construction joints as shown on Drawings.

All construction joints incorporating water stops as indicated on Drawings or joints of water-retaining structures shall incorporate rubber waterstops as specified hereinbefore. Jointing of waterstops other than by heat welding shall not be permitted. Waterstops shall be installed so that they are securely held in their correct positions whilst concrete is placed. Secure flanges of waterstops to reinforcing bars with 1.2 mm diameter tie wire spaced at a maximum of 450 mm. Use only approved tool recommended by manufacturer to perforate the flanges of waterstops. Concrete shall be fully and properly compacted around waterstops to ensure that no voids or porous areas remain. Where re-enforcement is present, adequate clearances shall be left between it and all waterstops to permit proper compaction of concrete. No holes shall be made through any waterstops to pass reinforcing steel.



Joints at concrete surfaces shall have 20 mm wide by 20 mm deep grooves for the full length of construction joints on both exposed sides. All joints shall be formed to the correct dimensions as specified and shown on Drawings and sealed with a sealing compound applied after the concrete has cured. .

Shear Keyways and Control Joints: Unless otherwise shown on Drawings, all construction joints of water-retaining structures shall be provided with shear keyways. Form keyways to details shown on Drawings.

Control joints shall be groove formed with hand tool finishing, at intervals as directed by the Engineer. Minimum depth of joint shall be equal to 1/4 of the slab depth.

Compaction: Concrete shall be thoroughly compacted during placing operation and carefully worked around reinforcement, around embedded fixtures and in-to corners of forms so that it will be in close contact with reinforcement and free of honeycombs. Concrete shall be compacted by approved immersion-type mechanical or electromechanical vibrators of proper sizes and diameters best suited for the cast element. Over vibration causing segregation shall be avoided and transportation of concrete through forms by vibrators shall not be permitted.

Curing: Protect freshly placed concrete from premature drying. Concrete shall be kept constantly wet for seven days. This period may be reduced to five days for rapid hardening cement. Water if used for curing concrete shall be same as that for concrete mixing. As climate is hot, dry or windy, concrete shall be covered by a layer of waterproof material immediately after placing, to be protected from rapid moisture loss before and during finishing operation. Maintain cover in contact with concrete for seven days.

Proper precautions and measures shall be taken to ensure proper curing of concrete by either setting up a mechanical water fog-spray system covering the total concreted surface, this system shall operate continuously during the curing period, or by covering the concreted surfaces with burlap weighing not less than 300 gm/m<sup>2</sup> or absorptive cover and thoroughly saturate cover with water so that they shall be kept moist continuously during the curing period.

Curing shall start immediately after the disappearance of free surface water. For special purposes additional extra test cubes of each portion or member, if requested by the Engineer, shall be cured in the same place and exactly in the same manner as the portions or members they represent. After seven days, they shall be transported to the laboratory where they shall be kept in water until tested.

Curing compound as specified in Clause 2.8.2 may be used for curing concrete in lieu of water. Curing compound shall be applied to all exposed concrete surfaces as soon as the surface of the freshly placed concrete becomes dull, (within 2 hours after surface water has disappeared) or immediately after form stripping of columns, vertical surfaces of walls and beam sides. Curing compound shall be applied by means of sprayers or rollers and shall result in a continuous whitish film. Rate of spraying shall be in strict conformance to the manufacturer's recommendations.

Work in Hot Weather: When shade air temperature is 35°C and rising, the coarse aggregate shall be sprayed with water or cooled by appropriate measures. Special precautions shall be taken during all concreting operations so that temperature of concrete does not exceed 32°C when placed.

Fresh concrete placed at these temperatures shall be carefully shaded from sunrays and wind.

Allowed Concrete pouring temperature shall be complied with ECP 203-2018.

In case of temperature more than 35°C, pouring shall be instructed by the Engineer

Cleaning: Before placing reinforcement into forms, all steel for reinforcement shall be cleaned and freed from loose mill scale, loose rust, oil and grease or other harmful matter that may destroy or reduce bond strength.

Placing: Concrete cover to reinforcing steel shall be as indicated on Drawings and shall be measured from the outer surface of steel reinforcement and outer surfaces of stirrups in case of beams and columns. All reinforcement shall be placed and rigid-ly maintained in positions shown on Drawings and secured against displacement. This shall be ensured by tying, welding, using spacing blocks, hangers, bolsters, metal clips or supports. Accurately place reinforcement and securely wire tie with pincers in precise position at all points where bars cross. Tie stirrups to bars at both top and bottom. No supports or metal clips shall be placed in contact with forms unless plas-tic-coated, galvanized or rust-proofed. The ends of binding tie wire shall be bent inward and trimmed allowing no encroachment on the concrete cover trimmed with exercising special care for surfaces to remain exposed and unpainted. Placing of reinforcement shall be checked by the Engineer and in no case shall concrete be poured around any steel that has not been approved by the Engineer.

Bending: All bars shall be bent cold and in accordance with bending schedules.

Bending by heat may be allowed for large diameter bars only after receiving a written permission from the Engineer.

If heating is permitted, provisions shall be made so that bending temperature does not exceed 800°C and steel is left to cool gradually. Sudden cooling by water is strict-ly prohibited.

For rods of cold twisted bars such as "Tor Steel" which have their strength increased by cold working, bending by heat shall not be permitted.

Reinforcement shall not be bent or straightened in a manner that will injure the material.

Where reinforcement bars are bent aside at construction joints and afterwards bent back into approximately their original positions, care shall be taken to ensure that at no time shall the radius of the bend be less than 4 bar diameters for normal mild steel and 6 bar diameters for high-yield steel. Care shall also be taken when bending back bars to ensure that concrete around bars is not damaged.

Splicing of reinforcing bars shall not be permitted except where shown on Drawings. All splices and overlaps shall comply with the requirements of the Egyptian Code of Practice for design and construction of reinforced concrete and the notes written on Drawings.

Spacing Blocks: Where concrete blocks are used to ensure the specified cover to the reinforcement, they shall be made of mortar not leaner than 1 part cement to 2 parts sand. Steel tie wire shall be embedded in spacing blocks to securely tie them to the reinforcement.

Plastic spacers and chairs may be used; they shall be according to steel diameter and required cover.

Spacers and chairs shall be placed at a maximum spacing of 1.0 meters.

The contractor shall provide all necessary distance pieces, chairs, and spacer bars at his own expense.

### 3.3 FORMWORK

General: Design, erect, support, brace and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. It shall be constructed to the correct size, and shape, to remain sufficiently tight to prevent loss of grout or mortar of concrete. Forms for concrete surfaces can be of timber, plywood, or metal. Wrought formwork shall be used where shown on Drawings or directed by the Engineer.

Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only.

Bolts and rods shall be used for internal ties. They shall be so arranged that when the forms are removed no metal shall exist within 30 mm of any surface. All holes shall be filled with mortar after the removal of the bolts and all external parts of the metal ties.

All exposed corners and edges of concrete shall be chamfered by using wood, metal, and PVC or rubber 25 x 25 mm triangular fillets inside the forms. Chamfered fillets shall also be used at horizontal construction joints in concrete walls to produce uniform smooth lines

Forms in contact with concrete shall be cleaned and treated with approved composition or form oil. Care shall be taken not to spatter reinforcement with such compositions.

**Metal Formwork:** Metal forms shall be selected for their surface flatness and smoothness. Where metal forms are selected for use, provide metal forms of standard manufactured units with a system to function easily and properly, to comply with the dimension, design loads of the project and of sufficient strength to withstand pressure of concrete placing operations.

Metal forms shall be fabricated by a specialized professional manufacturer having a minimum of 5 years' experience in successful fabrication of metal form and similar units required for this project.

Submit manufacturer's instruction, catalogues, detailed information concerning system, installation instruction, handling, jointing, connections, details at openings and supplemental steel framing, fasteners and accessories. Metal sheets shall be of sufficient thickness and reinforced with concealed stiffeners or backing materials or both as required producing required concrete smooth finish surface.

Provide forms easy to remove without hammering or prying against concrete surface.

Rust-stained steel formwork shall not be acceptable.

**Reuse of Formwork:** Clean surfaces of forms to be reused in work, remove fins and laitance.

Delaminated or otherwise damaged form-facing material shall not be acceptable for exposed surface.

**Strutting:** The design and erection of the formwork together with the adequacy of all bracing and strutting shall be the responsibility of the Contractor. The Contractor shall ensure that there shall be no deformations or failure of the shuttering during concreting and shall include in his rates for all necessary scaffolding or staging, boxing out for fittings and all other works incidental to the shuttering to be erected.

The Contractor shall submit to the Engineer detailed drawings and calculation of special strutting-work, if so requested, for his approval. Said approval shall not relieve the Contractor from his responsibilities in case of failure and his obligation to repair all defects at his own expense.

**Provision for Embedded Articles:** Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings accurately. All pipes passing through concrete walls, beams, or slabs shall pass through sleeves fixed into position before concreting. All pipes and sleeves passing through concrete shall have steel flanges welded to them as specified and as shown on Drawings.

Embedded articles shall be built-in as the work proceeds. Where impractical, steel inserts shall be built-in or holes and box-outs shall be left for fixation after removal of forms.

Threads of bolts shall be protected with a cold applied petroleum-based anti-corrosion coat and sealing tape or similar material approved by the Engineer, during delivery, storage and concreting.

After concreting, the threaded bolt projections, with attached nuts and washers shall be protected against corrosion with similar sealing tape and protected against mechanical change with a timber shield or otherwise approved method until the erection of the steel works.

**Formwork Coating:** Coat contact surface of formwork before reinforcement is placed with an approved non-residual, rust preventative form coating compound that will not bond with, stain or adversely affect

concrete surfaces and shall not impair subsequent treatment of concrete surfaces. Do not allow form-coating materials to accumulate in forms or to contact with hardened concrete surfaces against which fresh concrete shall be placed.

Form coating shall be applied to provide a thin uniform coating without contaminating the reinforcement.

Cleaning: All rubbish, particularly chippings, shavings, tie wire trim, and sawdust shall be removed from interior of forms before concrete is placed. Provide temporary openings in wall forms for cleaning. Prior to pouring, clean interior of walls as specified hereinbefore and patch openings.

Removal of Forms: In any case, forms shall not be removed until the concrete has attained sufficient strength to ensure structural stability and to carry both dead load and any construction loads that may be imposed on it. Concrete shall be hard enough so that surfaces will not be injured in any way when reasonable care is used in removing forms.

The minimum period of time that shall elapse between pouring concrete and removal of forms shall be in no case less than the age shown in ECP 203-2018.

In no circumstances shall forms of structural elements that support weight of concrete be removed and struck until concrete reaches a cube strength of at least seventy five percent (75%) of the concrete characteristic strength.

Forms shall be removed with due care and attention avoiding all shock or vibration that would damage concrete.

The Contractor shall make good all concrete surfaces after removal of forms.

Shores and Supports: Before removal of forms temporary shore and brace suspended slabs with suitable members of sufficient strength to withstand imposed loads.

After removal of forms, shore the produced slab so that, the employed supports are concentric on the shores supporting the underlying slab.

Keep shores in place until concrete has attained its required strength and heavy loads due to construction operation have been removed.

Surface Finish: Brushed or rough-tamped finish shall be applied on top surfaces of all cast in-situ slabs.

### 3.4 TESTING AND INSPECTION

Testing of Concrete: Testing for compressive strength of concrete sampled during the progress of the work shall be as follows:

Sampling Concrete: Concrete for the test specimens shall be taken at point of deposit to ensure that specimens are representing concrete cast into structure members, a number of concrete samples shall be taken from different points.

The quantity of each concrete sample shall be enough to mould the number of test specimens required and shall be taken from one work point. The location from which each sample is taken shall be noted.

Test Specimens: Test specimens shall be prepared as specified in ES 1658.

Storage of Test Specimens: Test specimens shall be stored on Site at temperature 15-20°C and humidity not less than 90%. Twenty-four hours after making specimens, they shall be released from moulds, marked, stored and cured by immersing them in water temperature (15-20°C). Specimens to be sent to a laboratory for testing, shall be packed for transit in damp sand or other suitable damp material and shall reach the laboratory at least 24 hours before test time. On arrival at the laboratory, they shall be similarly immersed in water until test date.

Method of Testing: Tests shall be made at age of concrete corresponding to that of the specified strength. Tests shall be made as specified in ES 1658.

Testing of Steel Reinforcement: Reinforcement steel used in concrete shall be tested before use for each consignment on Site. Tests shall be carried on three specimens for each different diameter, the results of which shall comply with the characteristic strength given by ES 262 for tested grade.

Core Testing of In Place Concrete: When strength tests of cube specimens have failed to meet the specified acceptance criteria, perform core testing and take samples of in-place concrete as required. Results of in-place concrete core testing shall be evaluated in accordance with ACI 318.

Load Testing of Structures: Should the Engineer have any doubts as to the workmanship and quality of the concrete of floor systems based on his evaluation for results of testing of concrete specimens and results of concrete core samples, then he may order the load testing of parts or whole sections of the structures, such testing shall be performed in full compliance with the requirements of the Egyptian Code of Practice for Design and Construction of Reinforced Concrete as amended herein.

This test shall be made after the expiry of 6 weeks of effective hardening of concrete. In such tests, the structure shall be subjected in 4 approximately equal stages to a superimposed load equal to one and half times the specified superimposed live load used for design plus a load equivalent to the final dead load (floors, partitions, etc..) and this load shall be maintained for a period of 24 hours, the reading of the deflection and width of the cracks shall be taken before removal of load. The value of deflection shall not be more than the limiting value as per the above mentioned code.

During the test, struts strong enough to sustain the whole load shall be placed in position leaving a gap under members to allow for the expected deflection. If deflection value is more than the above mentioned limit and if within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load and the crack width is within allowable limits the test loading shall be repeated. The part of structure shall be considered rejected if the recovery after the second test is not at least 75% of the maximum deflection shown during the second test. If during the test, or upon removal of the load, the structure shows signs of weakness, undue deflection or faulty construction, it shall be reconstructed or strengthened as necessary and instructed by the Engineer at the Contractor's own expense.

All such load testing shall be performed by the Contractor and at his own expense.

Repairs: No repairs or patching are to start before obtaining the approval of the Engineer as to the techniques to be followed and the extent of the work. The Engineer shall have the right to stop any or all work of repairs even after his approval of same if in his opinion the Contractor is not carrying the work properly or that there may exist a hazard or danger to the structure. All repairs, if approved, shall be made by the Contractor at no extra cost to the Employer.

### 3.5 TOLERANCES OF REINFORCED CONCRETE

The following are the allowable tolerances in Reinforced Concrete which shall be applicable as mentioned in the Egyptian Code of Practice for design and construction of reinforced concrete, ministerial Decree No. 203-2018.

END OF SECTION 0330000

## **DIVISIONS 3**

### **SECTION 035440 CEMENT-BASED SCREEDS**

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#### **PART 1     GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Submittals
- 1.4 Delivery, Storage, And Handling

#### **PART 2     PRODUCTS**

- 2.1 Products And Materials
- 2.2 Reinforcement
- 2.3 Curing Materials
- 2.4 Related Materials
- 2.5 Design Mixes
- 2.6 Mixing

#### **PART 3     EXECUTION**

- 3.1 Examination
- 3.2 Preparation
- 3.3 Screed Application
- 3.4 Protection And Curing
- 3.5 Repairs

## SECTION 035440 - CEMENT-BASED SCREEDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

This Section includes:

Cement-based screeds underlayment for interior finish floorings.  
Roof screed to attain required roof slopes.

#### 1.3 SUBMITTALS

Product Data: For each type of product indicated. Include mixing and application instructions.

Shop Drawings: Include plans, sections, and details showing slopes where indicated, screed thicknesses, penetrations, perimeter terminations control and expansion joints, reinforcement and sequence coating.

Design Mixes: For each screed mix specified.

Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

cement  
Admixtures.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

## PART 2 PRODUCTS

### 2.1 PRODUCTS AND MATERIALS

Screed: Cement-sand mix with admixtures applied over concrete deck to receive another finishing material.

Portland cement: Egyptian Standard Specification (E.S.S.) No. 4756.  
Compressive Strength: As indicated on drawings.

Slump: 200 mm maximum at point of placement for concrete containing high-range water-reducing admixture (super-plasticizer) and 75 mm maximum for other concrete.

Screed Additive: Plasticizers and water-retaining agents formulated for use with screed when applied to substrate and conditions indicated and to ap-proval.

Air Entraining Admixture: ASTM C260.  
Water Reducing Admixture: ASTM C494, Type A.  
Water-Reducing and Accelerating Admixture: ASTM C 494, Type F.

Aggregate: Normal Weight Aggregate: E.S.S. No. 1109 and as follows:

Fine aggregate, consisting of sand, clean, hard and free of deleterious matter. Grading is to be according to mix design.

Coarse aggregate for fine-mix concrete screeds: Maximum aggregate size is to be 8 mm.

Water: Potable.

Pre-Mixed Cement Screed: Pre-mixed blend of Portland cement, water, and aggregate offering high quality cement-based floor screed over concrete substrate, specially formulated to be low shrinkage to minimize the formation of surface cracking becomes a flowable and pumpable floor screed with addition of water, excellent workability properties and good compaction. Comply with the following requirements:

Compressive Strength at 28 Days: As indicated on drawings.  
Flexural Strength at 28 Days: 6 MPa.  
Linear Shrinkage at 28 Days: < 0.1%, maximum.

### 2.2 REINFORCEMENT

Fibrous Reinforcement: 100% virgin polypropylene fibrillated fibers containing no re-processed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Proportion shall be 0.9 kg per m<sup>3</sup> of concrete:



Specific Gravity: 0.91.  
Tensile strength: 345 - 758 N/mm<sup>2</sup>.

## 2.3 CURING MATERIALS

Absorptive Cover: Class 2, burlap cloth made from jute weighing approximately 305 g/sq. m when dry.

Water: Potable.

## 2.4 RELATED MATERIALS

Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752. Use cork fillers for applications that may be subject to surface water.

Acrylic-Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

Control Joint Profiles: Comply with requirements specified in Division 5, Section "Architectural Joint System". Intermediate movement zone shall be 10-mm wide. Height of profile shall be selected from manufacturer's full range in coordination with screed depth and finishing material that shall be installed above screed.

## 2.5 DESIGN MIXES

Prepare design mixes for mortar concrete screed by laboratory trial batch method according to ACI 211.1 and ACI 301 for each type and strength.

Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by the American Concrete Institute, ACI 301.

## 2.6 MIXING

Screed: Mix screed materials and water in appropriate drum-type batch machine mixer.

# PART 3 EXECUTION

## 3.1 EXAMINATION

Examine substrates, with Installer present, for conditions affecting performance of screed. Proceed with application only after unsatisfactory conditions have been corrected.

Verify that concrete base slabs meet finish and surface profile requirements in Division 3, Section "Cast-in-Place Concrete".

## 3.2 PREPARATION

Concrete Substrates: Mechanically remove laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair screed bond.

Install joint-filler strips where screed abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

Extend joint-filler strips full width and depth of joint, terminating flush with screed surface, unless otherwise indicated.

Terminate full-width joint-filler strips 13 mm below screed surface where joint sealants, specified in Division 7, Section "Joint Sealants," are indicated.

Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

### 3.3 SCREED APPLICATION

Mix and scrub bonding slurry into dampened concrete to a thickness of 1.5 to 3 mm as recommended by manufacturer, without puddling. Place screed while slurry is still tacky.

Place screed continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

Screed surface with a straightedge and strike off to correct elevations.  
Slope surfaces uniformly where indicated.

Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

Finishing:

(Substrate screed): Consolidate surface with power-driven floats as soon as screed can support equipment and operator. Re-straighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, and free from cracks, ridges or depressions. Finish screeds to a smooth surface with sheen.

Finishing (Roof): Consolidate surface manually using screeding level, trowel and all necessary tools. Re-straighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, and free from cracks, ridges or depressions. Finish screeds to a smooth surface with sheen.

Finish and measure surface so deviation from 3-m long straightedge, is +/-3mm maximum as gradual irregularities. Sudden irregularities or low spots are not permitted.

Construction Joints: Construct joints true to line with faces perpendicular to surface plane of screed, at locations indicated or as approved by Engineer.

Coat face of construction joint with SBR adhesive at locations where screed is placed against hardened or partially hardened screed.

Expansion Joints: Provide expansion joints in screeds coinciding on expansion joints in underlying structural slabs.

Control Joint Profiles: Control joint profiles for screeds shall be used under movement joints required in finishing layers. Position profile in such a way that they will be in direct alignment with the finishing layers movement joints.

Screed Mix: Use cement-sand screed for screeds less than 70 mm in thickness. Use fine-mix concrete for screeds 70 mm thick and more.

### 3.4 PROTECTION AND CURING

General: Protect freshly placed screed from premature drying and excessive cold or hot temperatures.

Begin curing immediately after finishing screed. Cure by one or a combination of the following methods:

Moisture Curing: Keep surfaces continuously moist for not less than seven days with water or absorptive cover, water saturated and kept continuously wet. Cover screed surfaces and edges with 300-mm lap over adjacent absorp-tive covers.

### 3.5 REPAIRS

Defective Screed: Repair and patch defective screed areas, including areas that have not bonded to concrete substrate.

END OF SECTION 035440

**DIVISIONS 5**

**SECTION 051200**  
**STRUCTURAL**  
**STEEL**

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**PART 1     GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Reference Standards
- 1.4 Submittals
- 1.5 Quality Assurance
- 1.6 Delivery, Storage And Handling
- 1.7 Coordination

**PART 2     PRODUCTS**

- 2.1 Materials
- 2.2 Grouting
- 2.3 Welding
- 2.4 Fabrication
- 2.5 Anchorage Of Masonry To Steel Structure
- 2.6 Galvanizing
- 2.7 Shop Painting
- 2.8 Testing

**PART 3     EXECUTION**

- 3.1 Erection
- 3.2 Quality Control
- 3.3 Tolerances For Structural Steel Work
- 3.4 Cleaning And Touch-Up Painting

SECTION 051200 - STRUCTURAL STEEL

PART 1     GENERAL

## 1.1 RELATED DOCUMENTS

Drawings and General Provisions of the Contract, including Contract Conditions and Division-1 Specification Sections, apply to work of this section.

## 1.2 SUMMARY

Extent of structural steel work is shown on Drawings. Schedules, notes and details are included to show size and location of members, typical connections and type of steel required.

Structural steel shall be fabricated according to the shop drawings prepared by the Contractor, after Engineer's approval, and based on the Drawings and specifications.

## 1.3 REFERENCE STANDARDS

All structural steel work shall be performed in strict accordance with the specifications, drawings and the stipulations of the Egyptian Code of Practice, the Egyptian Standard Specifications (ES) Latest Edition, the British Code of Practice, British Standard Specifications (BS) and the specifications of the American Society for Testing and Materials (ASTM) as noted herein below.

Egyptian Code of Practice ECP No.

279-2001 Steel Constructions and Bridges Egyptian

Standard Specifications

ES No.

243 Mechanical Tests for Welded Joints

257 Metal Arc Welding of Structural Steel

260 Structural Steels

350 Steel Pipes Suitable for Screwing

4756 Portland Cement (Ordinary and Rapid Hardening)

427 Commercial Bolts

428 Commercial Nuts

431 Plain Steel Washers for Special Purposes

435 Covered Carbon Steel for Arc Welding

715 Synthetic Priming Paints

917	Welder Qualifications
1058	Round Bars for Hot Rolled Steel Sections
1059	Hot rolled Steel Sections (Non-round Sections)
1060	Hot Rolled Steel Sections (Angles)
1061	Hot Rolled Steel Section (Beams)
1110	Mild Steel Sheets, Slips and Plates (Cold Rolled Steel Sheets)
1170	Hot Rolled Strip and Sheets
1171 continuous Process)	Mild Steel Sheets Strips and Plates (Hot Rolled Plates by Continuous and Non-
1423	General Technical Delivery Requirements (for Steel)

#### British Standard Specifications

##### BS No.

5135 Arc Welding of Carbon and Carbon Manganese Steel

5950 Structural Use of Steelworks in Buildings American Society for  
Testing and Materials

##### ASTM No.

A 6M	Specifications for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
A 36M	Specification for Structural Steel
A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 325M	Specification for High-Strength Bolts for Structural Steel Joints
A 490M	Specification for High Strength Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints
E 94	Guide for Radiographic Testing
E 142	Method for Controlling Quality of Radiographic Testing
E 146	Practice for Ultrasonic Contact Examination of Weldments
E 165	Practice for Liquid Penetrant Inspection Method
F 959	Specification Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

#### Steel Structures Painting Council (SSPC)

#### American Welding Society (AWS)

In the event of conflict between various codes and standards the most stringent conditions shall apply.

#### 1.4 SUBMITTALS

Product Data: Submit producer's or manufacturer's specifications and installation instructions for the following products:

Structural steel (each type), including certified copies of mill reports covering chemical and physical properties  
Ordinary bolts (each type), including nuts and washers  
High Strength bolts (each type)  
Structural steel primer and final paints  
Shrinkage-resistant grout  
Welding materials

Include laboratory test reports and other data to show compliance with specifications (including specified standards).

All connections details not shown in design drawings should be designed and detailed by the steel fabricator based on straining actions supplied by the engineer

Shop Drawings: Submit final design and detailed shop drawings prepared under supervision of a registered engineer, including the following.

Details of bracings, cuts, connections, cambers, holes and other pertinent data.

Indicate welds by standard symbols and show size, length and type of each weld, and materials involved. Information on whatever splices are necessary as a result of rolling limitations.

Qualities, diameters and distance between bolts with clear indication of the different bolts.

Final designs and their calculation sheets for the structural steel system under the same provisions and design criteria given on the Drawings.

Check Design Drawings issued within these documents. Inform the Engineer, for his decision, in case of any conflict, errors, etc.

Setting drawings, templates and directions for installation of anchor bolts and other anchorages to be installed during concreting.

Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

Structural steel including chemical and physical properties.

Bolts, nuts, and washers including mechanical properties and chemical analysis.

Direct-tension indicators.

Tension-control, high-strength bolt-nut-washer assemblies.

Shear stud connectors.

Shop primers.

Nonshrink grout.

Welding certificates: :Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs) to be according to AWS D1.1

Test Reports: Provide certificate signed by the manufacturer giving the steel grade.

Submit copies of reports of tests conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results.

Surveys: Submit certified copies of each survey conducted by a professional engineer, showing elevations and locations of base plates and anchor bolts to receive structural steel and final elevations and locations for major members. Indicate discrepancies between actual installation and drawings.

Method Statement: Submit for approval, Quality Control method statement in accordance with quality assurance procedures, and Erection method statement.

No fabrication work is to commence before approval of test reports and submittals

## 1.5 QUALITY ASSURANCE

Materials: Allow for a qualified inspection agency to inspect and test materials at shop and field. Such inspection and tests shall not relieve the Contractor of responsibility for providing materials and fabrication procedure in compliance with specified requirements. Promptly remove and replace materials or fabricated components, which do not comply.

Installer Qualifications and Fabricator Qualifications : Engage a firm experienced in structural steel similar to that indicated for this Project and With a record of success-ful in-service performance

Tests, including retesting of rejected materials and fabricated work, shall be done at the Contractor's expense.

Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, ES 257 and ES 917. Provide certification that welders to be employed in work have satisfactorily passed qualification tests. If recti-fication of welders is required, retesting shall be the Contractor's responsibility.

## 1.6 DELIVERY, STORAGE AND HANDLING

Deliver materials to Site at such intervals to ensure uninterrupted progress of work.

Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time so as not to delay the work progress.

Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms or other supports. Protect steel mem-bers and packaged materials from erosion and deterioration.

Do not store materials or structure in a manner that might cause distortion or dam-age to members or supporting structures. Repair or replace damaged materials or structures as directed.

Store fasteners in a protected place in sealed containers with manufacturer's labels intact

## 1.7 COORDINATION

Furnish anchorage items to be embedded in or attached to other construction with-out delaying the Work. Provide setting diagrams, sheet metal templates, instruc-tions, and directions for installation.

# PART 2 PRODUCTS

## 2.1 MATERIALS

Metal Surfaces, General: For fabrication of work which shall be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes and minor defects by grinding or by welding and grinding, prior to cleaning, treating and application of surface finishes.

The smoothing and straightening of plates and sections shall be carried out with a press or a roll machine in cold conditions.

All steel built up sections and plates shall be steel grade 52 with minimum yield stress of 3600 Kg/cm<sup>2</sup> except for hot rolled sections which shall be steel grade 37 with min-imum yield stress of 2400 Kg/cm<sup>2</sup> as illustrated on design Drawings. Also all materials shall be sound and free from such flaws, segregation, cracks lamination or surface flavors and must comply with the corresponding Egyptian Standard Specifications. For high-strength low-alloy steel, provide electrodes, welding rods and filler metals equal in strength and compatible in appearance with parent metal joints.

Materials used shall comply with ES No. 1423 and ES 260.

Structural Steel Shapes, Plates and Bars: All materials shall be sound and free from such flaws, segregation, cracks lamination or surface flavors and must comply with the corresponding Egyptian Standard Specifications. For high-strength low-alloy steel, provide electrodes, welding rods and filler metals equal in strength and compatible in appearance with parent metal joints.



teel Pipe: Structural steel hollow sections are to conform to :

ASTM A53 type E, Grade B, having a minimum yield stress of 240 N/mm<sup>2</sup> or equal.  
ASTM A500 Grade C having a minimum yield stress of 345 N/mm<sup>2</sup> or equal

Steel Sections: Shall comply with: ES No. 1060 Part I Equal Angles / Part II Unequal Angles and ES No. 1061, ASTM A36M and ASTM A572M.

Checkered Plates: The thickness shall not be less than 6 mm. Raised lugs shall be diamond shaped and shall have an angled and opposed pattern.

Steel sheets shall comply with ES No. 1171, ASTM A36M and ASTM A572M mild steel sheet

Steel Bearing Plates: ASTM A 36/A and ES No. 1110.

#### BOLTS, CONNECTORS, AND ANCHORS

Headed Stud-Type Shear Connectors: conform to AWS D1.1, type B, minimum yield strength 345 N/mm<sup>2</sup> at 0.2% offset, made from steel to ASTM A108, with mechanical properties to ASTM A370, and applied in accordance with Recommended Practices for Stud Welding.

Anchor Bolts: Anchor bolts to conform to ASTM F1554 grade 55 unless otherwise indicated.

Carbon-Steel Bolts and Threaded Fasteners: ES No. 427-428 for carbon-steel, hex-head bolts and threaded fasteners; Carbon-steel nuts; And flat, unhardened steel washers.

High-Strength Bolts, Nuts, and Washers:

ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; And ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

ASTM A 490M, Type 1, or DIN 6914 grade 10.9 heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers, uncoated.

Finish: Hot-dip zinc coating, ASTM F2329 for bolts.

## 26 GROUTING

Grouting: Cement Grout: Portland cement conforming to ES 4756 and clean, uniformly graded, natural sand. Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum water required for placement and hydration.

Non-metallic Shrinkage-Resistant Grout: Pre-mixed non-metallic, non-corrosive, non-staining product, containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents.

Non-Shrink Epoxy Grouting: Shall be medium viscosity, solvent free, two components product, with a high mechanical strength, chemical resistance and adhesive properties, recommended adhesion for steel to concrete or concrete to concrete and anchorage of bolts.

## 27 WELDING

Welding Electrodes: Comply with AWS standards and ES No. 435, AWS D1.1/ D1.1M.

Welding Electrodes: All welding shall be metal-arc welding of adequate capacity. The Contractor shall bear in mind the different types of electrodes when choosing the welding machine to be used. Type and diameter of electrodes will be according to the characteristics of the base material and the position of the welding.

## 2.4 FABRICATION

Shop Fabrication and Assembly: Fabricate items of structural steel for locations shown with dimensions, spacing, details and anchorages as indicated on Drawings, in accordance with the Egyptian Code of Practice (ECP) Specifications and other equivalent international standards as indicated on approved final shop drawings.

Provide camber in structural members where indicated taking into account deflection due to self-weight and applied loads.

Use new materials of size and thickness indicated, or if not indicated, as required to produce strength and durability in finished product for use intended; Use proven details of fabrication and support.

All plates, bars and sections shall be flattened and straightened and made free from twist before any work is done on them.

Allow for thermal movement resulting from a maximum change in ambient temperature of 30°C in the design, fabrication and installation to prevent buckling, and over-stressing of welds and fasteners. Base design calculations on actual temperature of metals and to both solar heat gain and nighttime sky heat loss.

Shear and punch metals clearly and accurately and remove burrs.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 0.8 mm unless otherwise indicated.

Remove sharp and rough areas on exposed traffic surfaces.

At exposed connections, grind exposed welds smooth and flash to match and blend with adjoining surfaces.

Form exposed connections with hairline joints, using concealed fasteners wherever possible.

Provide for anchorage of type shown, coordinate with supporting structure. Fabricate and space anchorage devices to provide adequate support for intended use.

Properly mark and match-mark materials for field assembly maintain marking until steel has been erected. Fabricate for delivery sequence which shall expedite erection and minimize field handling of materials.

Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs and other defects. Bearing plates shall be machined to receive trusses.

Connections: Weld or bolt shop connections as indicated.

Bolt field connections, except where welded connections or other connections are indicated.

Provide high strength threaded fasteners for principal bolted connections.

Welded Construction: Comply with ES Code and ES No. 257 and AWS D1.1/ D1.1M for procedures, appearance and quality of welds and methods used in correcting welding work.

Specified weld length in shop drawings shall be effective length excluding end criteria.

For high-strength low-alloy steels, follow welding procedures as recommended by steel producer for exposed and concealed connections.

All bevels or chamfers of edges indicated on Drawings shall be carried out before welding and in strict accordance with the dimensions and indications specified.

Butt welds shall always be continuous and of complete penetration.

Weld shall be ground smooth and flush with adjacent surfaces.

Holes for other work: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on final shop drawings.

Provide threaded nuts welded to framing and other specialty items as indicated to receive other work.

Cutting: Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

Perform cutting by machine to greatest extent possible or cutting shall be carried out with saw, shears or flame cutting. Electric arc cutting is strictly forbidden.

Accurately mill ends of columns and other members transmitting loads in bearing.

Comply with fabrication tolerance limits of ECP 205.

For Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Shop weld shear connectors, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's printed instructions.

## 2.5 ANCHORAGE OF MASONRY TO STEEL STRUCTURE

Provide and weld at surface against masonry works straps of metal strip 6 mm thick, 40 mm wide and 250 mm long, capable to sustain without failure a load 6 times the loads imposed by masonry.

Straps shall be at a vertical distance of 500 mm o.c.

## 2.6 GALVANIZING

Hot-Dip Galvanized Finish: Where indicated on Drawings, apply zinc coating by the Hot-dip process to structural steel according to ASTM A 123/ A 123M.

Fill vent holes and grind smooth after galvanizing.

Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

## 2.7 SHOP PAINTING

Comply with requirements of Division 09 Section "Painting"

General: Shop paint structural steel, except those members or portions of members to be embedded in concrete or mortar.

Do not paint surfaces, which shall be welded or high-strength, bolted with friction type connection.

Paint on surfaces, which are scheduled to receive sprayed-on fireproofing and shall be in accordance to fireproofing material manufacturer's recommendations.

Apply 2 coats of paint to surfaces, which are inaccessible after assembly or erection or shall be embedded in other work.

Surface Preparation: All surfaces of steel shall be thoroughly cleaned by sand blasting in the fabricating shop. After inspection and before transporting, clean steel works to be painted. Remove loose rust, loose milscale and spatter, slag or flux deposits and dust.

Dirt, burrs and other foreign matter shall be removed by grinding. All grease and oil shall be removed by solvents. Surfaces shall be thoroughly dry before painting.

Painting for members with fire proofing: Immediately after surface preparation apply structural steel primer paint as mentioned in Division 9 Section "Intumescent Painting":

Primer: Zinc rich epoxy based compatible with applied intumescent paint.

Providing the intumescent fire proof paint as mentioned in Section "Intumescent Painting" with thickness in accordance to fireproofing manufacturer's recommendations and according to the fire zoning and fire rating hours mentioned in the architectural fire zoning drawings and mentioned in BOQ for steel structure.

Top Coat: Acrylic resin based top sealer coat, compatible with applied intumescent paint.

Painting for members with no fire proofing: Immediately after surface preparation apply structural steel primer paint as mentioned in Division 9 Section "Painting":

General: Coating system for structural steel shall comply with ISO 12944-5 for Corrosivity Category C2, high durability.

Warranty for corrosion resistant :10 years

Exterior Paint

Primer: Zinc rich epoxy based.

Top Coat: Polyurethane based top coat.

Minimum Dry Film Thickness: According to manufacture written recommendations to comply with Corrosivity Category according to ISO 12944-

#### 5. Interior Paint

Primer: Zinc rich epoxy based.

Top Coat: Epoxy based coat.

Minimum Dry Film Thickness: According to manufacture written recommendations to comply with Corrosivity Category according to ISO 12944-

## 2.8 TESTING

The Engineer shall perform shop inspections and tests and prepare test reports, and shall state in each report whether the test specimen complies with or deviates from requirements.

Correct deficiencies in, or remove and replace structural steel not complying with requirements.

Shop-bolted connections shall be tested and inspected in addition to visual inspection, shop welded connections shall be tested.

Perform non-destructive tests of welds on at least 10% of all fillet weld lengths as a first testing round, depending on the results, the Engineer might instruct the Contractor to extend the testing process at no extra cost. Selection of tested samples to be approved by the Engineer. Non-destructive tests of butt welds (groove) to be done on 100% of the welded lengths.

Visual inspection, shop-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:

Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.

Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1

## PART 3 EXECUTION

### 3.1 ERECTION

**Surveys:** Employ a professional engineer or land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces and locations of anchor bolts and similar devices, before erection work proceeds and report discrepancies to the Engineer. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon by the Engineer.

**Temporary Planking:** Provide temporary planking shores, braces and working plat-

forms as necessary during erection to keep structural steel secure, plumb and in alignment to effectively complete work.

Arrange that sufficient tack welds, bolts, braces or guy ropes are used to ensure that work shall remain rigid until final bolting, riveting or welding is completed.

**Anchor Bolts:** Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work.

Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.

Remove temporary supports when permanent structural steel, connections, and bearings are in place.

**Setting Bases and Bearing Plates:** Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

All bearing members, stanchion bases, beams and girders shall be securely supported on suitable steel packs.

Packs shall not be larger than necessary, and shall not protrude unduly from stanchion base. They shall be grouted in and the grout shall totally enclose them.

Set loose and attach base plates and bearing plates for structural members on wedges, setting nuts or other adjusting devices.

Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.

Bearing plates shall not be grouted until the steel work has been finally leveled and plumbed.

Bearing plates shall be bedded in neat Portland cement Non shrinkage grout to a thickness not exceeding 25 mm.

Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials and allow curing.

For proprietary grout materials, comply with manufacturer's instructions.

Maintain erection tolerances of structural steel within the Egyptian Code ECP 205.

**Field Assembly:** Set structural frames accurately to position, lines and elevations indicated. Align and adjust various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces, which shall be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

Level and plumb individual members of structure within specified tolerances.

Locate decking bundles to prevent over loading of supporting members.

Make allowance for difference between temperature at time of erection and mean temperature at which structure shall be when completed.

Splice members only where indicated and accepted on shop drawings.

Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

Comply with specifications for bearing, adequacy of temporary connections, alignment and removal of paint on surfaces adjacent to field welds.

When ordinary bolts are used, the matching of the holes shall be checked by inserting a cylindrical gauge 1.5 mm smaller in rated diameter than the hole.

All holes shall be drilled not punched.

Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

Bolts shall be of sufficient length to show at least one full thread beyond the nut after tightening.

When using high strength bolts a washer shall always be placed under the head and under the nut. Nuts shall be tightened with ganged wrenches measuring the applied torque.

Site connections generally shall be made with a minimum of two bolts to any connections.

Gas Cutting: Do not use gas-cutting torches in field for correcting fabrication errors in primary structural framing. Cutting shall be permitted only on secondary members, which are not under stress, as acceptable to the Engineer. Finish gas-cut sections equal to a sheared appearance when permitted.

Cold sawn machine cut and flame cut edges shall be cleaned free of burns and slag and left as smooth as regular as those produced by edge planning.

Ensure bolts are in center of slotted holes after erection of structure

For Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Shop weld shear connectors, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's printed instructions.

### 3.2 QUALITY CONTROL

Engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform field inspections and tests and prepare test reports.

Testing agency shall conduct and interpret tests and state in each report whether tested work comply with requirements, and specifically state any deviations therefrom.

Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

Correct deficiencies in or remove and replace structural steel work, which inspections and test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any non-compliance of original work and as may be necessary to show compliance of corrected work.

Field Bolted Connections: Shall be tested and inspected in accordance with BCP.

Field Welding: Remove paints from surfaces adjacent to field welds. All due precautions shall be taken to protect the welding works against the wind.

It is forbidden to accelerate the cooling of welds by artificial means.

On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

Perform visual inspection of all welds. In addition to visual inspection field welded connections shall be inspected and tested during fabrication according to equipment as follows, at the Engineer's option:

## 28 Liquid Penetration Inspection ASTM E 165

Magnetic Particle Inspection performed on root pass and on finished weld ASTM E 709

3. Radiographic Inspection ASTM E 94

4. Ultrasonic Inspection ASTM E 164

Perform non-destructive tests of welds on at least 10% of all fillet weld lengths as a first testing round, depending on the results, the Engineer might instruct the Contractor to extend the testing process at no extra cost. Selection of test-ed samples to be approved by the Engineer. Non-destructive tests of butt welds (groove) to be done on 100% of the welded lengths.

In addition to visual inspection, shop-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:

Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.

Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

### 3.3 TOLERANCES FOR STRUCTURAL STEEL WORK

Comply with tolerance limits specified in ECP 205

No structural steel work member shall differ from the lines, level and plumb as

shown on Drawings by more than 3 mm and any such departure from the true line or plumb shall not occur at a rate in excess of 1%. Any work laying outside the above mentioned tolerances shall be dealt with as directed by the Engineer and at the Contractor's expense.

### 3.4 CLEANING AND TOUCH-UP PAINTING

Immediately after erection clean field welds, bolted connections and abraded area of shop paint. Necessary solvent cleaning shall be done before hand cleaning or power tool cleaning.

Remove loose rust, mill scale, loose paint by hand chipping, scraping, sanding and wire brushing, or by power tool cleaning.

Apply paint to exposed areas using same materials used for shop painting.

Apply by brush or spray to provide a minimum film thickness as manufactories rec-ommendations.

Clean areas where galvanizing is damaged or missing and repair galvanizing to com-ply with ASTM A 780

END OF SECTION 051200



## **DIVISIONS 5**

### **SECTION 053100**

#### **STEEL DECKING**

##### **PART 1 GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Action Submittals
- 1.4 Informational Submittals
- 1.5 Quality Assurance
- 1.6 Delivery, Storage, And Handling

##### **PART 2 PRODUCTS**

- 2.1 Performance Requirements
- 2.2 Roof Deck
- 2.3 Composite Floor Deck
- 2.4 Noncomposite Form Deck
- 2.5 Accessories

##### **PART 3 EXECUTION**

- 3.1 Examination
- 3.2 Installation, General
- 3.3 Roof-Deck Installation
- 3.4 Floor-Deck Installation
- 3.5 Field Quality Control
- 3.6 Protection

## SECTION 053100 – STEEL DECKING

### PART 1 GENERAL

#### 29 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

Section Includes:

Roof deck.  
Composite floor deck.

Non-composite form deck.

Related Requirements:

Section 033000 «Cast-in-Place Concrete» for normal-weight and lightweight structural concrete fill over steel deck.

Section 051200»Structural Steel Framing «for shop- and field-welded shear connectors.

Division 9 painting Sections for repair painting of primed deck and finish

painting of deck.

#### 1.3 ACTION SUBMITTALS

Product Data: For each type of deck, accessory, and product indicated.

Shop Drawings:

Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

For steel deck indicated to comply with certain design loadings, include structural analysis data sealed and signed by the qualified professional engineer who was responsible for its preparation.

#### 1.4 INFORMATIONAL SUBMITTALS

Welding certificates signed by Contractor certifying that welders comply with requirements specified under the «Quality Assurance» Article.

Product Certificates: For each type of steel deck Signed by steel deck manufacturers certifying that products furnished comply with requirements.

Evaluation Reports: For steel deck.

Field quality-control reports.

## 1.5 QUALITY ASSURANCE

Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, «Structural Welding Code – Sheet Steel».

Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's «Electrical Construction Equipment Directory» for use with standard header ducts and outlets for electrical distribution systems.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's «North American Specification for the Design of Cold-Formed Steel Structural Members.»

## 30 ROOF DECK

Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with «SDI Specifications and Commentary for Steel Roof Deck,» in SDI Publication No. 31, and with the following:

Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G90 (Z275) zinc coating or approved equal.

Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 80, zinc coating or approved equal; Cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

## 31 COMPOSITE FLOOR DECK

Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with «SDI Specifications and Commentary for Composite Steel

Floor Deck,» in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G90 (Z275) zinc coating or approved equal.

Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G60 (Z180) zinc coating or approved equal; With unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard baked-on, rust-inhibitive primer.

## 2.4 NONCOMPOSITE FORM DECK

Non-composite Form Deck: Fabricate ribbed-steel sheet non-composite form-deck panels to comply with «SDI Specifications and Commentary for Non-composite Steel Form Deck,» in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G90 (Z275) zinc coating or approved equal.

Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G60 (Z180) zinc coating or approved equal; Cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

## 2.5 ACCESSORIES

General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; Or self-drilling, self-threading screws.

Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; Self-drilling, carbon-steel screws 4.8mm minimum diameter.

Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 230 Mpa, not less than 0.91mm design uncoated thickness, of same material and finish as deck; Of profile indicated or required for application.

Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 230 Mpa, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 1.90 mm thick, with factory-punched hole of 9.5mm minimum diameter.

Flat Sump Plates: Single-piece steel sheet, 1.90 mm thick, of same material and finish as deck. For drains, cut holes in the field.

Recessed Sump Pans: Single-piece steel sheet, 1.90 mm thick, of same material and finish as deck, with 76-mm- wide flanges and level recessed pans of – 38-mm minimum depth. For drains, cut holes in the field.

Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

## PART 3 EXECUTION

### 3.1 EXAMINATION

Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

Install temporary shoring before placing deck panels if required to meet deflection limitations.

Locate deck bundles to prevent overloading of supporting members.

Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

Place deck panels flat and square and fasten to supporting frame without warp or deflection.

Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

### 3.3 ROOF-DECK INSTALLATION

Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 38 mm long, and as follows:

Weld Diameter: nominal.

Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support.

Weld Washers: Install weld washers at each weld location.

Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of  $\frac{1}{2}$  of the span or mm, and as follows:

Mechanically fasten with self-drilling, 4.8mm diameter or larger, carbon-steel screws.

- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of mm, with end joints as follows:

End Joints: Lapped 51 mm minimum.

Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 305 mm apart with at least one fastener at each corner.

Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Division 7.

### 3.4 FLOOR-DECK INSTALLATION

Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

Weld Diameter: nominal.

Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 305 mm apart, but not more than 457 mm apart.

Weld Washers: Install weld washers at each weld location.

Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or mm, and as follows:

Mechanically fasten with self-drilling, 4.8mm diameter or larger, carbon-steel screws.

- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of mm, with end joints as follows:

End Joints: Lapped.

Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

Electrified Cellular Floor Deck: Install cellular floor system with deck.

Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components specified in Division 16 Section «Underfloor Raceways for Electrical Systems» with installation of electrified cellular metal floor deck.

3.5 FIELD QUALITY CONTROL

Testing Agency: Engage a qualified testing agency to perform tests and inspections at Contractor's expenses.

Field welds will be subject to inspection.

Testing agency will report inspection results promptly and in writing to Contractor and Engineer.

Remove and replace work that does not comply with specified requirements.

Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 PROTECTION

Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A780M and manufacturer's written instructions.

Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on of prime-painted deck immediately after installation, and apply repair paint.

Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 9.

Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

**DIVISIONS 5**

**SECTION 055000**

**METAL FABRICATIONS**

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## SECTION 055000 – METAL FABRICATIONS

### PART 1 GENERAL

#### 32 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

This Section includes the following:

Steel framing and supports for mechanical and electrical equipment.

Steel framing and supports for applications where framing and supports are not specified in other Sections.

Elevator machine beams, hoist beams, and divider beams.

Support angles for elevator door sills.

Miscellaneous steel trim.

Miscellaneous framing supports.

Concealed applications where framing and supports are not indicated.

Steel framing and supports for engineering applications.

Shelf angles.

Loose bearing and leveling plates.

Steel welded plates and angles for casting into concrete not specified in other Sections.

Metal ladder.

Ladder safety cage.

Vanity supports.

Grating.

Products furnished, but not installed, under this Section include the following:

Loose steel lintels.

Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

Related Sections include the following:

Division 3 Sections for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.

Division 4 Section «Unit Masonry» for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.

Division 9 Section “Painting” for surface preparation and field applied finishes.

### 1.3 SUBMITTALS

PART 1 - Product Data: For each product specified.

PART 2 - Shop Drawings: Show fabrication and installation details for metal fabrications.

SCHEDULE 0 - Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

SCHEDULE 1 - Provide templates for anchors and bolts specified for installation under other Sections.

PART 3 - Samples:

SCHEDULE 0 - Samples representative of materials and finished products as may be requested by the Engineer.

### 1.4 QUALITY ASSURANCE

PART 4 - Fabricator Qualifications: Firms experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units, without delaying the work.

PART 5 - Engineering Responsibility: Engage fabricators who utilize qualified structural engineers licensed to practice in Egypt to prepare design calculations, shop drawings, and other structural data.

PART 6 - Welding: Qualify procedures according to 1.

Egyptian Standards E.S.S. 921.

### 1.5 COORDINATION

PART 7 - Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

## PART 2 PRODUCTS

### 2.1 STEEL WELD PLATES AND ANGLES

PART 8 - Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

### 33 MISCELLANEOUS STEEL TRIM

PART 9 - Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

PART 10 - Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

SCHEDULE 0 - Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

PART 11 - Galvanize exterior miscellaneous steel trim and interior miscellaneous steel trim, where indicated.

### 34 VANITY SUPPORTS

PART 12 - Vanity supports are to be fabricated from hot-rolled, normal-mild steel sections in welded construction to details indicated on Drawings and approved shop drawings. Finish is to be field-applied alkyd paint system as specified in Division 9, Section «Painting». Color is to be as directed by the Engineer.

## 2.4 GRATING

PART 13 - Ductile Cast Iron Bar Grating: Medium and heavy duty gratings, manufactured from ductile cast iron. All castings shall be free from blow holes, shrinkage defects, swells, cracks and other defects.

### 35 Loading Class: A15

PART 14 - Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings from the same basic material as grating. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

PART 15 - Finish of Cast Iron Gratings: One coat of epoxy zinc rich primer shop applied

## 2.5 FINISHES, GENERAL

PART 16 - Comply with NAAMM's «Metal Finishes Manual for Architectural and Metal Products» for recommendations for applying and designating finishes.

PART 17 - Finish metal fabrications after assembly.

## 2.6 EXTERNAL CHAIN LINK FENCE AND GATE

PART 18 - Gate frame is to be fabricated from black welded formed steel sections and plates made from normal mild steel. Provide welded steel lugs for building in gate openings. Frame is to be square with the corners mitered. Galvanize frame after fabrication.

PART 19 - Chain link fabric is to be to ASTM F 668, galvanized and PVC coated mild steel wire helically wound and interwoven to form a continuous mesh without knots or ties except in case of knuckling or twisting the ends of the wire to form the selvage at both ends of the fabric. The woven wires will form a mesh with diamond-shaped openings. Size to be as indicated on Drawings.

PART 20 - Finish: Use polyurethane coating over epoxy system complying with requirement in division 9 sections "Painting".

## 2.7 METAL ROOF PANEL

PART 21 - Steel Sheet: Metallic-Coated Steel Sheet EN 10143, Coated by the hot-dip process and prepainted by the coil-coating process to comply with EN 10147.

SCHEDULE 0 - Zinc-Coated (Galvanized) Steel Sheet: 275 gm/m<sup>2</sup>.

SCHEDULE 1 - Surface: Smooth, flat finish.

SCHEDULE 2 - Exposed Finishes: Apply the following coating, as specified or indicated on Drawings.

PART 22 - Powder Coating Finish: Apply polyester powder coating electrostatically, lead free, comply with EN 12206, and Qualicoat Class 2, with a cured-film thickness not less than 60 microns.

PART 23 - Color: As selected by Engineer from manufacturer's full range.

## PART 3 EXECUTIONS

### 3.1 INSTALLATION, GENERAL

PART 24 - Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; With edges and surfaces level, plumb, true, and free of rack; And measured from established lines and levels.

PART 25 - Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

PART 26 - Field Welding: Comply with the following requirements:

SCHEDULE 0 - Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

SCHEDULE 1 - Obtain fusion without undercut or overlap.

SCHEDULE 2 - Remove welding flux immediately.

SCHEDULE 3 - At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

PART 27 - Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

PART 28 - Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

### 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

PART 29 - General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

PART 30 - Anchor supports for operable partitions securely to and rigidly brace from building structure.

PART 31 - Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

SCHEDULE 0 - Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in «Installing Bearing and Leveling Plates» Article.

PART 32 - Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in «Installing Bearing and Leveling Plates» Article.

SCHEDULE 0 - Grout baseplates of columns supporting steel girders after girders are installed and leveled.

### 3.3 INSTALLING BEARING AND LEVELING PLATES

PART 33 - Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

PART 34 - Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

SCHEDULE 0 - Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; Use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.

SCHEDULE 1 - Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.4 ADJUSTING AND CLEANING

PART 35 - Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting.

SCHEDULE 0 - Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

PART 36 - Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

PART 37 - Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with Egyptian standards.

END OF SECTION 05500

**DIVISION 07**  
**SECTION**  
**071340**  

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**POLYETHYLENE**  
**SHEET**  

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**PART 1      GENERAL**

- 1.1      Summary
- 1.2      Submittals
- 1.3      Quality Assurance

**PART 2      PRODUCTS**

- 2.1      Polyethylene Sheets

**PART 3      EXECUTION**

## SECTION 071340 – POLYETHYLENE SHEET

### PART 1 GENERAL

#### 36 SUMMARY

PART 1 - This section covers the work of polyethylene sheet under slabs on grade.

#### 1.2 SUBMITTALS

PART 2 - Product Data: Include data substantiating that employed materials comply with requirements specified in this section, and written instructions for preparing, and treating substrate, and testing physical and performance properties.

#### 1.3 QUALITY ASSURANCE

PART 3 - Installer Qualifications: Engage an experienced installer who has completed sheet work similar in materials, design and extent to that indicated for project and that has resulted in construction with a record of successful in-service performance.

PART 4 - Single-source Responsibility: Obtain materials and secondary materials from a single manufacturer.

### PART 2 PRODUCTS

#### 2.1 POLYETHYLENE SHEETS

PART 5 - General: Provide polyethylene sheet which comply with the specified requirements or provide other similar alternative products which are certified in writing by manufacturer to be superior in performance for application indicated

PART 6 - Polyethylene sheets shall meet the required following values:

Parameter	Test Method	Value
Thickness, microns	ASTM D-374	400 max
Specific Gravity	ASTM D-792, Method A-1	0.940 to 0.960
Tensile Properties, Kg/cm <sup>2</sup>	ASTM D-882	
MD		200
TD		180
Elongation Properties, %	ASTM D-882	
MD		450
TD		500



Parameter	Test Method	Value
Dimensional Stability Each Direction, %		□ 2 max.

### PART 3 EXECUTION

PART 7 - Substrate shall be uniform well compacted soil, with surface graded and smooth.

PART 8 - Comply with manufacturer's recommendations, except where more stringent requirements are indicated or specified and where project conditions require extra precautions or provisions to ensure satisfactory performance of work.

END OF SECTION 071340

**DIVISION 07**  
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**SECTION 075216**

**STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS  
MEMBRANE**

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- 1.1            Related Documents
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- 1.3            Delivery, Storage, And Handling
- 1.4            Warranty

**PART 2            PRODUCTS**

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- 2.2            Auxiliary Waterproofing Membrane Materials
- 2.3            Separator Sheet
- 2.4            Protection Course

**PART 3            EXECUTION**

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- 3.2            Preparation
- 3.3            Separation Sheet Installation
- 3.4            Waterproofing Membrane Installation, General
- 3.5            Sbs-Modified Bituminous Membrane Installation
- 3.6            Field Quality Control
- 3.7            Protecting And Cleaning

## SECTION 075216- STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE

### PART 1 GENERAL

#### 37 RELATED DOCUMENTS

PART 38 - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

PART 39 - This Section includes the following:

SCHEDULE 0 - SBS-modified bituminous membrane waterproofing.

PART 40 - Related Sections include the following:

SCHEDULE 0 - Division 03 Section «Cast-In-Place Concrete».  
SCHEDULE 1 - SUBMITTALS

PART 41 - Product Data: For each type of product indicated.

PART 42 - Shop Drawings: For waterproofing system. Include plans, elevations, sections, details, and attachments to other Work.

PART 43 - Samples for Verification: For the following products:

SCHEDULE 0 - 300-by-300-mm square of waterproofing membrane.  
SCHEDULE 1 - 300-by-300-mm square of vapor retarder.

PART 44 - Installer Certificates: Signed by waterproofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install waterproofing system.

PART 45 - Qualification Data: For Installer and manufacturer.

PART 46 - Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of waterproofing system.

PART 47 - Research/Evaluation Reports: For components of waterproofing system.

PART 48 - Maintenance Data: For waterproofing system to include in maintenance manuals.

### 1.3 DELIVERY, STORAGE, AND HANDLING

PART 49 - Deliver waterproofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.

PART 50 - Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing system manufacturer. Protect stored liquid material from direct sunlight.

SCHEDULE 0 - Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

### 1.4 WARRANTY

PART 51 - Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of waterproofing system that fail in materials or workmanship within specified warranty period.

38            Warranty Period: 10 years from date of Substantial Completion.

PART 52 - Warranty includes removing and reinstalling protection boards, insulation and paving.

## PART 2 PRODUCTS

### 2.1 SBS-MODIFIED ASPHALT-SHEET MATERIALS

PART 53 - Waterproofing Membrane Sheet: superior high performance pre-fabricated SBS Modified Bitumen Membrane consisting a proprietary waterproofing compound reinforced with spunbonded non-woven polyester mat.

PART 54 - Comply with the following Requirements:

<u>Parameter</u>	<u>Standard</u>	<u>Unit</u>	<u>Value</u>
Thickness		mm	4
Softening Point (Ring and Ball)	ASTM D-36	° C	≥ 110
Cold Temperature Flexibility	EN-1109	°C	-10
Tensile Strength      Long Wide	EN-12311-1	N/5cm N/5cm	950 700
Elongation              Long Wide	EN-12311-1	% %	45 55
Tear Resistance	EN 12310-1	N	200
Joint Tensile Strength	EN12317-1	N	950/700

Dimensional Stability	Long	EN 1107	%	± 0.5
	Wide		%	± 0.5
Water Absorption		ASTM D-5147	%	0.1 max
Adhesion to Concrete		EN 12316	N/cm <sup>2</sup>	40

<u>Parameter</u>		<u>Standard</u>	<u>Unit</u>	<u>Value</u>
Thickness			mm	4
Softening Point (Ring and Ball)		ASTM D-36	° C	≥ 110
Cold Temperature Flexibility		EN-1109	°C	-10
Tensile Strength	Long	EN-12311-1	N/5cm	950
	Wide		N/5cm	700
Elongation	Long	EN-12311-1	%	45
	Wide		%	55
Tear Resistance		EN 12310-1	N	200
Joint Tensile Strength		EN12317-1	N	950/700
Dimensional Stability	Long	EN 1107	%	± 0.5
	Wide		%	± 0.5
Water Absorption		ASTM D-5147	%	0.1 max
Adhesion to Concrete		EN 12316	N/cm <sup>2</sup>	40

### 39 RPROOFING MEMBRANE MATERIALS

PART 55 - General: Auxiliary materials recommended by waterproofing system manufacturer for intended use and compatible with waterproofing membrane.

PART 56 - Asphalt Primer: ASTM D 41.

PART 57 - Waterproofing Asphalt: ASTM D 312, Type III or IV as recommended by waterproofing system manufacturer for application.

PART 58 - Waterproofing Asphalt: ASTM D 6152, SEBS modified.

PART 59 - Asphalt Waterproofing Cement: ASTM D 4586, asbestos free, of consistency required by waterproofing system manufacturer for application.

PART 60 - Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.

PART 61 - Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening waterproofing membrane components to substrate, tested by manufacturer for required pullout strength, and acceptable to waterproofing system manufacturer.

PART 62 - Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section «Sheet Metal Flashing and Trim.»

PART 63 - Miscellaneous Accessories: Provide miscellaneous accessories recommended by waterproofing system manufacturer.

#### 40           SEPARATOR SHEET

PART 64 - Polyethylene-Sheet Separator Sheet: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. M).

SCHEDULE 0 - Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

### 2.4           PROTECTION COURSE

PART 65 - All membrane water proofing should be protected.

SCHEDULE 0 - Vertically by using bitumen protection board unless otherwise recommended by the manufacturer.

## PART 3   EXECUTION

### 3.1           EXAMINATION

PART 66 - Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of waterproofing system:

SCHEDULE 0 - Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

SCHEDULE 1 - Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

PART 67 - Clean substrate of dust, debris, moisture, and other substances detrimental to waterproofing installation according to waterproofing system manufacturer's written instructions. Remove sharp projections.

### 3.3 SEPARATION SHEET INSTALLATION

PART 68 - Loosely lay polyethylene-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 50 mm and 150 mm, respectively.

### 3.4 WATERPROOFING MEMBRANE INSTALLATION, GENERAL

1. Seal side and end laps with tape.

PART 69 - Install waterproofing membrane system according to waterproofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's «Quality Control Guidelines for the Application of Polymer Modified Bitumen Waterproofing.»

PART 70 - Start installation of waterproofing membrane in presence of waterproofing system manufacturer's technical personnel.

PART 71 - Cooperate with testing and inspecting agencies engaged or required to perform services for installing waterproofing system.

PART 72 - Coordinate installing waterproofing system so insulation and other components of the waterproofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

SCHEDULE 0 - Provide tie-offs at end of each day's work to cover exposed waterproofing membrane sheets and insulation with a course of coated felt set in waterproofing cement or hot waterproofing asphalt with joints and edges sealed.

SCHEDULE 1 - Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of waterproofing system.

SCHEDULE 2 - Remove and discard temporary seals before beginning work on adjoining waterproofing.

PART 73 - Asphalt Heating: Heat and apply sSBS-modified waterproofing asphalt according to waterproofing system manufacturer's written instructions.

PART 74 - Substrate-Joint Penetrations: Prevent waterproofing asphalt from penetrating substrate joints, entering building, or damaging waterproofing system components or adjacent building construction.

### 3.5 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

PART 75 - Install modified bituminous waterproofing membrane sheet and cap sheet according to waterproofing manufacturer's written instructions, starting at low point of waterproofing system. Extend waterproofing membrane sheets over and terminate beyond cants, installing as follows:

SCHEDULE 0 - Torch apply to substrate.

SCHEDULE 1 - Unroll waterproofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

PART 76 - Laps: Accurately align waterproofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

SCHEDULE 0 - Repair tears and voids in laps and lapped seams not completely sealed.

SCHEDULE 1 - Apply waterproofing granules to cover exuded bead at laps while bead is hot.

PART 77 - Install waterproofing membrane sheets so side and end laps shed water.

### 3.6 FIELD QUALITY CONTROL

PART 78 - Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and to prepare test reports.

PART 79 - Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of waterproofing membrane as follows:

SCHEDULE 0 - Approximate quantities of components within waterproofing membrane will be determined according to ASTM D 3617.

PART 80 - Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect waterproofing installation on completion and submit report to Ministry Representative.

SCHEDULE 0 - Notify Engineer 48 hours in advance of date and time of inspection.

PART 81 - Repair or remove and replace components of waterproofing system where test results or inspections indicate that they do not comply with specified requirements.

PART 82 - Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.7 PROTECTING AND CLEANING

PART 83 - Protect waterproofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger waterproofing, inspect waterproofing for deterioration and damage, describing its nature and extent in a written report, with copies to Ministry Representative and Ministry.

PART 84 - Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.



PART 85 - Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075216

**DIVISION 31  
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**SECTION 312000**

**EARTHWORK**

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- 3.7 Field Quality Control
- 3.8 Auxiliary Works
- 3.9 Tolerance Limits
- 3.10 Surface Finish
- 3.11 Disposal

## SECTION 312000 – EARTHWORK

### PART 1 GENERAL

#### 41 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including Contract Conditions and Division 1 Specification Sections, apply to work of this section.

#### 1.2 SUMMARY

This section covers:

- Survey of the site
- Cleaning and garbing
- Stock piling and disposal of excavated material
- All necessary safety measures
- Testing
- Excavation and backfilling for building and structures to subgrade elevations.
- Preparing subgrades for slab-on-grade, walkways, pavement, etc.. to final grade and levels

Extent of excavation, backfilling shall be as indicated on the Drawings.

#### 1.3 REFERENCE STANDARDS

Earth works including cut, fill and backfilling and grading works shall be performed in compliance with Drawings, tests and the requirements of the project, and the specifications of the American Society of Testing and Materials (ASTM) as noted below:

American Society of Testing and Materials

ASTM No.

ASTM C131 Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and impact in the Los Angeles Machine.

ASTM C136 Sieve Analysis of Fine and Coarse Aggregates  
ASTM C142 Clay Lumps and Friable Particles in Aggregates

ASTM D421 Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants

ASTM D422 Particle Size Analysis of Soils  
ASTM D427 Shrinkage Factors of Soils

ASTM D512 Chloride Ion in Water

ASTM D516 Sulfate Ion in Water

ASTM D638 Tensile Properties of Plastics

ASTM D698 Moisture Density Relation of Soils and Soil Aggregate Mixtures

ASTM D854 Specific Gravity of Soils

ASTM D1293 pH of Water

ASTM D1556 Density of Soil in Place by the Sand-Cone Method

ASTM D1557 Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10 lb (4.54 kg) Hammer and 18 in (457 mm) Drop

ASTM D1586 Penetration Test and Split-Barrel Sampling of Soils

ASTM D1883 Standard Test Method for California Bearing Ratio of Laboratory Compacted Soils

ASTM D2167 Density and Unit Weight of Soil In-Place by the Rubber Balloon Method  
ASTM D2487 Classification of Soils for Engineering Purposes

ASTM D2488 Description and Identification of Soils (Visual-Manual Procedure) ASTM D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D2940	Graded Aggregate Material for Bases or Sub-bases for Highways or Airports
ASTM D3776	Standard Test MG7000 for Mass per Unit Area (Weight) of woven fabric
ASTM D3786	Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics-Diaphragm Bursting Strength Tester Method
ASTM D4253	Maximum Index Density of Soils Using a Vibratory Table
ASTM D4254	Minimum Index Density of Soils and Calculation of Relative Density
ASTM D4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4491	Standard Test Method for Water Permeability of Geotextiles by Permittivity
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4718	Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D5030	Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit

#### 1.4 RELATED SECTIONS

The following sections includes requirements which relate to this section:

Division 01 Section: Quality Control  
Division 02 Section: Geotechnical Investigation and Reporting  
Division 03 Section: Cast-in-Place Concrete

#### 1.5 SUBMITTALS

Submit the following in accordance with Conditions of the Contract and Division-1 Specification Sections:

Product Data for the following:

Each type of plastic warning tape  
Drainage fabric  
Separation fabric

Photographs of existing adjacent structures and site improvements.

Certificates: Submit a certificate of control of water.

Samples: Submit for verification purposes:

42 kg samples sealed in airtight containers, of each proposed fill and backfill soil material from on-site or borrow sources

300 mm long of each type of plastic warning tape  
300 x 300 mm samples of drainage fabric

Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

Detailed design of temporary side slopes and side support system (if any) for approval.

Stock piling of excavated materials for approval.

## 1.6 DEFINITIONS

Borrow soil: Satisfactory soil imported from off-site for use as fill or backfill.

Fill: Soil materials used to raise existing grades.

Backfill: Soil material or controlled low-strength material used to fill an excavation.

For utility trench

Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

Final Backfill: Backfill placed over initial backfill to fill a trench.

Rock Fill: Material composed of hard, sound, durable rock with only a small amount of fine particles used for filling or back filling

Sub-base Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

Retain definitions that remain after this Section has been edited. Revise to suit office or local earthwork practices.

Base Course: Course placed between the sub-base course and hot-mix asphalt paving.

Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

Revise heading in first paragraph below to read «Capillary Water Barrier» or a similar title if required.

Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

Bulk Excavation: Excavation more than 3 m in width and more than 9 m in length.

Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials.

Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

## 1.7 PROJECT CONDITIONS

Project Site Information: Excavation shall be unclassified and shall be completed regardless of the type, nature or condition of material encountered.

A geotechnical report has been prepared for this project and is available. The opinions expressed in this report, the design and drawings are those of the geotechnical engineer and represent interpretations of the subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer.

The Contractor shall carry out his own site investigations and shall inform and satisfy himself as to the character, quality and distribution of all material to be excavated, filled, spoiled and borrowed. The Contractor shall be fully responsible for asserting necessary information concerning permanent water-table, period of rainfall and all matters affecting the excavation and foundation work.

The contractor is responsible to verify the required different levels before starting construction works.

Before starting any construction works compacting the top surface is required to assure the quality of compaction.

Topographic Survey: Do not assume accuracy of the existing benchmark, and run a closing survey of the existing project area and take cross-sectional elevations and levels of the works on the Site and submit the result to the Engineer for approval, as quantities of excavation, earthwork etc., shall be measured from these levels as agreed and signed by the Engineer.

Locate datum level used to establish benchmarks sufficiently distant so as not to be affected by movement resulting from excavation operations.

Employ a qualified professional engineer or surveyor; Establish exact elevations at fixed points, construct and protect benchmarks during the period of construction. Such benchmarks shall be checked periodically and whenever required by Engineer.

Existing Utilities: Do not interrupt utilities, if any, serving facilities occupied by Employer or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

## 1.8 USE OF EXPLOSIVES

Blasting and use of explosives is prohibited. Do not bring explosives onto Site or use in work.

## 1.9 CONTRACTOR'S RESPONSIBILITY

The methods of excavation which the Contractor desires to use shall be at the sole discretion of the Contractor.

The Contractor shall perform all excavation and backfilling as required for all works under this Contract. Excavations shall be carried out in all materials, by whatever means necessary and shall be performed accurately to the lines, levels and grades shown on Drawings.

Except where indicated on the Drawings to remain undisturbed, the Contractor shall remove all unaccepted topsoil, plants, roots, vegetation, rubbish, rock, etc., from areas lying within limits of structures and from area to receive fill, embankment, surfacing, road construction, concrete or other constructions.

Safety of Excavations: It is the Contractor's responsibility to provide and maintain safe excavations for all phases of construction. In no case shall any be made in such a manner to endanger or damage workmen, adjacent utilities, paving or structures. The Contractor shall be responsible for providing safe construction slopes and he shall adequately shore and sheet the side of excavations to ensure complete safety against collapse of soil at these areas.

In the event of a fall occurring in any excavation the Contractor shall carry out at his own expense and to the satisfaction of the Engineer any re-excavation reinstatement or repairs which may become necessary as the result of such fall. Any voids caused by a fall shall be filled and consolidated as directed by the Engineer.

Protection of Persons and Properties: The Contractor shall erect temporary fencing or barricade open excavations occurring as part of this work and post with warning lamps and take all necessary steps to prevent any entry of public to the vicinity of open excavation. He shall protect structures and utilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

The Contractor shall restore and repair any damage or defects caused to adjacent structures, utilities or properties without responsibilities or extra charge to the Employer.

Protection of Utilities and Services: Any cable, pipeline or other services exposed by Contractor shall be protected and supported by him to prevent damage to the service. Supports shall be maintained throughout the whole period of the exposure of services and it shall be the Contractor's responsibility to ensure that, on and after backfilling or Building in, they said services are adequately supported by any satisfactory means so that no damage shall be caused to them on or after such backfilling or building in.

## PART 2 PRODUCTS

### 2.1 SOIL MATERIALS

General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

Topsoil: Natural and cultivated surface-soil layer containing organic matter and sand, silt and clay particles, friable, pervious, and black or darker shade of brown, gray or red than underlying subsoil, reasonably free of subsoil, clay lumps, gravel, and other objects more than (50mm) in diameter, and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

Engineering/Structural Fill: Fill under foundation of structures and backfill of excavation for foundations shall be classified as structural fill, Table 1. This backfill shall be used as well below slab on grades, ramps, and steps. Material for structural fill shall be in accordance the requirements shown on Part 2 unless otherwise approved by the Geotechnical Engineer.

Structural fill shall be used underneath the structures and under slab on grade.

The source of the Engineering fill shall be provided by the Contractor and approved by the Engineer. The Contractor shall provide samples at specified intervals to monitor the material, and to the Engineer satisfaction.

Engineering fill shall be used underneath the structures, roads, shoulders and paved areas and under slab on grade as specified in the geotechnical report.

**Table 1**

#### **Structural Fill Gradation and Criteria**

Sieve Designation	Percent Passing (by Weight)
50 mm (2")	100
19 mm (3/4")	80-100
4.75 mm (No.4)	50-100
0.425 mm (No.40)	15-40

0.075 mm (No.200)	2-10
Liquid limit	Not greater than 25%
Plasticity index	Not greater than 10%
Free swell	Not greater than 0 %

Cu > 4 and  $1 < C_c < 3$

Selected Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or graded sand; Plasticity index shall not exceed 10%. The soaked CBR value shall not be less than 15% and the swell shall not exceed 2.0%.



**Table 2**

**Selected Fill**

<b>Sieve Designation</b>	<b>Percent Passing (by Weight)</b>
100 mm (4»)	100
75 mm (3»)	90-100
37.5 mm (1.5»)	80-100
10 mm (3/8»)	45-100
4.75 mm (No.4)	25-85
0.425 mm (No.40)	8-45
0.075 mm (No.200)	0-15
Liquid Limit	Not greater than 40%
Plasticity index	Not greater than 10%
CBR (Soaked)	Greater than 15%
Swell	Not greater than 2%

Common Fill: Areas of using common fill are as follows:

For depth from 3.0 m to 10.0 m (under buildings area) with max. Fines percentage 20% and min. Compaction percentage 85% (as stated in table 3).

For depth from 2.0 m to 10.0 m (under roads and parking area) with max. Fines percentage 25% and min. Compaction percentage 85%.

Landscape area and non-loaded area (non-structural fill) with max. Fines percentage 25% ,min. Compaction percentage 85% and the maximum thickness for each layer is 700 mm.

Maximum dry density and optimum moisture content shall be determined based on Modified Proctor Test according to ASTM D 1557.

Backfilling material uses under buildings specifications and criteria are stated in the following table:

**Table 3**

**Backfill specifications and criteria under buildings**

<b>Depth of Back- filling under Foundation Level (m)</b>	<b>Material Type</b>	<b>Compaction Layer's Thickness (mm)</b>	<b>Max. Grain Size (mm)</b>	<b>Maximum Fines Percent (%)</b>	<b>Compaction percent (%)</b>
0 – 1.5 m	Structural Fill	250	50	10	95
1.5 – 3.0 m	Selected Fill	300	100	15	90
3.0 – 10.0 m	Common Fill	500	250	20	85

Backfilling material uses under roads and parking areas specifications and criteria are stated in the following table:

**Table 4**

**Backfill specifications and criteria under roads and parking areas**

<b>Depth of Back- filling under Foundation Level (m)</b>	<b>Material Type</b>	<b>Compaction Layer's Thickness (mm)</b>	<b>Max. Grain Size (mm)</b>	<b>Maximum Fines Percent (%)</b>	<b>Compaction percent (%)</b>
0 – 1.0 m	Structural Fill	250	50	10	95
1.0 – 2.0 m	Selected Fill	350	100	15	90
2.0 – 10.0 m	Common Fill	600	250	25	85

Backfilling material uses under roads and parking areas specifications and criteria are stated in the following table:

Bedding for Underground Utility Installation: Bedding shall be granular, well graded, with all material passing 12.5 mm (1/2 inch) mesh screen and at least 90 percent retained on 75 µm (No. 200) sieve as determined in accordance with ASTM D 422.

Trench Backfill (Within the Pipe Zone): Trench backfill shall contain no rocks or stones larger than 25 mm in the greatest dimension and shall be free of vegetation, trash, chunks of highly plastic clay, or other unsatisfactory- material. Trench backfill placed under roadways or structures shall meet the requirements of engineering fill.

Sub-base Material: Naturally, or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; With at least 90 percent passing a 37.5-mm sieve and not more than 10 percent passing a 0.075-mm sieve.

Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; With at least 95 percent passing a 37.5-mm sieve and not more than 8 percent passing a 0.075-mm sieve.

Drainage Course: Narrowly graded mixture of crushed stone, or crushed , or uncrushed gravel, ASTM D 448; Coarse-aggregate grading Size 57; With 100 percent passing a 37.5-mm sieve and 0 to 5 percent passing a 2.36-mm sieve.

Sand: ASTM C 33; Fine aggregate, natural, or manufactured sand.

#### 43 WARNING TAPE

Acid- and alkali-resistant polyethylene film warning tape for marking and identifying underground utilities 150 mm wide and 4 mils thick, continuously inscribed with a description of the utility; Colored as follows:

Red: Electric  
Yellow: Gas, oil, steam and dangerous materials  
Orange: Telephone and other communications  
Blue: Water systems  
Green: Sewer system

#### 44 WATER

Water used for soil compaction shall be clean and free from unusual proportions of dissolved salt, organic matters and industrial contamination oils, acids or other deleterious matter.

Water shall not contain chemical salts including sulphates (SO<sub>4</sub>) and chlorides (Cl) in a percentage that shall increase the overall salts percentage for filling materials more than 0.35%.

For the water used in compaction process, water sample from wells and/or any source shall be tested to satisfy the previous limits.

#### 2.4 EQUIPMENT

Use types of equipment that are most suitable for the work and of numbers, sizes and capacities that can perform earthwork as specified within the time schedule. Equipment for earthwork shall be operated in strict accordance to manufacturer's instructions and recommendations and shall be always maintained by the Contractor in such condition that they shall deliver manufacturer's rated capacities.

#### PART 3 EXECUTION

Should the Contractor through negligence or other fault excavate or fill beyond the designated lines, he shall replace/remove such excavation/fill in an approved manner and condition at his own expense with satisfactory soil materials and thoroughly compact to a density equal to adjacent original ground.

Do not neglect to check for underground services, which may not initially appear to be of interest. Protect utilities, structures, improvements, pavement from damage caused by settlement due to lateral movement created by earthwork operations.

No compensation shall be paid to the Contractor in respect to excavation or backfilling for the extra width.

### 3.1 OPEN-CUT EXCAVATION, GENERAL

Excavation shall be performed as indicated on Drawings and in the Specifications to the lines, grades and elevations shown or as directed by the Engineer.

Survey points, benchmarks, boundary stones and the like shall be removed only with the engineer's written consent.

Removed boundary stones and marking shall be stored according to the engineer instructions.

Extra temporary benchmarks to be provided by the Contractor shall be furnished with a plate, approximately 25x25 cm in size. With the benchmark inscription painted in black letters on a light background with clearly legible weatherproof oil paint.

For all fill and cut over 1 m in height, sturdy stakes shall be placed at any changes of direction of the ground but in all cases at intervals not greater than 30 m as directed by the engineer.

Permanent slope (if any) to be kept in the sand it shall be stabilized by one of the following means:

- Mass concrete blinding
- Cement/sand mixture
- Bituminous/cement mixture.

The quantity, type and capacity of the equipment provided, the work method envisaged transportation and distribution of the excavated materials, location of stock-piles, main storage areas as well as the approximate number of laborers, etc. And the working schedule and any amendment to it during the construction period shall require the engineer's period approved.

Bottom and slopes of open-cut elevations on which concrete is to be placed shall be finished exactly according to the established levels and slopes. The slopes can be taken 3Hal:2Val as mentioned in the geotechnical report.

Regardless of the methods of excavation adopted, the basis of payment shall be as assumed in Section 012700 "Measurement and Payment".

Excavation shall consist of removal of all earth, rocks, boulders, remains of buildings, services not to be used and all material encountered within the limits indicated to subgrade elevations indicated on Drawings and subsequent stock piling of materials needed for backfilling or disposal of material determined unsuitable.

Excavation shall be unclassified and shall be completed regardless of the type of material and obstruction encountered together with soil, boulders and other materials.

The Contractor shall make his own estimate of the kind and extent of the various materials and presence or absence of water which shall be encountered in the excavation.

The final 150 mm depth of all excavations shall be taken out manually or otherwise if accepted by the Engineer and the bottom levelled and rammed immediately prior to placing structures.

Footings, foundations and pipes shall rest on firm undisturbed soil free from loose materials.

Stockpile soil materials suitable for backfill at sufficient distance away from edge of excavation and neatly pile in stock piles in a manner that shall not overload or cause collapse of excavation sides. All unsuitable and surplus excavated materials shall be immediately removed from site, loaded and transported to dumps approved by local authorities.

Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, for inspection.

Excavate to indicated elevations and dimensions within a tolerance of  $\pm 25$  mm.

No back-throwing whatever shall be allowed and all materials shall be brought to the surface and formed in heaps clear of excavation.

Excavation in rock, if any, rock layer should be classified according to the geotechnical consultant, field and lab tests and confirmed by the geotechnical engineer. The excavation on rock layer (if any) will be measured with rate only.

Over Excavation: If somewhere and for any reason excavations are executed beyond the established lines and without the engineer's previous approval, the Contractor shall backfill with lean concrete or other approved materials, the volume corresponding to the over excavation.

Drainage of Excavated Areas: Grading in the vicinity of excavations shall be controlled to prevent surface water from flowing into excavated areas.

Protect subgrades from softening and damage by rain or water accumulation.

The excavation shall at all times be well drained, kept free from storm water, percolating water or subsoil water.

The Contractor shall make good at his own expense any damage that may result from his failure to keep the excavation free from water.

### 3.2 EXCAVATION FOR STRUCTURES

Excavation Limits for Structures: Banks shall be either shored or sloped at a safe angle according to conditions and to the approval of the Engineer. If necessary extend a reasonable sufficient distance from footing and foundations to permit placing and removal of concrete form work, shoring, installation of services and other constructions, for performing all works in the excavation and for inspection. No compensation shall be paid to the Contractor in respect to excavation or backfilling of extended distances.

If any part of an excavated area is in error or excavated wider than required, the excess excavated distance shall be backfilled as directed by the Engineer and compacted at the Contractor's charge.

Excavation for underground: tanks, basins and mechanical or electrical utility structures. Do not disturb bottom of excavations intended for bearing surface.

### 3.3 APPROVAL OF SUBGRADE BOTTOM

When excavation has reached required subgrade elevations, the Engineer shall inspect soil materials at these elevations for suitability as a foundation level for the related construction, and he may instruct the Contractor to test the bearing capacity of the soil at this level. Should the bottoms of excavation be found to be unsuitable as bearing surfaces as a result of such tests the Engineer may decide to continue excavation until suitable bearing materials are encountered and replace with compacted backfill. Additional excavation and replacement material shall be paid for, according to Contract.

Excavated materials shall not be piled up along sides of excavations in a manner that will overload or cause collapse of excavation sides.

Sub-soil from the excavation shall be selected for suitability for backfilling and compaction, shall be free from any organic materials and shall not have big lumps. It shall be placed directly in its final position or stacked on site as directed by the Engineer in the vicinity of the work and those unsuitable for fill shall be removed from site to a tip provided by the Contractor. All other filling materials shall be imported.

Cleaning, grubbing and removal of trash and debris from excavation shall be done before backfilling works.

Contractor shall make corrections and adjustments in methods or moisture content in order to achieve the correct fill density.

Compaction areas shall be kept separate and no layer shall be covered by another until the proper density is obtained.

Roads' banks, if any, shall be sloped at a safe angle of repose.  
Materials shall be as specified in Part 2 of this section and compaction requirements shall be based on relative density.

The soil used in backfilling shall be mixed with sufficient water to provide a moisture content within a range of 2% from the optimum value. The mixing process shall be completed out of backfill area then soil shall be spread in loose lifts and compacted at designated locations. The moisture content shall be uniform throughout the compacted layer. If the field quality testing as specified in Clause 3.9 revealed moisture content out of the previously specified range, the soil shall be removed, remixed and compacted again.

The Engineer, at his own discretion, may allow greater lift thickness not exceeding 350 mm thick if proper density and uniformity is obtained. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous levelling and manipulating shall be required to assure uniform density. Water shall be added in order to obtain the correct water content and the required density on stocked soil outside the excavation. Construction equipment shall be routed uniformly over the entire surface both in width and longitudinal extent of each layer before the next lift is started. At the start of the work a field test shall be performed in the Site over an adequate area not less than 100 m<sup>2</sup> to determine the allowable thickness of layers that can be compacted to the required density by means of the compaction equipment provided by the Contractor.

Pipes and reinforced concrete foundation members such as tie-beams laid on natural ground shall be protected with a minimum of 1000 mm of tamped fill over the top surface or according to Drawings before heavy equipment is allowed to pass over.

Backfill excavations shall start as promptly as work permits, but not until completion of the following:

Pipes and reinforced concrete foundation members such as tie beams laid on natural ground shall be protected with a minimum of 1000 mm of tamped fill over the top surface or according to Drawings before heavy equipment are allowed to pass over.

Acceptance of layers below finish grade including, where applicable, damp-proofing, waterproofing and perimeter insulation.

Inspection, testing, approval and recording locations of underground utilities have been performed and recorded. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by the Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.  
Removal of concrete formwork.

Removal of temporary shoring and bracing, backfilling of voids with satisfactory materials. Cut off temporary sheeting, piling driven below bottom of structures and remove in a manner to prevent settlement

of the structure or utilities or leave in place if required. External surfaces of wood sheeting instructed to be left in place shall be painted with suitable protective material.

After installation of pipes and cables according to specifications and all related tests are performed and approved by Engineer.

Removal of trash and debris from excavation.

### 3.4 FOOTING SUBGRADE

Unless otherwise indicated on Drawings, the subgrade under footings and tie-beams shall be prepared in the following sequence:

Excavate under footing and tie-beams down to the required depth from existing ground surface.

Clean bottom of excavation from the loose surface soil skin and compact the soil using suitable compaction equipment.

### 3.5 BACKFILLING AROUND FOUNDATIONS

Use selected fill materials as specified in Clause 2.1 and compact mechanically or by manual tamping to 90% of maximum dry density according to ASTM D 1556 at optimum moisture content during excavation.

### 3.6 SOIL REPLACEMENT UNDER FOUNDATIONS AND ABOVE WATER LEVEL

Use Engineering/structural fill materials as specified in Clause 2.1, Percentage of fine materials passing ASTM Sieve No. 200 must not exceed 10, and the percentage of sulphates (SO<sub>3</sub>) and chlorides (Cl), shall not exceed 0.35%.

Percentage of absorbed water by weight shall be 10% maximum. Percentage of dissolution in water of coarse and fine aggregates shall be 5% maximum.

Compaction requirement shall be based on Relative Density Compaction Replacement and shall be executed in loose lift (250 mm thick) uniformly spread, compacted mechanically or by manual tamping, either equipment or vibratory equipment according to available space, replacement shall be compacted to a minimum of 95% of maximum dry density.

### 3.7 FIELD QUALITY CONTROL

Allow testing agency to inspect and test each subgrade and each fill layer.

Compaction and field density tests of in-place soil or the fill shall be made at each location directed by the Engineer at the rate of one (1) test every 250 m<sup>2</sup> for each compacted layer according to ASTM D1556.

Field density tests shall be performed in accordance with AASHTO T-191 (sand cone method). The Contractor shall perform the following tests at locations as directed by the Engineer:

Laboratory test for Maximum Dry Density (MDD), Optimum moisture content, for each layer.

Field density and California Bearing Ratio (CBR), for each layer as required by the Engineer.

The areas shall be rejected if the resulting test results do not satisfy specified requirements.

The Contractor shall be responsible for making good all settlement of filling that may occur at/to the end of the Defect Liability Period.

### 3.8 AUXILIARY WORKS

Unless otherwise specified, all and any kind of works, materials, services, safety measures, etc. As well as, and if so requested by the Engineer, all tests and samples required for the completion of the work shall be for the responsibility of the Contractor. The auxiliary works comprises, but not limited to the following:

Removing and storing of boundary stones, bench marks, etc., protection of surveying points/designations by means of boards, survey and protection of all secondary survey points, profiles, etc.

Difficulties to be overcome where excavation may have to be carried out in layers.

Keeping 1200mm diversion of water if any, including any pump required, difficult work caused by water, etc.

Removal of any groyne, buried pipes, fascines and the like that might interfere with excavation profiles, irrespective of whether or not such structures are specified.

Difficulties resulting from the specification relating to filling, eliminating unsuitable material from filling and if necessary, mixing of different soil materials.

Transport of excavated materials to fill or deposit, placing and spreading in layers according to conditions and drawings and careful compaction.

Difficulties in transport due to existing ground condition.

Sorting of excavated materials which if necessary, are to be used for special purposes.

Providing, maintaining and later removing access way-maintaining existing ways and roads providing, placing, maintaining and later removing, conveying and dumping materials and/or equipment that might be required.

### 3.9 TOLERANCE LIMITS

The tolerance limits for the permanent finished earthworks will be as follows:

Horizontal dimensions will be within +75 mm and –75 mm of the true dimensions shown on the approved drawings.

For slopes to embankments or cutting the horizontal deviation between the top and the bottom of the slope will be within +5% and –5% of the true horizontal component of the slope shown or calculated from the approved drawings.

Formation levels shall be within 0 mm and –25 mm of the true levels shown on drawings.

Other earth work levels be within +50 and –50 mm of the true levels shown on the approved drawings.

### 3.10 SURFACE FINISH

The top surface area shall be of dense and level without any protruding rock fragments in excess of 50 mm, recesses or soft spots to the satisfaction of the engineer.

### 3.11 DISPOSAL

Remove, only by night, surplus satisfactory soil and waste material including unsatisfactory soil, trash, debris, and legally dispose of it off to the public disposal areas.

END OF SECTION 312000



**DIVISION 31  
CONTENT**

**SECTION 315000  
EXCAVATION SUPPORT AND  
PROTECTION**

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## SECTION 315000 – EXCAVATION SUPPORT AND PROTECTION

### PART 1 GENERAL

#### 45 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

Section includes temporary excavation support and protection systems.

#### 1.3 PERFORMANCE REQUIREMENTS

Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil, hydrostatic pressure, and superimposed and construction loads.

Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

Prevent surface water from entering excavations by grading, dikes, or other means.

Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

Monitor vibrations, settlements, and movements.

#### 1.4 SUBMITTALS

Shop Drawings: The Contractor shall submit to the Engineer shop drawings for the specified works for review and approval at least one (1) week prior to commencement of construction.

Method Statement: The Contractor shall submit to the Engineer a method statement for review and approval at least one (1) week prior to commencement of construction.

Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

Coordinate first paragraph below with qualification requirements in Division 01 Section «Quality Requirements. «Qualification Data: For qualified land surveyor and professional engineer.

Other Informational Submittals:

Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

46            Note locations and capping depth of wells and well points.

## 1.5            QUALITY ASSURANCE

Pre-installation Conference: Conduct conference at **Project site**.

Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

- Geotechnical report.
- Existing utilities and subsurface conditions.
- Proposed excavations.
- Proposed equipment.
- Monitoring of excavation support and protection system.
- Working area location and stability.
- Coordination with waterproofing.
- Abandonment or removal of excavation support and protection system.
- Construction statement.

### Design Criteria

The design criteria and analysis methodologies presented in these shoring design standards have been developed in accordance with recognized engineering principles.

Review and acceptance of shoring submittals by the engineer shall not relieve the contractor and the shoring engineer from their responsibilities towards design and construction of the shoring system, including responsibility for errors and omission in submittals, and construction deviation from accepted design plans.

### Review and acceptance

Review and acceptance of shoring submittals by the engineer shall not relieve the contractor and the shoring engineer from their responsibilities towards design and construction of the shoring system, including responsibility for errors and omission in submittals, and construction deviation from accepted design plans.

## 1.6 PROJECT CONDITIONS

Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.  
Do not proceed with interruption of utility without Construction Manager's written permission.

Project-Site Information: No geotechnical report is available for this Project. The available geotechnical data of an old project at the vicinity of this project, has been considered. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. The data given in this report has been used as guidance only. Owner will not be responsible for interpretations or conclusions drawn from the data.

Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.

Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; Establish exact elevations at fixed points to 1240 ± 0.024 benchmarks. Clearly identify benchmarks and record existing elevations.

During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 PRODUCTS

### 2.1 MATERIALS

General: Provide materials that are either new or in serviceable condition.

Structural Steel:

High tensile steel 40/60 with yield stress of not less than 400 N/mm<sup>2</sup>; And Mild steel 24/35 with yield stress of not less than 240 N/mm<sup>2</sup>.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; With continuous interlocks.

Corners: Site-fabricated mechanical interlock.

Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

Cast-in-Place Concrete:

Cement content shall not be less than 350 kg/m<sup>3</sup> of concrete and free water/cement ratio shall not be greater than 0.45. Admixtures shall not be used without prior approval by the Engineer.

Sources of cement and aggregate to be used in concrete works shall be approved by the Engineer. As a rule, crushed stone fine aggregate shall not be used in concrete works. The following cement types may be used in all concrete works, in accordance with the Egyptian Code for Design and Construction of Concrete works:

Portland cement with mineral additions, in the form of Ground Granulated Blast Furnace Slag (GGPS); And Portland cement with percentage of Tricalcium Aluminate (C3A) ranging from 6 to 10%.

Water used in concrete works shall be clean, free from silt, organic matter, alkali, salts, and other deleterious impurities and shall comply with the requirement of the Egyptian Code for Design and Construction of Concrete works.

Maximum slump of concrete shall be 175 mm plus or minus 25 mm. Minimum slumps shall be 100 mm where concrete is to be placed into water free unlined hole and 150 mm where concrete is to be placed by tremie under water or drilling fluid.

For secondary (male) piles and capping beams, test cubes compressive strength shall not be less than 30 N/mm<sup>2</sup> after 28 days. For primary (female) piles in Hard-Firm secant pile walls, test cubes compressive strength shall not be less than 3 N/mm<sup>2</sup> after 28 days.

Tiebacks: Steel bars, ASTM A 722/A 722M.

Tiebacks: Steel strand, ASTM A 416/A 416M.

American concrete institute (ACI), Building code requirement for reinforced concrete ACI 318

Ground anchors

Ground anchors are used as a support system for the wall in case of relatively high retained depth, the ground anchors consists of steel bars or strands and grout;

Steel bars/ strand tendons: shall conform to the American society for testing and materials ASTM A722 and ASTM A416.

Cement Grout: the used grout for anchor is typically a neat cement grout conforming to ASTM C150.

Cement and Bentonite Mixture Primary (female) piles shall consist of self-hardening cement and bentonite mixture with test cubes compressive strength not less than 3.0 N/mm<sup>2</sup>. Design of the self-hardening mix shall be carried out by the Contractor and submitted to the Engineer for review and approval.

## PART 3 EXECUTIONS

### 3.1 PREPARATION

Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

Shore, support, and protect utilities encountered.

Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

The excavation support and protection system shall include, but not limited to, one of the following:

### 3.2 SOLDIER PILES AND LAGGING

Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.

Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact. Install wales horizontally, if required, to secure soldier piles.

### 3.3 SECANT PILES

Secant piles are constructed so that there is an intersection of one pile with another. The usual practice is to construct alternative piles along the line of the wall leaving a clear space of a little under the diameter of the required intermediate pile. The exact spacing is determined by the construction tolerance which can be achieved. These initially placed piles do not have to be constructed to the same depth as the intermediate piles which follow depending on the way in which the wall has been designed and reinforced.

Concrete is added, and before it fully sets, the intermediate piles are placed. A heavy casing whose cutting edge is toothed should be used to enable the casing to cut into the initial piles on either side.

Secant piles can be constructed either with conventional drilling methods or through the use of CFA techniques. Secant pile wall typically include both reinforced (secondary or male) and unreinforced (primary or female) piles. The secondary piles overlap with the primary piles, which essentially 126ob e126 concrete lagging.

The reinforcement in the secondary pile generally consists of rebar cage or steel beams or as giving in the drawings.

The primary and secondary piles diameters, the overlap distance, the piles lengths and reinforcement are taken according to the construction drawings approved by the Engineer. The secant piles may be supported by a single or multi-rows of ground anchors (tiebacks) or lateral support (Props). The lengths, spacing and inclinations of the ground anchor(s) / prop(s), as well as the pre-stressing forces are taken as per the construction drawings approved by the Engineer.

### 3.4 SHEET PILING

Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line

and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

### 3.5 TIEBACKS

Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

### 3.6 BRACING / RAKERS

Bracing/raker: Locate bracing/raker to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing/raker before removing original brace.

Provide walers where required, at each level of bracing/raker. As excavation proceeds, place walers on open face of support system wall. Wedge, drypack, and otherwise provide tight bearing between walers and support system wall, with ample bearing areas to provide uniform transfer of loads.

Do not place bracing/raker where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.

Install internal bracing, if required, to prevent spreading or distortion of braced frames.

Maintain bracing/raker until structural elements are supported by other bracing/raker or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

Design internal bracing/raker support members for maximum loads which may occur during excavation and removal stages.

Provide a safe bearing support/footing for rakers

### 3.7 GROUND ANCHORS TESTS

Ground anchors: Drill, install, grout, and tension tiebacks.

Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

Maintain the ground anchors in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

Load testing for ground anchors: the number of tests depends on the life span of the excavation support (temporary or permanent) shall conform to the FHWA-IF-99-015 (or relevant codes), are as the following:

Performance tests involve incremental loading and unloading of the anchor, and shall be used to:

- Verify anchor capacity

- Establish load-deformation behavior

- Identify the causes of anchor movement

- Verify the actual free length

- The results may be used to assist in interpretation of proof tests

- The tests shall be performed on the first two executed anchors and on a minimum of two percent (2%) of the remaining anchors

- Additional tests may be needed in case the surrounding soil is cohesive (creep possibility)

Proof tests: involves a single load cycle and a load hold at test loads;

The test provides a means for evaluating the acceptability of anchors that were not “performance” tested.

The most common tests, and are performed on the majority of ground anchors.

Extended creep tests: are only required for anchors installed in cohesive soils with a plasticity index (PI) greater than 20% or liquid limit (LL) greater than 50

A minimum of two (2) tests are required

### 3.8 REMOVAL AND REPAIRS

Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.

Fill voids immediately with approved backfill compacted to density specified in Division 31 Section «Earth Moving.»

Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

Leave excavation support and protection systems permanently in place.

### 3.9 TOLERANCE

Position: At cut-off level, the maximum permitted deviation of pile center from the center point shown in setting out drawing shall be 25 mm in any direction.

Verticality: The maximum permitted deviation of the finished pile from the vertical at any point equals 1 in 200. The contractor shall demonstrate to the satisfaction of the Engineer the pile verticality is within the allowable tolerance.

Correction: Should the piles be installed outside these tolerance values affecting the design and appearance of the structure, the contractor shall propose and carry out immediate remedial measure to the approval of the engineer at his own time and cost

END OF SECTION 315000

## DIVISIONS 41

### SECTION 412200

#### CRANES AND HOSITS

#### PART 1 GENERAL

- 1.1 Related Documents
- 1.2 Description of Work



- 1.3 Reference Standards
- 1.4 Coordination
- 1.5 Submittals
- 1.6 Quality Assurance
- 1.7 Warranty

**PART 2 PRODUCTS**

- 2.1 General
- 2.2 Constituents of the Overhead Cranes
- 2.3 Materials

**PART 3 EXECUTION**

- 3.1 Installation
- 3.2 Field Quality Control
- 3.3 Unauthorized Use by Contractor

## SECTION 412200 – CRANES AND HOSITS

### PART 1 GENERAL

#### 47 RELATED DOCUMENTS

PART 1 - Drawings and general provisions of the Contract, including General Conditions, Conditions of Particular Application and Division-1 Specification Sections, apply to work of this Section.

#### 1.2 DESCRIPTION OF WORK

PART 2 - This section covers the specifications of overhead mono-rail. Extent of the mono-rail crane is shown on drawings.

#### 1.3 REFERENCE STANDARDS

PART 3 - All materials used in the work shall be performed in strict accordance with specifications, Drawings and the general equipment stipulations of the International Standards as noted herein below:

Crane Manufacturer's Association of America  
CMAA No. 70 Specifications of Electric Overhead Travelling Cranes

PART 4 - ANSI MH 27.1 Specifications of Underhung Cranes and Monorail System

PART 5 - ANSI B 30 American National Standards Institute

National Fire Protection Association Standards  
NFPA No. 70

#### 1.4 COORDINATION

PART 6 - The Contractor shall furnish inserts and anchorages, which must be built into other work for installation of mono-rail crane and related work, coordinate delivery with construction schedule to avoid delay.

PART 7 - All equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with Drawings, specifications, instructions and recommendations of the equipment Manufacturer.

PART 8 - The overhead mono-rail cranes shall be complete with hoist and trolley, load chain, safety devices and all other accessories necessary for a complete installation and proper operation.

## 1.5 SUBMITTALS

PART 9 - Product Data: Submit product data for the crane units, indicating dimensions, capacities, sizes, performances, operations, safety features, finish and similar information. Indicate any variations from specified requirements.

PART 10 - Shop Drawings: Submit shop drawings including dimensioned Drawings for the mono-rail cranes, showing plans, elevations, sections and large-scale details indicating fabricated steel girders, coordination with building structure and relationships with other constructions activities indicate any variations from specified requirements plus maximum dynamic and static loads imposed on building structure at points of support.

PART 11 - Maintenance Manuals: Bound manual for specified type of cranes. Include operating and maintenance instructions, parts listing, with sources indicated, recommended parts inventory listing, emergency instructions and similar information.

## 1.6 QUALITY ASSURANCE

PART 12 - Provide certification that Manufacturer and Installer are regularly engaged in the production and erection of components and equipment of this type and whose equipment have been satisfactorily used in similar service for not less than five (5) years.

## 1.7 WARRANTY

PART 13 - Provide special project warranty, agreeing to replace, repair or restore defective materials and workmanship of overhead mono-rail crane work during warranty period.

# PART 2 PRODUCTS

## 2.1 GENERAL

PART 14 - Subject to compliance with requirements.

PART 15 - Provide single beam overhead mono-rail crane electrical operated hoists and trolleys.

PART 16 - The overhead mono-rail cranes shall include, but not limited to, all operating, safety devices and components.

PART 17 - Complete and operating installation including hoist and trolley etc.,

48                    CONSTITUENTS OF THE OVERHEAD CRANES

PART 18 - The cranes shall consist but not limited to the following:

PART 19 - Bridge Crane: Single beam bridge crane assembly including bridge girder beam, track and trolley for hoist support.

PART 20 - The bridge shall be single I-beam section or flat flanged type rigidly fixed. The bridge shall be constructed to accommodate a top running or underhung hoist trolley.

PART 21 - Track: Includes but not limited to rails, inserts, stops fastenings, etc., required for construction of the track.

PART 22 - Steel design and fabrication shall comply with applicable portions of the specifications of the American Institute of Steel Construction. Loadings, impact allowances, and allowable stresses shall be in accordance with the governing standards. Deflection of the main girder shall not exceed 1/800 of the span with the maximum load at any point.

PART 23 - Wheels: Trolley wheels for I-beam section shall be made of rolled, forged, or cast steel. Trolley side plates shall be cut from hot rolled steel plate and extend past the wheels to provide bumper protection on all four wheels trolley. Axles shall be heat treated alloy steel rigidly supported in the trolley side plates. Wheel bearings shall be permanently shielded, lifetime-lubricated ball or tapered roller type, antifriction type, adequate for radial and end thrust loading.

PART 24 - The load chain anchorage associated fittings and framework at the slack end shall be at least equal in strength to 2.5 times the maximum tension in the load chain when the working load limit is being lifted. Any links used for connecting the load chain to a terminal fitting shall be of the material specified for the chain and heat treated to provide mechanical properties and strength equivalent to those of the load chain. The hook shall be made from high grade forged steel and provided with a safety latch. The safe working load shall be marked on the hook in kilograms.

PART 25 - Longitudinal and cross traverse motions shall be provided on the crane and shall be such that operation is speedy without impairing safety in working.

PART 26 - An extending, portable aluminum ladder shall be provided for access to the crane for maintenance, etc..

PART 27 - The crane shall also bear the manufacturer's name, serial number and year of manufacture.

Bumpers and Stops: Bumpers and stops for the trolley of the governing standards.

PART 28 - Trolley Materials

SCHEDULE 0 - Frame: Steel; Rigid construction.  
SCHEDULE 1 - Wheels: Rolled, forged, or cast steel with hardened treads.  
SCHEDULE 2 - Wheel Axles: High carbon steel or heated treated alloy steel; Fixed type.  
SCHEDULE 3 - Bearings: Permanently shielded, lifetime lubricated ball, antifriction type.  
SCHEDULE 4 - Trolley Drive: Hand geared trolley.  
SCHEDULE 5 - Gear: Machined from machine steel or drop forging, and full depth gear teeth.  
SCHEDULE 6 - Hoist Material: Hoist materials shall be as follows:  
SCHEDULE 7 - Bearings: Antifriction type; Oil lubrication or lifetime grease packing.  
SCHEDULE 8 - Gearing: Spur or helical type; Fully enclosed in oil tight housing.  
SCHEDULE 9 - Load Chain: As recommended by the Manufacturer.  
SCHEDULE 10 - Lifting Hook: Forged steel, slow opening, fracturing, with safety latch.  
SCHEDULE 11 - Sheave Bearings: Antifriction or sleeve type.

PART 3 EXECUTIONS

3.1 INSTALLATION

PART 29 - Equipment and accessories installed under this section shall be assembled, erected, and placed in proper operating condition in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment Manufacturer unless exceptions are noted by the Engineer.

PART 30 - Beam Hoist: The beam and trolley shall be erected by workmen regularly engaged in crane erecting and acceptable to the crane Manufacturer. The orientation of installation of the hoist and trolley on the beam shall be as directed by the Engineer.

PART 31 - Bumpers and Stops: Bumpers and stops shall be installed on the bridge, trolley, and located so that no part of the bridge or trolley encroaches on clearances specified or indicated on the construction Drawings.

3.2 FIELD QUALITY CONTROL

PART 32 - Installation Check: The monorail hoist, and trolley and their installation shall be inspected and checked by an experienced and competent technical representative of the equipment Manufacturer as required by the Quality Control Section.

PART 33 - The Contractor shall make all adjustments to the equipment as directed by the technical representative.

PART 34 - Operational Tests: After installation of the equipment as directed is complete, the Contractor shall conduct such operational tests as required to demonstrate that the crane shall operate in accordance with the requirements of these specifications.

PART 35 - Prior to acceptance of the monorail hoist, the Contractor shall clean and lubricate the equipment and make all final adjustments necessary to ensure operation satisfactory.

### 3.3 UNAUTHORIZED USE BY CONTRACTOR

PART 36 - The Contractor shall not use the electrical monorail hoist to install other equipment in the performance of his work under this contract.

END OF SECTION

## 4.2 Architectural Specifications

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#### **DIVISION 2**      **THERMAL AND MOISTURE PROTECTION**

- 2.1 GENERAL SHEET MEMBER WATERPROOFING

#### **DIVISION 3**      **DOORS AND WINDOWS**

- 3.1 METAL DOORS AND FRAMES
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- 4.3 PAINTING



## **1- MASONRY**

### **1.1 CONCRETE MASONRY**

1. Contractor should provide everything required to complete the concrete masonry works as Egyptian Standard Specification.
- 1.1.2 QUALITY STANDARDS:
  - a. Provide experienced, well-trained workers competent to complete the work as specified.
  - b. Unless approved by the Contract Administrator, provide all related products and accessories from one manufacturer
- 1.1.3 SUBMITTALS: Submit the following after receiving the Notice to Proceed.
  - a. Product Data: For each different masonry unit, accessory, and other manufactured product specified, including mortars and grouts.
  - b. Qualification Data.
  - c. Required submittals as directed by the Structural Engineer.
  - d. Shop drawings indicated, but not limited to, typical reinforcing details (as standards), control and expansion joints, typical junctions, and corners.
- 1.1.4 MATERIALS HANDLING:
  - a. Provide all materials required to complete the work. Deliver, store, and transport materials to avoid damage to the product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer to be as specified.
  - b. Store masonry off the ground, protected from dirt, ground moisture, contaminants, and weather.
- 1.1.5 PRECONSTRUCTION PROJECT PREPARATION: Examine and verify that job conditions are satisfactory for speedy and acceptable work. Use agreed schedule for installation and for Contract Administrator's field observation.
- 1.1.6 ACCESSORIES AND OTHER RELATED MATERIALS:
  - a. Provide all accessories and materials as required for complete, proper installation, including any required flashing to create water tightness.
  - b. Install anchorage as standards, and reinforcing as directed by Structural Engineers.
- 1.1.7 CONCRETE UNIT MASONRY:
  - a. Provide concrete unit masonry as specified herein as manufactured by local supplier. Sizes are noted in standards, but local sizes may be used (providing prior approval by Structural Engineer and Architect).
  - b. Concrete unit masonry units shall comply with standards.
- 1.1.8 WORK PREPARATION AND CONDITIONS:
  - a. Complete this work in a timely fashion, without interfering with, or delaying the work of other trades.
  - b. Prepare a work layout to establish and assure correct coursing and openings. Space and coordinate expansion/contraction joints to match building frame and thru-joints.
  - c. Do not build walls in heights exceeding 1.5 meters in one day, unless permitted by Structural Engineer.
  - d. NOTE: In addition to structural barriers, conduits, piping and duct work have to be enclosed in fire resistive shafts. Any penetration in these shafts must be sealed with a non-combustible material for the full thickness and equal to the fire rating of the barrier to ensure the fire integrity of the shaft wall.
- 1.1.9 UNIT MASONRY INSTALLATION AND MORTAR APPLICATION:

- a. Complete this work in a timely fashion, without interfering with, or delaying the work of other trades. Complete all work according to applicable codes and regulations or to the Egyptian Standards.
  - b. Masonry shall be tooled as per the Structural Engineers specifications.
- 1.1.10 MASONRY ACCESSORIES AND REINFORCING – INSTALLATION:
  - a. Install metal ties for bonding as standards. Assure compliance in types, sizes, spacing, depth of anchoring and corrosion resistance. All exterior ties and fixings shall be stainless steel.
  - b. Install reinforcing as standards.
  - c. For internal, non-load bearing walls without stone veneer, block walls shall be generally un-reinforced with 2-12 full height vertical bars at wall ends, corners, intersections, and openings. Reinforcing bars should have tension development length to fully developed dowels at bottom.
  - d. Wall heights shall for 120mm thick walls shall not exceed 3.2 meters unless approved by Structural Engineer.
  - e. Wall heights shall for 150mm thick walls shall not exceed 4.4 meters unless approved by Structural Engineer.
  - f. All walls shall have appropriate head restraint at top, per Structural Engineers design.
- 1.1.11 GROUTING:
  - a. Complete required building department inspection of masonry before grouting. Complete grout mix testing and certification before grouting.
  - b. Install inserts, anchor bolts, straps, dowels, and bars as per detail drawings.
  - c. Follow grout manufacturer's instructions for grouting, vibration, rodding, and protection when stopping work for an hour or more.
- 1.1.12 PARING, AND WATERPROOFING: Use waterproofing manufacturer's recommended curing procedures.
- 1.1.13 WORK PROTECTION AND CLEANING:
  - a. Clean all surfaces and work area prior to work, during work shifts, and immediately upon completion.
  - b. Protect tops of uncompleted wall sections at end of each full work shift.
- 1.1.14 REPAIR AND TOUCH-UP: After installation, inspect all work for improper installation or damage. Repair or replace any work damaged during installation. Make repair work undetectable.

## **2- THERMAL AND MOISTURE PROTECTION**

### **2.1 GENERAL SHEET MEMBER WATERPROOFING**

- 2.1.1 Contractor should provide everything required to complete the waterproofing system works as Egyptian Standard Specification.
- 2.1.2 SUBMITTALS:
  - a. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations. Including certification of data including VOC [Volatile Organic Compound] content of all components of the waterproofing system.
  - b. Samples: Submit representative samples of the Sheet membrane for approval.
- 2.1.3 QUALITY ASSURANCE:
  - a. Manufacturer: Sheet membrane waterproofing systems shall be manufactured and marketed by a firm with a minimum of 10 years' experience in the production and sales of self-adhesive sheet membrane waterproofing. Manufacturers proposed for use, but not named in these specifications, shall submit evidence of ability to meet all requirements specified.
  - b. Installer: A firm which has received the required manufacturers training.
  - c. Materials: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.
  - d. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.
- 2.1.4 Deliver materials and products in labelled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations, and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures, and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.
- 2.1.5 Do not double-stack pallets of membrane on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
- 2.1.6 Protect primer, mastic and adhesive from moisture and potential sources of ignition.
- 2.1.7 Store drainage composite or protection board flat and off the ground. Provide cover on top and all sides.
- 2.1.8 Sequence deliveries to avoid delays but minimize on-site storage.
- 2.1.9 PROJECT CONDITIONS:
  - a. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.
  - b. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.
  - c. Prior to beginning installation of waterproofing, the Contractor shall assure that all substrates are compatible with waterproofing installation.
- 2.1.10 WORK:
  - a. Provide everything required to complete the work as specified.
  - b. Contractor shall thoroughly investigate all Construction Documentation packages and ensure that appropriate flashings and counter flashings are included in each applicable construction package. The following specification shall establish basic standards; however it is not meant to be exhaustive and relies on the Contractors Professional experience to ensure satisfactory completion.
- 2.1.11 QUALITY STANDARDS:
  - a. Provide experienced, well-trained workers competent to complete the work as specified.

- b. Unless approved by the Architect, provide all related products and accessories from one manufacturer.
- 2.1.12 Submit the following after receiving the Notice to Proceed
  - a. Submit list of materials to be provided for this work; manufacturer's data required to prove compliance with these Specifications, manufacturer's installation instructions; shop drawings as required with complete details and assembly instructions.
  - b. Submit samples as required for approval by the Architect.
- 2.1.13 PRECONSTRUCTION AND PREPARATION: Examine and verify that job conditions are satisfactory for speedy and acceptable work.
- 2.1.14 EXAMINATION: The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.
- 2.1.15 PREPARATION OF SUBSTRATES:
  - a. Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be structurally sound and free of voids, spalled areas, looser aggregate, and sharp protrusions. Remove contaminates such as grease, oil, and wax from exposed surfaces. Remove dust, dirt, loose stone, and debris. Use repair materials and methods which are acceptable to manufacturer of sheet membrane waterproofing.
  - b. Cast-In-Place Concentrate Substrates:
    - i. Do not proceed with installation until concrete has properly cured and dried.
    - ii. Fill form tie rod holes with concrete and finish flush with surrounding surface.
    - iii. Masonry Substrates: Apply waterproofing over concrete block and brick with smooth trowel-cut mortar joints or parge coat.
    - iv. Repair bugholes over 13 mm (0.5 in.) in length and 6 mm (0.25 in.) deep and finish flush with surrounding surface.
    - v. Remove scaling to sound, unaffected concrete and repair exposed area.
    - vi. Grind irregular construction joints to suitable flush surface.
  - c. (minimum 7 days for normal structural concrete and minimum 14 days for lightweight structural concrete).
  - d. Related Materials: Treat joints and install flashing as recommended by waterproofing manufacturer.
- 2.1.16 INSTALLATION: Refer to manufacturer's literature for recommendations on installation, including but not limited to, the following:
  - a. Apply primer at the rate recommended by manufacturer. Recoat areas not waterproofed if contaminated by dust. Mask and protect adjoining exposed finish surfaces to protect those surfaces from excessive application of primer.
  - b. Delay application of membrane until primer is completely dry. Dry time will vary with weather conditions.
  - c. Seal daily terminations with trowelled bead of mastic.
  - d. Apply protection board and related materials in accordance with manufacturer's recommendations.
- 2.1.17 CLEANING AND PROTECTION:
  - a. Remove any masking materials after installation. Clean any stains on materials which would be exposed in the completed work.
  - b. Protect completed membrane waterproofing from subsequent construction activities as recommended by manufacturer.
  - c. After installation, the Contractor shall test the installation per Manufacturers recommendations, prior to covering up the work.
- 2.1.18 WARRANTY: 10-year material warranty should be supplied for all installations of sheet membrane waterproofing.



### **3- DOORS AND WINDOWS**

#### **51 METAL DOORS AND FRAMES**

- 3.1.1 Contractor should provide everything required to complete the metal doors works as Egyptian Standard Specification.
- 3.1.2 Contractor should provide experienced, well-trained workers competent to complete the work as specified.
- 3.1.3 Unless approved by the Architect / Interior Designer, provide all related products and accessories from one manufacturer.
- 3.1.4 Contractor Should submit the following after receiving the Notice to Proceed:
  - a. Submit 12" x 12" (300mm x 300mm) samples of each specified door material, finished as indicated on the Door and Finish Schedules.
  - b. Submit list of materials to be provided for this work.
  - c. Submit manufacturer's data required to prove compliance with these Specifications.
  - d. Submit manufacturer's installation instructions.
  - e. Submit Shop Drawings with complete details and assembly instructions.
  - f. Submit door set Certificate, indicating that door, frame and entire door set assembly meets all local regulatory requirements, including all requirements for the fire rating as scheduled.
  - g. Submit details of all fixing anchors into Concrete / Masonry structures to the engineer for approval.
- 3.1.5 MATERIALS HANDLING:
  - a. Provide all materials required to complete the work as shown on specified herein. Deliver and transport materials to avoid damage to the product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer to be as specified.
  - b. Store materials safely to avoid damage and locate to expedite the work. Store delivered doors consistently vertical or flat. Provide sheet materials at bottom and top sides, to protect doors from damage. Lift and carry doors when moving them; do not drag into position.
- 3.1.6 Provide doors that are straight, free of defects and blemishes, and have correct finish material thickness. Doors will be complete with reinforcing and backing plates.
- 3.1.7 Verify that factory preparation and pre-fitting follow required hardware standards.
- 3.1.8 Provide fire-rated doors that comply with all Building Code and Fire Codes requirements.
- 3.1.9 Doors shall be manufactured by local supplier, as approved by the Architect / Interior Designer.
- 3.1.10 FINISH HARDWARE: Manufacturer shall prepare frames for finish hardware using hardware supplier's templates. Use hardware supplier's templates to install or prepare for all finish hardware.
- 3.1.11 PRECONSTRUCTION AND PREPARATION:
  - a. Examine and verify that job conditions are satisfactory for speedy and acceptable work.
  - b. Do not allow door swings to conflict with electrical switches or outlets, wall guards or rails.
  - c. It is the expressed intention that all rated door assemblies, will strictly conform to any local regulations and codes. Any doors that are designated as rated or fire protected will have fully conforming rated frames, hardware, etc. It is the Contractors responsibility to ensure that all door assemblies are correctly assembled and installed.
- 3.1.12 INSTALLATION:

- a. Mount frames prior to wall construction wherever practical to do so. Mount frames plumb, straight, and securely braced until permanently anchored.
  - b. Hang doors straight, plumb, smooth in opening and closing.
  - c. Provide clearances below doors as necessary to allow for thresholds, weatherstripping, etc.
  - d. Do not cut fire-rated doors to negate fire rating.
  - e. Seal or re-seal doors whenever they are cut. Seal, stain, or paint exterior doors before or immediately after installing them.
- 3.1.13 INSPECTION, REPAIR, AND TOUCH-UP:
- a. After installation, inspect all doors and frames to find and repair damaged surfaces. Repair or replace any damaged materials so that repairs are undetectable. Any costs for replacing doors for non-compliance will be paid by the Contractor.
  - b. Final door mounts shall be square, smooth operating, and plumb when doors are closed, partially open, and fully open.

## 3.2 **WOOD DOORS**

- 3.2.1 Contractor should provide everything required to complete the aluminium windows works as Egyptian Standard Specification.
- 3.2.2 WORK: Provide wood doors and frames, complete with hardware, Provide and install all door hardware.
- 3.2.3 QUALITY STANDARDS:
- a. Provide experienced, well-trained workers competent to complete the work as specified.
  - b. Unless approved by the Architect / Interior Designer, provide all related products and accessories from one manufacturer.
- 3.2.4 SUBMITTALS: Submit the following after receiving the Notice to Proceed:
- a. Submit 12" x 12" (300mm x 300mm) samples of each specified door face material.
  - b. Submit list of materials to be provided for this work.
  - c. Submit manufacturer's data required to prove compliance with these Specifications.
  - d. Submit manufacturer's installation instructions.
  - e. Submit Shop Drawings with complete details and assembly instructions.
  - f. Submit door set Certificate, indicating that door, frame and entire door set assembly meets all local regulatory requirements, including standards requirements for fire rating as scheduled.
- 3.2.5 MATERIALS HANDLING:
- a. Provide all materials required to complete the work, Deliver and transport materials to avoid damage to the product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer to be as specified.
  - b. Deliver after interior finish materials are dry and after building reaches average long-term interior humidity. Packaging must be sealed with clear manufacturer and identification markings. Seal all edges of unfinished doors.
  - c. Store materials safely to avoid damage and locate to expedite the work. Store flat on 2x4's (50mm x 100mm timber battens) spaced at 12" (300mm) centres, and safely protected from damage, weather, and moisture.
- 3.2.6 Doors shall be manufactured by approved local manufacturer.
- 3.2.7 Provide doors that are straight, free of defects and blemishes, and that have correct finish material thickness.
- 3.2.8 Verify that factory preparation and prefitting follow required hardware templates. Hollow-core doors must have core construction as required to receive finish hardware.
- 3.2.9 Provide door glazing with stops as required and labelled safety glass.
- 3.2.10 PRECONSTRUCTION AND PREPARATION:

- a. Examine and verify that job conditions are satisfactory for speedy and acceptable work.
  - b. Do not allow door swings to conflict with electrical switches or outlets, wall guards or rails.
  - c. It is the expressed intention that all rated door assemblies, will strictly conform to any local regulations and codes. Any doors that are designated as rated or fire protected will have fully conforming rated frames, hardware, etc. It is the Contractors responsibility to ensure that all door assemblies are correctly assembled and installed.
- 3.2.11 INSTALLATION:
- a. Mount frames and doors plumb, straight, and securely braced.
  - b. Mounting tolerances: Bottom clearance, ½" (12mm) maximum; top clearance, 1/8" (mm) maximum; lock and hinge edge, bevel at 1/8" in 2" (3mm in 50mm) maximum.
  - c. Hang doors straight, plumb, smooth in opening and closing. Provide clearances below doors as necessary to allow for thresholds, weatherstripping, acoustic drop down seals, etc.
  - d. Seal or re-seal doors whenever they are cut. Seal, stain, or paint exterior doors before or immediately after installing them.
  - e. Install fastenings and hardware as per Hardware Schedule and instructions of manufacturer.
- 3.2.12 INSPECTION, REPAIR, AND TOUCH-UP:
- a. After installation, inspect all doors and frames to find and repair damaged surfaces. Repair or replace any damaged materials or improperly hung doors as directed by the Architect. Repair or replace any other materials damaged during installation. Any costs for replacing doors for non-compliance will be paid by the Contractor.
  - b. Final door mounts shall be square, smooth operating, and plumb when doors are closed, partially open, and fully open.

## **52     ALUMINIUM WINDOWS**

- 3.3.1 Contractor should provide everything required to complete the aluminium windows works as Egyptian Standard Specification.
- 3.3.2 Provide metal frame windows where shown as specified herein.
- 3.3.3 QUALITY STANDARDS:
- a. Provide experienced, well-trained workers competent to complete the work as specified.
  - b. Unless approved by the Architect, provide all related products and accessories from one manufacturer
- 3.3.4 Submit the following after receiving the Notice to Proceed:
- a. Submit list of materials to be provided for this work.
  - b. Submit manufacturer's installation instructions
  - c. Submit Shop Drawings with complete details and assembly instructions
  - d. Submit manufactures complete window schedule including keyed elevations and section cuts, which are referenced to shop drawings.
- 3.3.5 MATERIALS HANDLING:
- a. Provide all materials required to complete the work as shown on specified herein.
  - b. Deliver and transport materials to avoid damage 144ob e144 product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer 144ob e as specified.
  - c. Store materials safely to avoid damage and locate to expedite the work. Store delivered doors and frames consistently vertical or flat. Lift and carry windows and frames with care to avoid damage.



- 3.3.6 Provide windows complete with glazing as per exists.
- 3.3.7 Window Construction:
  - a. Windows shall be constructed as composite units. Separate coupling mullions or transoms to connect windows within an opening shall not be acceptable.
  - b. The corners of the aluminium system shall be mechanically jointed by the use of aluminium multi chambered cleats crimped and profiled to accept an injected epoxy adhesive.
  - c. Mitres formed during the construction of the framing elements are to be epoxy bonded.
- 3.3.8 Glazing: The outer glazing gasket shall be of one length, jointed at the head and bonded under compression. The outer gasket shall be so designed to resist ingress of water into the system due to pumping action of wind upon the glass.
- 3.3.9 Drainage: The window glazing rebate shall be ventilated and drained via drainage slots.
- 3.3.10 Exposure: Classification for watertightness, air permeability and wind resistance shall be in accordance with standards, Air permeability shall comply with standard, Watertightness for the system shall comply with standards.
- 3.3.11 Fixing: The system may be reinforced and be complete with all structural members to resist the dead/imposed wind loadings. The system is to be capable of transferring all loads subjected upon it to the main structure via sufficient, permanent and where necessary, flexible fixings.
- 3.3.12 Thermal Movement: The aluminium framework and glazing assemblies shall be constructed and installed in the prepared locations and openings with sufficient tolerance and, where necessary, expansion joints incorporated within the couplings to provide for expansion and contraction as will be caused by the climatic conditions and temperature changes, winter to summer, day to night, without buckling, distortion of joints, damage to the sealants or other detrimental effects over the temperature range 0°C to +50°C. The design shall accommodate, noiselessly, the thermal movement within the combination units without distortion. Details shall be prepared based upon the dimensions at 20°C and take account of the ambient temperatures at the time of assembly and installation
- 3.3.13 PRECONSTRUCTION: Examine and verify that job conditions are satisfactory for speedy and acceptable work.
- 3.3.14 INSTALLATION:
  - a. Window dimensions and alignments shall be as exists.
  - b. Install windows according to manufacturer's instructions. Install windows that are weathertight and allow no air infiltration.
  - c. Tolerances: Construct openings of six feet (1800mm) or less within plus or minus 1/16 inch (4mm) tolerance in each direction. Construct openings larger than six feet within plus or minus 1/8 inch (8mm) tolerance in each direction. Construct openings with diagonal dimensions within 1/8 inch (8mm) of each other.
- 3.3.15 INSPECTION, REPAIR, AND TOUCH-UP:
  - a. After installation, inspect all windows and frames to find and repair damage. Repair or replace any damaged materials as directed by the Architect. Any costs for replacing windows for non-compliance will be paid by the Contractor.
  - b. After installation, protect all materials from physical and chemical damage. Make undetectable repairs to damaged materials or finishes.

#### **4- FINISHES**

##### **4.1 SUSPENDED CEILING SYSTEMS**

- 4.1.1 Contractor should provide everything required to complete the suspended ceiling works as Egyptian Standard Specification.

- 4.1.2 Contractor should provide experienced, well-trained workers competent to complete the work as specified.
- 4.1.3 Unless approved by the Architect, provide all related products and accessories from one manufacturer.
- 4.1.4 Submit the following after receiving the Notice to Proceed.
  - b. Submit list of materials to be provided for this work.
  - c. Submit manufacturer's specifications required to prove compliance with these specifications.
  - d. Submit manufacturer's installation instructions.
  - e. Submit Shop Drawings as required with complete details and assembly instructions.
  - f. Submit samples of each proposed ceiling tile with selected finish, colour, backing, grid system (if exposed), and perimeter termination channel.
- 4.1.5 Before Starting works, provide all materials required to complete the work
- 4.1.6 Deliver, store, and transport materials to avoid damage 146ob e146 product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer 146ob e as specified.
- 4.1.7 Store materials in a safe, secure location, protected from dirt, moisture, contaminants, and weather.
- 4.1.8 Examine and verify that job conditions are satisfactory for speedy and acceptable work. Confirm there is no conflict between this work and governing building and safety codes. Confirm there are no conflicts between this work and work of other trades. Confirm that work of other 146ob e146t hat must precede this work has been completed. Meet all requirements to secure any applicable warranty.
- 4.1.9 Notify Architect when work is scheduled 146ob e started and completed.
- 4.1.10 GRID SYSTEM: Provide a complete grid system of light fixtures and grilles as per Drawings. Include all required supports, anchors, and other accessories for a complete ceiling system.
- 4.1.11 PREPARATION: Measure and layout ceiling to avoid panels less than ½ panel in size, if possible. Keep and use correct manufacturer's instructions. Follow ceiling layout to provide clearances for all other work.
- 4.1.12 INSTALLATION:
  - a. Install ceiling system as per manufacturer's instructions. Follow ceiling grid space pattern as designed in ceiling plans or approved by the Architect. Do not allow loads of anything but the ceiling system on the ceiling supports. Do not allow ceiling to brace or support mechanical or electrical equipment.
  - b. Provide fire and sound barriers as shown on Drawings. Provide undamaged, uninterrupted, and tightly sealed through-ceiling fire barriers. Install through-ceiling sound walls undamaged and tightly sealed. Any additional required connectors and fastenings must match the rest of ceiling.
  - c. Provide lateral bracing for secure installation and as per governing building code.
  - d. Tolerances: Level whole ceiling within a tolerance of 1/8" in 10' (3mm in 3 metres) and straight within the same tolerance.
- 4.1.13 CLEANING AND REPAIR
  - a. Keep work area thoroughly clean and remove all scrap daily as work proceeds.
  - b. Repair or replace defective work as directed by the Architect. Make repairs undetectable.
- 4.1.14 STRUCTURAL LIABILITY: The Contractor 146ob e take on all liability concerning the structural stability 146ob e146 ceilings and canopies.

- 4.1.15 DESIGN: The Contractor shall be responsible 147ob e147t design 147ob e147 following:
- a. Fixings
  - b. Support systems allowing maintenance access to light fittings, air-conditioning ductwork and dampers, access hatches, sprinkler-heads, smoke-alarms, etc.
  - c. Compliance with ‘spread-of-flame’ and / or fire-resistance requirements.
  - d. Compliance with impact-resistance requirements.
  - e. Any safety issues.
- 4.1.16 The Contractor 147ob e consider any statutory and/or local regulation regarding installation of this type. All are 147ob e installed in accordance with approved manufacturers / supplier’s recommendations.

## **26            CERAMIC TILE**

- 4.2.1 Contractor should provide everything required to complete the ceramic tiles works as Egyptian Standard Specification.
- 4.2.2 WORK: Contractor should provide all necessary materials mortars, grouts, adhesives, waterproofing membranes, and skilled labour to install ceramic / glass tile, ceramic / glass tile mosaics.
- 4.2.3 QUALITY STANDARDS:
- a. Provide experienced, well-trained workers competent to complete the work as specified.
  - b. Unless approved by the Architect, provide all related products and accessories from one manufacturer.
  - c. All work shall comply with manufacturer's instructions and any governing building and safety codes.
- 4.2.4 Contractor should submit the following after receiving the Notice to Proceed:
- a. list of materials to be provided for this work.
  - b. manufacturer's specifications required to prove compliance with these specifications.
  - c. manufacturer's installation instructions.
  - d. typical Shop Drawings as required with complete details and assembly instructions. This shall include the setting out points, and detailed shop drawings for ceramic / glass tile mosaics.
- 4.2.5 MATERIALS HANDLING:
- a. Provide all materials required to complete the work as shown on specified herein.
  - b. Deliver, store, and transport materials to avoid damage to the product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer to be as specified.
  - c. Store materials in a safe, secure location, protected from dirt, moisture, contaminants, and weather.
- 4.2.6 PRECONSTRUCTION AND PREPARATION:
- a. Examine and verify that job conditions are satisfactory for speedy and acceptable work. Confirm there is no conflict between this work and any governing building and safety codes. Confirm there are no conflicts between this work and work of other trades. Confirm that work of other trades that must precede this work has been completed. Meet all requirements to secure any applicable warranty.
  - b. Notify Architect when work is scheduled to be started and completed.
- 4.2.7 TILE AND ACCESSORIES:
- a. Colours, textures, and patterns shall match samples approved by the Architect.
  - b. Provide all accessory shapes to complete the work as shown in specified herein.
- 4.2.8 GROUT:
- a. Grout colour shall be as selected by the Architect or Interior Designer or installed as indicated on Drawings and Finishes Schedules otherwise.
  - b. Portland Cement grout: Use mixture of Portland Cement and other materials manufactured for this purpose. Grout must comply with tile manufacturer's instructions.
- 4.2.9 OTHER MATERIALS:
- a. Provide all related materials required for a complete, proper installation.
  - b. Adhesive, sealant, and grout as per applicable trade standards and tile manufacturer's instructions, delivered in new unopened containers, with correct colour additives.
  - c. Provide non-corrosive lath, zinc-coated, lapped, and tied with zinc-coated wires.
  - d. Install waterproofing and backing that will absolutely block water leakage. All waterproofing and backing must be as per manufacturer's instructions.

#### 4.2.10 PREPARATION:

- a. Keep work surfaces and working environment clean, dry, well lit, well ventilated, free of airborne construction dust and at comfortable working temperature, minimum 60 degrees F.
- b. Provide supports for fixtures and related construction. Pre-mark and double-check locations for accessories to be installed. Set accessories in place before beginning tile work. Put in place and properly position, work of related trades.
- c. Install all support framing, furring, and backing, plumb, square, aligned, and well secured so surfaces will not move or deflect.
- d. Prepare floors for tiling so the finish floor will be either perfectly level or slope properly to drains.
- e. Work preparation: Install waterproofing and backing that will absolutely block water leakage: Install control joints and edge strips securely fastened. Set layout start points to achieve tile patterning that is symmetrical and complete.

#### 4.2.11 INSTALLATION:

- a. Work standards and conditions: Comply with manufacturer's instructions, Work temperature must be as per instructions of materials manufacturers, Tile over floor membrane may not be installed until membrane is tested and accepted.
- b. Tile must be installed as a complete, uninterrupted covering. Extend tile into recesses and under and behind future equipment or fixtures. Terminate tile neatly at edges, obstructions, or penetrations of other work.
- c. Lay tile in standard grid unless shown otherwise on Drawings or directed by the Architect or Interior Designer. Align joints of adjoining same size tiles on floor, base, walls, and trim. In tile layout, centre tile fields both directions on each floor or wall area. Joint widths must be consistent and uniform.
- d. Provide expansion and control joints where needed as standard.
- e. Perfectly match tile pieces with other tile work. Apply tile surface smoothly and free of irregularities, humps, or dips. Install tile joints straight, level horizontally, aligned, and exact vertically. Make tile cuts uniform and not smaller than half a tile.
- f. Complete grouted or thin-set adhesion so no tiles can be pulled loose.

#### 4.2.12 PROTECTION, CLEANING, AND REPAIR:

- a. Completely protect finished tile and allow no damage to the work.
- b. Use cleaning solutions and materials as per manufacturer's instructions. Wash tile surfaces with clean water before and after cleaning. Remove excess corrosive cleaning solutions from site; do not empty into building drains.
- c. Repair and replace defective work. Reject tiles and replace if chipped, scratched, loose, or misaligned. Repair or replace all defective and non-conforming work as directed by the Architect. Make repairs undetectable.

## 27 PAINTING

- 4.3.1 Contractor should provide everything required to complete the painting works as Egyptian Standard Specification.
- 4.3.2 The Contractor may source local products; however, these must be approved by the applicable Design Consultant. If a suitable local equivalent is not found, the Contractor is responsible for providing the finish, as specified in the Finish Schedules and approved drawings.
- 4.3.3 Provide experienced, well-trained workers competent to complete the work as specified.
- 4.3.4 Unless approved by the Architect / Interior Designer, provide all related products and accessories from one manufacturer.
- 4.3.5 Contractor should Provide manufacturer's specifications and other data to prove compliance with specified requirements.
- 4.3.6 Following selection of colours by the Architect / Interior Designer, submit samples 150ob e150t Architect's / Interior Designer's review. Provide samples of each colour and gloss for each material. Samples shall be on the material the finish is specified 150ob e applied. Samples shall be approximately 1 metre x 1 metre in size. Do not start finish painting until samples are approved and available at job site.
- 4.3.7 MATERIALS HANDLING:
  - a. Provide all materials required to complete the work as shown on Drawings and specified herein.
  - b. Deliver, store, and transport materials to avoid damage 150ob e150 product or to any other work. Return any products or materials delivered in a damaged or unsatisfactory condition. Materials and products delivered will be certified by the manufacturer 150ob e as specified.
  - c. Store materials in a safe, secure location, protected from dirt, moisture, contaminants, and weather.
- 4.3.8 JOB CONDITIONS: Strictly follow paint manufacturer's requirements as to temperature, humidity, and condition of work surfaces.
- 4.3.9 PRECONSTRUCTION AND PREPARATION:
  - a. Examine and verify that job conditions are satisfactory for speedy and acceptable work. Confirm there is no conflict between this work and any governing building and safety codes. Confirm there are no conflicts between this work and work of other trades. Confirm that work of other 150ob e150t hat must precede this work has been completed. Meet all requirements to secure any applicable warranty.
  - b. Notify Architect when work is scheduled 150ob e started and completed.
- 4.3.10 Provide all materials and tools required for the work.
- 4.3.11 LIMITATIONS ON USE:
  - a. Undercoat must be from the same manufacturer as the finish coat. Thinners must be as recommended by the paint manufacturer and used only as recommended. The undercoat, finish coat and thinner are integrated parts of a total paint finish.
  - b. Do not use latex primer on bare wood. Do not use alkyd primer on gypsum board. Apply primer or sealer to knots and pitch pockets on wood that is to be painted.
- 4.3.12 MATERIALS DELIVERY AND STORAGE:
  - a. All paint materials shall be delivered new, in labelled, unopened containers. Material quality may be verified as necessary by onsite or laboratory tests.
  - b. Do not use mixed brands or partial substitutions. Have materials delivered in a timely sequence as required to expedite the workflow. Store all paint materials with ample ventilation, in fire-protected space, secure from damage. Keep paint storage areas clean and clear of spilled material, empty containers, rags, and scrap.
- 4.3.13 APPLICATION EQUIPMENT: Use painting tools and equipment only as recommended by the paint manufacturer. Prior to work, verify that proposed equipment is compatible with material to be applied.

- 4.3.14 **WORKING CONDITIONS:** Maintain a proper work environment, dry, clean, well ventilated, free of airborne construction dust, well lit, in temperature and humidity ranges required by paint manufacturer. Keep humidity low enough to prevent moisture condensation on work surfaces. Never apply paint to damp or wet surfaces.
- 4.3.15 **MATERIALS PREPARATION:** Handle and mix paint materials strictly according to manufacturer's instructions. Store paint materials in tightly covered containers when not in use. Maintain paint storage and mix containers clean and free from dirt or paint residue.
- 4.3.16 **SURFACE PREPARATION:**
- a. Test areas with paint and match dried paint to approved colour and texture samples. Keep colour samples on hand and use them continuously for comparisons.
  - b. Prepare and clean working surfaces as per paint manufacturer's instructions. Remove or protect items attached to work surfaces which are not to be painted. After painting in each area, reinstall removed items using workers competent in the related trades. Remove oil and grease with clean cloths. Cleaning must not contaminate adjacent freshly painted surfaces. Cleaning solvent must meet safety standards of governing building and safety codes.
  - c. Clean wood of dirt, oil, and any other material that may interfere with painting. Sand exposed wood to smooth uniform surface. Do not paint wood having moisture content of 12% or higher. Measure moisture content of wood with an approved moisture meter.
  - d. Clean metal of dirt, oil, and any other material that might interfere with painting. Clean and etch galvanized metal with phosphoric acid as required for painting.
- 4.3.17 **PREPARATION AND COORDINATION:**
- a. Handle and store materials as per manufacturer's instructions. Remove or fully protect adjacent or related work that might be marred by painting.
  - b. Touch up and repair any damaged shop-applied prime coats. Touch up bare areas prior to start of finish coat application. Finish coat materials must be compatible with prime coats. Review other Sections of these Specifications to determine prime coatings on various materials. Do not allow paint gaps or overlaps at edges of hardware, fixtures, or trim.
- 4.3.18 **PAINT APPLICATION:**
- a. Mix and apply materials strictly as per manufacturer's instructions. Apply paint to thoroughly cover undercoat, and do not allow show-through, lap or brush marks or any other defects. Vary the hue of succeeding coats slightly to clearly show coats are applied as required. Only coats of paint inspected and approved by the Architect / Interior Designer will be counted as completed. Sand defects smooth between coats. Defects are defined as irregularities visible to the unaided eye at a five-foot (1500mm) distance.
  - b. Keep approved samples on hand for comparison with work.
  - c. Allow drying time between coats as instructed by the paint manufacturer. Work and smooth out brush coats onto surface in an even film. Where spraying, apply each coat to provide the hiding equivalent of brush coats. Do not double back with spray equipment to build up film thickness of two coats in one pass. Match applied work with approved samples as to texture, colour, and coverage.
- 4.3.19 **PAINTING AND CLEANING SPECIAL SURFACES:**
- a. Paint ventilation registers, panels, access doors, ducts, etc. to match adjacent surfaces (unless indicated otherwise). Paint back sides of access panels to match exposed sides. Paint visible duct surfaces behind vents, registers, and grilles as directed by the Architect / Interior Designer. Exposed vents: Apply two coats of heat-resistant paint.
  - b. Wash metal to be painted with solvent recommended by paint manufacturer. Add prime coat followed by two coats of alkyd enamel.

- c. Exposed pipe and duct insulation: Apply one coat of latex on insulation which has been sized or primed under another Section. Apply two coats on such surfaces when unprimed. Remove pipe or duct bands before painting and replace after painting.
- d. Hardware: Paint prime-coated hardware to match adjacent surfaces. Allow no paint to come in contact with hardware that is not to be painted.
- e. Damp spaces: In shower or toilet rooms and other damp rooms add approved fungicide to paints.

4.3.20 CLEANING AND EXTRA STOCK:

- a. Maintain thorough dust and dirt control throughout the painting process. Thoroughly protect all surfaces that won't be painted with clean, undamaged drop cloths and masking tape. Immediately clean any spilled materials and do not allow dirt or spilled materials to be tracked in a work area or to other work areas. Allow absolutely no paint smears or splatters to remain on adjacent surfaces.
- b. Upon completion of painting work, deliver to the Owner an extra stock of 10% or more of each colour, type, and gloss of paint used in the work. Tightly seal and clearly label each container with notes on contents and location used.

4.3.21 INSPECTION, TOUCH UP AND REPAIRS:

- a. Tests may be made at random to confirm paint coat thicknesses and paint work quality. Unacceptable work includes surface imperfections such as spotting, laps, brush marks, and runs.
- b. Remove, refinish, or repaint work not in compliance with specified requirements. Replace or repair all non-conforming work as directed by the Architect / Interior Designer. Do repairs and touch-ups so they are undetectable.



## **4.3 Electrical Specifications**

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**SECTION 26 05 04**  
**CLEANING, INSPECTION, AND TESTING OF ELECTRICAL EQUIPMENT**

**PART 1 – GENERAL**

**SCOPE**

The work under this section includes the required cleaning, inspection, adjustment, maintenance and testing of electrical equipment, as specified herein. This applies only to new electrical and existing electrical equipment being furnished, modified, worked on or serviced by this contractor for this project. Included are the following topics:

**PART 1 – GENERAL**

Scope

**PART 2 – PRODUCTS**

Not Used

**PART 3 – EXECUTION**

General Inspection and Cleaning of All Electrical Equipment

Mechanical and Electrical Interlock System

Ground Fault Systems

Switchboards (Low voltage)

Panelboards

Motor Starters and Motor Control Centers

Cables

Manholes

Light Fixtures

**PART 2 – PRODUCTS**

Not Used.

**PART 3 – EXECUTION**

**GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT**

Inspect for physical damage and abnormal mechanical and electrical conditions.

Any item found to be out of tolerance, or in any other way defective as a result of the required inspection or testing, shall be reported to the DFD. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed, the item shall be re-tested.

Compare equipment nameplate information with the latest single line diagram and report any discrepancies.

Verify proper auxiliary device operation and indicators.

Check tightness of accessible bolted electrical joints. Use torque wrench method.

Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. That may not have been removed during original installation.

Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.

Clean All Equipment:

**Multi-Educational Programme for Employment Promotion in Migration-affected Areas (MEPEP)**  
**Technical Assistance and Supervision Services for Refurbishment and Construction Works**  
**Labs/Workshops**

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Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, bus ducts, MCC's, and the exterior of all Communications and Electronic Safety and Security hardware and equipment.

Loosen attached particles and vacuum them away.

Wipe all insulators with a clean, dry, lint free rag.

Clean insulator grooves.

Re-vacuum inside surfaces as directed by the DFD Construction Representative or Inspector

Inspect equipment anchorage.

Inspect equipment and bus alignment.

Check all heater elements for operation and control.

Lubricate nonelectrical equipment per manufacturer's recommendations.

**MECHANICAL AND ELECTRICAL INTERLOCK SYSTEM**

Physically test each system to insure proper function, operation and sequencing.

Closure attempt shall be made on locked open devices.

Opening attempt shall be made on locked closed devices.

Key exchange shall be made with devices operated in off normal positions.

**GROUND FAULT SYSTEMS**

Inspect for physical damage.

Inspect the neutral main bonding connection to assure:

Zero sequence system is grounded upstream of sensor.

Ground strap systems are grounded downstream from the sensing device.

Ground connection is made ahead of the neutral disconnect link.

**SWITCHBOARDS (LOW VOLTAGE)**

Visual and Mechanical Inspection:

Inspect for physical, electrical and mechanical conditions. Re-torque all bolted connections.

Compare equipment nameplate information with latest single line diagram and report discrepancies.

Inspect for proper alignment, anchorage and grounding

All doors, panels and sections shall be inspected for paint, dents, scratches, and fit.

All active components shall be exercised and cleaned where possible.

All indicating devices shall be inspected for proper operation.

**PANELBOARDS**

Torque all the connections per the manufacturers spec. Verify phase wires, color coding, separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.

Vacuum clean the panelboard enclosure.

**MOTOR STARTERS AND MOTOR CONTROL CENTERS**

Verify the control circuits. Confirm the fusing and the grounding of the control transformers. Torque all of the connections. Confirm the overload elements and the circuit breakers (fuse) for proper sizing. Verify all grounding. Operate and test each motor starter for proper operation.

**CABLES**

600 Volt cable:

Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections.

Check all cable connectors for tightness (with a torque wrench) and clearances. Torque test conductor terminations to manufacturer's recommendations.

**MANHOLES**

Check cable racking and system grounding in all manholes.

Verify all cable labels.

**LIGHT FIXTURES**

Check the bonding and proper lamping. Verify that recessed fixtures are installed with hold down clips. Confirm operation of the fixture with the proper switch or sensor.

END OF SECTION

**SECTION 26 05 19**  
**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 – GENERAL**

**SCOPE**

The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing. Included are the following topics:

**PART 1 – GENERAL**

- Scope
- References
- Submittals
- Project Conditions

**PART 2 – PRODUCTS**

- General
- Building Wire
- Service Entrance Conductors
- Variable Frequency Drive (VFD) Wire
- Aboveground Wire for Exterior Work
- Underground Wire for Exterior Work
- Wiring Connectors

**PART 3 – EXECUTION**

- General Wiring Methods
- Wiring Installation in Raceways
- Wiring Connections and Terminations
- Field Quality Control
- Branch Circuits

**REFERENCES**

SPS 316- Electrical

**SUBMITTALS**

Submit product data: Provide for each cable assembly type.

Submit factory test reports: Indicate procedures and values obtained.

Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

**PROJECT CONDITIONS**

Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required for project conditions.

Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

**PART 2 – PRODUCTS**

**GENERAL**

All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

All conductors shall be copper conductors and larger may be substituted for copper and used for phase and neutral conductors for transformer feeders, switchboard feeders, and panelboard feeders. All ground conductors shall be copper.

Insulation shall have a 600V/1KV rating.

All conductors shall be stranded.

Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

#### **BUILDING WIRE**

Description: Single conductor insulated wire 90 degree C.

Insulation: Type THHN/THWN-2, XHHW-2 insulation

#### **SERVICE ENTRANCE CONDUCTORS**

Description: Single conductor or multi-conductor insulated wire. 90 degree C sized at the 75 degree C table.

Insulation: Type USE-2, XHHW-2 insulation for service entrance conductors routed from exterior source to exterior termination location.

Type XHHW-2 insulation for services entrance conductors routed from exterior source to interior termination location.

#### **VARIABLE FREQUENCY DRIVE (VFD) WIRE**

All power wiring from the VFD output to the motor shall be type XHHW-2 insulation, single conductor wire.

#### **ABOVEGROUND WIRE FOR EXTERIOR WORK**

Description: Single conductor insulated wire, 90 degree C.

Insulation: Type XHHW-2 insulation.

#### **UNDERGROUND WIRE FOR EXTERIOR WORK**

Description: Stranded single or multiple conductor insulated wire, 90 degree C.

Insulation: Type USE-2, XHHW-2, RHW-2 insulation.

This wiring shall be used in all underground feeder and branch circuit applications, except THHN/THWN-2 is permitted when run in a concrete-encased duct bank.

#### **WIRING CONNECTORS**

Split Bolt Connectors: Not acceptable.

Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment terminals. Not approved for splicing.

Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The manufacturer's wire fill capacity must be followed. Use Silicone filled twist type spring connectors in all wet location areas.

Mechanical Spring Actuation Connectors: Toolless type spring actuation connector (push-in) with spacers for copper wire splices and taps. Use for conductor sizes 12 AWG and smaller. The manufacturer's wire fill capacity must be followed. Use in interior, dry locations only.

All wire connectors used in underground or exterior pull boxes or hand holes shall be gel filled twist connectors or a connector designed for damp and wet locations. Gel filled twist type connectors can be used for copper conductor sizes 6 AWG and smaller for site lighting applications. The manufacturer's wire fill capacity must be followed.

Mechanical Connectors: Bolted type tin-plated; High conductivity copper alloy; Spacer between conductors; Beveled cable entrances.

Compression (crimp) Connectors: Long barrel; Seamless, tin-plated electrolytic copper tubing; Internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector must be installed with a crimper tool listed for use with the manufacturer and type of compression connector.

Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B Listed. May be used only for connection of a tap conductor in run and tap type applications when main conductor is 8 AWG and larger.

### **PART 3 – EXECUTION**

#### **GENERAL WIRING METHODS**

All wire and cable shall be installed in conduit.

Do not use wire smaller than 12 AWG for power and lighting circuits.

All phase, neutral and ground conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. According to NEC code or EGY. Code

Ground conductor size shall be increased per NEC 250.122(B) when phase and phase/neutral conductors are increased in size.

Make conductor lengths for parallel conductors equal.

Splice only in junction or outlet boxes.

No conductor less than 10 AWG shall be installed in exterior underground conduit.

Neatly train and lace wiring inside boxes, equipment, and panelboards.

### **WIRING INSTALLATION IN RACEWAYS**

Pull all conductors into a raceway at the same time. Use Listed water or silicone based wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary. Wax based lubricants are not allowed. Pulling lubricant is not required for low friction type products where the cable manufacturer recommends that cables be pulled without lube.

Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

Completely and thoroughly swab raceway system before installing conductors.

Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.

Manufacturers maximum pulling tensions shall be not be exceeded and individual pulls shall not exceed 270 degrees.

VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.

In high ambient spaces, mechanical rooms, utility rooms and exterior exposed conduit, 90 degree C, XHHW-2 conductors shall be utilized.

### **WIRING CONNECTIONS AND TERMINATIONS**

Splice only in accessible junction boxes.

Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.

All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

Use solderless twist type spring connectors (wire nuts) with insulating covers for copper wire splices and taps, 10 AWG and smaller or toolless type actuation connectors (push-in) with spacers for copper wire splices and taps, 12 AWG and smaller. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the wiring.

Thoroughly clean wires before installing lugs and connectors.

At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

### **FIELD QUALITY CONTROL**

Field inspection and testing will be performed under provisions of Section 26 05 04.

Additional testing as follows shall be performed if aluminum conductors are used:

Feeders terminated with aluminum conductors shall be tested with a thermal imager and recorded.

Conductors shall be closely checked for loose or poor connections, and for signs of overheating or corrosion.

Test procedures shall meet NETA guidelines.

Test results and report shall be provided to the engineer and included in OandM manual under AL conductors/ tests.

Contractor shall correct all deficiencies reported in the test report.

#### **BRANCH CIRCUITS**

The use of single-phase, multi-wire branch circuits with a common neutral is not permitted. All single-phase branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.

END OF SECTION



**SECTION 26 05 36**  
**CABLE TRAYS FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**SCOPE**

The work under this section includes furnishing of all labor, material, supports and services to install a complete cable tray system as shown and or indicated on the drawings. The cable tray system is defined to include, but not limited to, straight sections of cable tray, bends, tees, elbows, drop-outs, supports and all other related accessories necessary for a complete installation. Included are the following topics:

**PART 1 – GENERAL**

- Scope
- References
- Submittals

**PART 2 – PRODUCTS**

**PART 3 – EXECUTION**

- Installation
- Field Quality Control

**REFERENCES**

ASTM A1011/A1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength  
ASTM A123 – Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip  
ASTM A510 – General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel  
ASTM A513 – Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing  
ASTM A580 – Standard Specification for Stainless Steel Wire  
ASTM B 633 – Specification for Electro-deposited Coatings of Zinc on Iron and Steel  
ASTM A641/A641M – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire  
ASTM A653/A653M-00 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process  
ASTM D769 – Standard Specification for Black Synthetic Iron Oxide  
NEMA VE 1 – Metal Cable Tray Systems  
NEMA VE 2 – Metal Cable Tray Installation Guidelines

**SUBMITTALS**

Product Data: Submit manufacturer's data for cable trays and trunking.

Samples:- Submit 50 cm length of each size of cable tray and trunking complete with its accessories and fittings.

Shop Drawings: Submit dimensioned layout drawings on architectural backgrounds of cable trays and trunking including, but not limited to, offsets and connections. Show accurately scaled cable trays with locations of supports and fittings, including fire stops and weather seals. Indicate relationship of cable trays to other associated equipment indicate arrangement of cables on cable trays complete with sections and elevations.

Submit a detailed calculations of capacity of cables installed inside the tray and the trunking assuring a maximum 40% occupancy.

**PART 2 - PRODUCTS**

Refer to list of recommended manufacturers.

**PART 3 - EXECUTION**

Install cable trays and trunkings and accessories as indicated in accordance with the requirements of applicable standards and in accordance with recognized industry practices to ensure that installation complies with requirements and serves intended function.

Coordinate as necessary to interface installation of cable trays and trunkings work with other work.

Install integral fire stops where cable trays and trunkings penetrate fire-rated walls and floors. Seal between cable trays and trunkings and opening and around opening with fire-rated sealant not less than wall, or floor, fire ratings.

At floor openings provide concrete curb, 10cm wide and 10cm high, around cable trays and trunkings and seal with non-combustible material.

Provide electrical bonding and equipment earthing connections for cable trays and trunkings . Tighten connections to comply with tightening torques specified by manufacturers to assure permanent and effective connections and grounds.

Route cable trays and trunkings as required and make final field measurements before ordering cable tray.

Where there is insufficient elevation or lateral change in direction to accommodate fittings directly connected, adjustable vertical connectors or adjustable horizontal connectors with straight section in between may be used. Avoid slopes that would cause cable to bend on smaller radii; than that allowed by cable manufacturer.

Provide hangers, rods, straps, special brackets, and other means of supporting cable tray and trunkings as required.

Cables shall not occupy more than 40% of the trunking cross sectional area.

#### **FIELD QUALITY CONTROL**

Prior to installing cables in cable trays and trunkings, test for electrical continuity of bonding, and earthing connections, and to demonstrate compliance with earthing requirements.

Electrically energize cable tray and trunkings systems and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

END OF SECTION

## **SECTION 26 24 16** **PANELBOARDS**

### **PART 1 - GENERAL**

#### **SCOPE**

The work under this section includes main, distribution and branch circuit panelboards. Included are the following topics:

#### **PART 1 - GENERAL**

- Scope
- References
- Submittals
- Spare Parts

#### **PART 2 - PRODUCTS**

- Power Distribution Panelboards
- Branch Circuit Panelboards
- Coordination Branch Panelboards
- Retrofit Panelboards

#### **PART 3 - EXECUTION**

- Installation
- Field Quality Control

#### **REFERENCES**

ANSI C57.13 – Instrument Transformers  
NEMA AB 1 - Molded Case Circuit Breakers  
NEMA KS 1 - Enclosed Switches  
UL-891 - Dead Front Switchboards

#### **SUBMITTALS**

Include outline and support point dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, and interrupting ratings confirming a fully-rated system for all equipment and components.

Submit required short circuit coordination study per specification section 26 05 73 to the consulting engineer for review and approval. Submittal shall be on or before date of panelboard equipment submittal.

#### **SPARE PARTS**

Keys: Furnish 2 keys for each panelboard to Owner.

Handle lock-off: Furnish (2) 20/1P circuit breaker handle lock-off devices for each panelboard to Owner.

One set of three spare fuses of each size and type utilized.

### **PART 2 - PRODUCTS**

#### **POWER DISTRIBUTION PANELBOARDS**

Panelboards: Circuit breaker or fusible switch type.

The panelboard and overcurrent devices contained within shall be **fully-rated**.

Enclosure: NEMA [Type 1.] [Type 3R.] [\_\_\_\_\_] Minimum cabinet size: 6.5 inches (165 mm) deep; 26 inches (660 mm) wide. Constructed of galvanized code gauge steel.

Cabinet front cover and cabinet shall be Type 4X, 304 stainless steel in wet and damp locations including kitchen, foodservice and therapeutic/pool applications.

Power distribution panelboards installed in electrical rooms and mechanical rooms shall utilize a standard dead front cover. In all other areas provide cabinet front with hinged door, flush lock and hinged trim (door-in-door) to allow access to wiring gutters without removal of panel front. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Neutral and ground bars can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

**Multi-Educational Programme for Employment Promotion in Migration-affected Areas (MEPEP)**  
**Technical Assistance and Supervision Services for Refurbishment and Construction Works**  
**Labs/Workshops**

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Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings and as required by short circuit/coordination study.

Main breakers shall be individually mounted. Back feed mains shall NOT be utilized.

The circuit breakers are to be totally front accessible and mounted in the panelboard to permit installation, maintenance and testing without reaching over line side bussing. The circuit breakers are to be removable by the disconnection of only the load side terminations and line and load side connections are to be individual to each circuit breaker. Common mounting brackets or electrical bus connectors are not acceptable.

Circuit breakers shall be provided with provisions for mounting handle padlock attachments.

Breaker feeder lugs shall be dual rated for use with either aluminum or copper conductors.

Each circuit breaker is to be furnished with an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate, as well as exercise the circuit breaker operating mechanisms.

A minimum of 20% future circuit breaker spaces shall be included. Spaces for future circuit breakers shall be "prepared" spaces. These spaces shall be provided with the necessary mounting hardware and bus extensions so that when future breakers are added, only the breaker itself needs to be purchased by the installer.

Circuit breakers serving single motor loads shall be magnetic only, instantaneous trip. Overload protection shall be part of the motor combination controller.

Circuit breakers in 480V power distribution panelboards shall be fully adjustable LSI circuit breakers with electronic trip for frame sizes greater than 400A.

**Circuit Breakers:**

Electronic Trip Circuit Breakers: As scheduled on the drawings, electronic circuit breakers shall have, at a minimum, adjustments for long time, short time and instantaneous trip. Provide integral ground fault sensing with adjustable ground fault trip where indicated on the drawings.

Molded Case Circuit Breakers: As scheduled on the drawings, integral thermal and instantaneous magnetic trip elements in each pole.

**Fusible Distribution Switches:**

Fusible switches shall be quick make, quick break and shall be group mounted in panel type construction. Switches of 30 amperes to 200 amperes shall have plug-on line side connections. Each switch is to be contained in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses which shall be interlocked with the operating handle to prevent opening the cover when the switch is in the "ON" position.

This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. Units shall have padlocking provisions in "OFF" position and operating handle position shall give positive switch position indication, i.e. red for "ON" and black for "OFF". Switches shall pass industry standard I2t with-stand tests and fuse tests.

A minimum of 20% future fusible switch spaces shall be included. Spaces for future fusible switches shall be "prepared" spaces. These spaces shall be provided with the necessary mounting hardware and bus extensions so that when future fusible switches are added, only the fusible switch itself needs to be purchased by the installer.

**BRANCH CIRCUIT PANELBOARDS**

Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

The panelboard and overcurrent devices contained within shall be **fully-rated**.

Enclosure: [Type 1.] [Type 3R.] [\_\_\_\_.] Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.

Cabinet front cover and cabinet shall be Type 4X, 304 stainless steels in wet and damp locations including kitchen, food service and therapeutic/pool applications.

Provide [flush] [surface] cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Phase, neutral and ground bar terminations can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

Incoming conductors shall terminate at lug landing pads rated for the panelboard.

Provide compression type lugs to accommodate the conductor shown on drawings.

Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings and as required by short circuit/ coordination study.

Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

Do not use tandem circuit breakers.

Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.

Provide a minimum of 10% spare circuit breakers in branch panelboards.

All of the panelboards provided under this section shall be by the same manufacturer

### **COORDINATION BRANCH PANELBOARDS**

Branch Circuit Panelboards: Fusible switch type with current limiting Class J time delay or equivalent protection.

The panelboard and overcurrent devices contained within shall be fully-rated.

Enclosure: [Type 1.] [Type 3R.] [\_\_\_\_\_] Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.

Provide [flush] [surface] cabinet front with concealed trim clamps, concealed hinge and flush cylinder locks all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Phase, neutral and ground bar terminations can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of devices.

Overcurrent devices shall be fused branch disconnects including compact base and fuse holder with the following features:

- Current limiting Class J time delay or equivalent protection.
- Single handle common trip, 1-, 2-, and 3 pole versions.
- Bolt on type.
- Local open fuse indication.
- UL listed for type and temperature rating of wire specified.
- Permanently installed integrated lockout/tag out provisions.
- 600V AC rated.

### **RETROFIT PANELBOARDS**

Lighting and Appliance Branch Circuit MLO Panelboards: Circuit breaker type.

The panelboard and overcurrent devices contained within shall be **fully-rated**.

Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Phase, neutral and ground bar terminations can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings and as required by short circuit/ coordination study.

Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.

The panelboard shall be specifically designed for retrofit applications in existing panelboard boxes. The manufacturer shall supply in advance to the consultant complete application instructions and information on the panelboards.

The retrofit panelboards shall be UL listed, labeled, and tested to meet the heat rise and short circuit current requirements when installed in 4½" deep, Minimum 14.25" wide enclosure.

Basis of design is Cutler-Hammer Pow-R-Line 1R. Other manufacturers will be accepted if UL67 listed for installation into an existing back box. Alternatively, product will be accepted if manufacturer provides field evaluation by UL personnel of interior and back box combination and equivalency is established.

Interiors shall be completely factory assembled devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

Trims for retrofit panelboards shall be designed specifically for retrofit applications. Trim mounting shall not be dependent nor attached to the existing enclosure. Trims shall have concealed hardware. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Doors over 48 inches in height shall have auxiliary fasteners.

The panelboard shall be provided with an integrated depth adjustment mechanism as part of the assembly that includes depth markings for use by the installer.

Surface trims shall be same height and width as box. Flush trims shall overlap the box by ¾ of an inch on all sides.

Enclosures shall be identified for retrofit suitability in advance. The structural integrity of all existing enclosures shall be verified. Any enclosure that is damaged shall be replaced with a new enclosure and panelboard.

Existing enclosures shall have a minimum width of 14.25 inches and a minimum depth of 4½ inches. Minimum gutter space shall be verified and shall be in accordance with the National Electrical Code.

### **PART 3 - EXECUTION**

#### **INSTALLATION**

Install panelboards plumb with wall finishes.

Height:

Power Distribution panelboards: Minimum 12" above finished floor and maximum of 6'-7" to center of the grip of the operating handle of the top most mounted switch or circuit breaker, when at its highest position.

Branch panelboards: 6'-0" to top of panelboard.

Install a crimp type stud termination to stranded conductor when terminating on circuit breakers without a captive assembly rated for terminating stranded conductors.

Provide filler plates for unused spaces in panelboards.

See section 26 05 53 for identification requirements. Provide typed circuit directory for each panelboard per NEC 408.4(A). Revise directory to reflect circuiting changes required to balance phase loads.

Stub three (3) empty ¾" conduits to accessible location above ceiling or below floor out of each recessed panelboard. Cap these conduits to prevent material from entering them.

**FIELD QUALITY CONTROL**

If aluminum conductors size #1/0 and larger (per Section 26 05 19) are to be used as panelboard feeders, it is the responsibility of the contractor to provide panelboards with adequate wire bending space to accommodate the aluminum conductors and terminators to meet allowable code requirements.

The Contractor shall circuit the panelboards as shown on the drawings. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent.

Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

END OF SECTION

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 - GENERAL**

**SCOPE**

This section describes the products and execution requirements relating to furnishing and installing wiring devices and related systems for the project. Included are the following topics:

**PART 1 - GENERAL**

Scope  
Submittals

**PART 2 - PRODUCTS**

Device Colors  
Device Plates and Box Covers  
Wall Switches and PUSHBUTTONS  
Receptacles  
Ceiling outlet (Lighting outlets)  
Cord outlets

**PART 3 - EXECUTION**

Installation  
Field Quality Control

**SUBMITTALS**

Product Data: Submit manufacturer's data on wiring devices.

Samples : Submit samples of all wiring devices included in the contract.

**PART 2 - PRODUCTS**

**DEVICE COLORS:**

Device colors shall be selected by project architect's interior designer and coordinated with Agency representative during shop drawing review.

All switches and convenience outlets on emergency circuits shall have a red handle or red face with matching red cover plate.

**DEVICE PLATES AND BOX COVERS**

**Decorative Cover Plate:** [Smooth thermoplastic nylon.] [302/304 lined stainless steel.] Note requirement for red plates on emergency outlets and switches.

**Weatherproof Cover:** All receptacles installed in wet locations shall have an enclosure that is weatherproof whether or not the attachment plug is inserted. Covers shall be gasketed metal with hinged "in-use" device covers, powder coat painted. Non-metallic covers are not allowed. Covers shall be latching type and shall be lockable. Covers shall be identified as "extra-duty" type per NEC 406.9(B)(1).

**Damp Location Cover:** All receptacles installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure that is weatherproof when the receptacle is covered (attachment plug not inserted and receptacle covers closed). Covers shall be gasketed metal with hinged device covers, powder coat painted. Non-metallic covers are not allowed.

**Surface Cover Plate:** Raised galvanized steel.

**Modular Pigtailed Connector:** Polarized connector with minimum six-inch stranded copper wire leads, polycarbonate right-angle housing, UL498 listed, with finger-safe connector housing which provides insulation from conductive surfaces. Contacts shall be brass. Connector shall be manufactured so that it provides a secure connection such that it will maintain contact with the device until the device is removed for replacement. Modular connectors shall be provided with covers which protect the contacts from paint, drywall mud, and construction dust and debris. Connectors shall be Hubbell SNAP Connect, Leviton Lev-Lok, Pass and Seymour PlugTail, or approved equal.

**WALL SWITCHES and PUSHBUTTONS**

All switches for lighting circuits shall comply with IEC 60669-1 and shall be quick make and break for use on a.c. supplies. Switches shall be single pole and rated not less than 10 A, 220 V for use only on a.c. systems, including fluorescent or inductive loads.



Switches shall be one-way or two-way or intermediate or push button as indicated on the drawings.

Switches for lighting shall be of the plastic insulated cover plate switch type with rocker operation, and in single or multi gang formation where installed in groups.

In damp or outside positions, switches shall be IP54, single pole. The switch enclosure shall be metallic weatherproof.

Push buttons single units or forming part of a multi gang unit shall be rated at 10 A, 220 V. The pushbutton switch shall be single/double-pole and arranged for push to make/ to break the contacts as applicable for the application.

All push buttons shall be illuminated type.

## **RECEPTACLES**

### **General Requirements:**

Receptacles shall be German standard 10/16A DIN (2P +E).

Industrial type switched receptacles shall be used in Electrical / Mechanical plant rooms tunnels, workshops etc. and shall be of all rigid metal construction for surface mounting.

Three phase receptacles shall be 3 poles + neutral + earth 16 Amp. Unless otherwise indicated made of rigid metal construction.

Receptacles shall be supplied complete with plugs.

Generally, all receptacles shall be duplex convenience type unless otherwise noted.

All receptacles on emergency circuits shall have a red face with matching red cover plate.

All receptacles installed in outdoor locations, garages, rooftops, and in other damp or wet locations shall be weatherproof

## **CEILING OUTLET (LIGHTING OUTLETS)**

Ceiling outlet shall be considered as lighting outlet and shall be designed for the safe and efficient permanent connection of cables to a wiring system to lighting fixtures.

Ceiling outlet shall consist of a base and cover molded in white non-tracking insulating material.

The cover shall either screw on to the base or be held on the base by not less than two screws. No connections or terminations shall be incorporated into the cover but it may include an outgoing flexible cable clamp.

The base shall include terminals for incoming cable and outgoing flexible connections with a separate terminal unit for the earth connection.

The complete ceiling outlet and its attachment to the ceiling shall be designed to support safely either the maximum weight suspended by a flexible cord from the ceiling outlet in accordance with IEE wiring regulations, or a luminaries directly attached to the ceiling outlet and having a weight up to a maximum of 25 Kg complete including shades and lamps.

Ceiling outlet shall incorporate means for avoiding any mechanical load or strain from flexible pendant cables being transmitted to the terminals.

## **CORD OUTLETS**

Outlet plates for cables or flexible cords shall be similar to switch plates and complete with not less than two fixing screws. Terminals shall be provided to accommodate incoming wiring and outgoing cables or flexible cord. The unit shall be unfused and shall incorporate an outgoing cable clamp or cord grip. The cover plate of white molded plastic shall have a smooth aperture for the cable/flexible exit.

## **PART 3 – EXECUTION**

### **INSTALLATION**

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Install wiring devices as indicated, in compliance with manufacturer's written instructions, requirements of applicable standards, and in accordance with recognized industry practices to ensure that installation complies with requirements and serves intended function.

Coordinate as necessary to interface installation of wiring devices with other work.

Install wiring devices only in electrical boxes which are clean, free from excess building materials, dirt, and debris.

Install wiring devices after wiring work is completed and tested.

Install wall-plates after painting work is completed.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices.

Protection of Wall-plates and Sockets upon installation of wall-plates and sockets advise Contractor regarding proper and cautious use of convenience outlets. Prior to Owner accepting project, replace those items which have been damaged, including those burned and scored by faulty plugs.

Provide equipment earthing connections for wiring devices, unless otherwise indicated.

Verify exact locations of switches and receptacles with architectural and interior design drawings.

Install switches indicated on plans for the various rooms directly adjacent to the entrance door and as shown on the approved shop drawings.

Check the architectural drawings for the door swings and locate all switches on the lock side of the openings. Verify in field prior to switch outlet installation.

Coordinate all final mounting heights with Architect's elevations and details prior to installation. Where heights are different than those indicated or specified, the architectural heights take precedence.

Where two or more switches control more than one 220 volt branch circuit, barrier boxes to prevent 380 volts occurring in any one box.

Where more than one wiring device is mounted in the same location, gang mount such devices under a common face plate.

Vertically align devices shown above each other on the drawings on a common centerline unless shown otherwise.

Where an outlet is indicated as serving a specific piece of equipment, locate outlet as required by equipment or layout roughing drawings. Work from approved equipment and roughing shop drawings to locate outlets.

Fully coordinate switched mounted in architectural frames, posts and mullions with all trades involved. Submit method of wiring and type and style switch to Architect for approval.

**FIELD QUALITY CONTROL**

Upon completion of installation of wiring devices, prior to energizing circuitry, test wiring devices for electrical continuity. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

END OF SECTION

**SECTION 26 27 28**  
**DISCONNECT SWITCHES**

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes disconnect switches, fuses and enclosures. Included are the following topics:

**PART 1 - GENERAL**

- Scope
- References
- Submittals
- General

**PART 2 - PRODUCTS**

- Disconnect Switches
- Fuses

**PART 3 - EXECUTION**

- Installation

**REFERENCES**

NECA (National Electrical Contractors Association) "Standard of Installation"  
NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies  
NEMA KS 1 – Enclosed Switches  
UL 50 – Enclosures for Electrical Equipment  
UL 98 – Enclosed and Dead-front Switches

**SUBMITTALS**

Include outline drawings with dimensions, and equipment ratings for voltage, ampacity, horsepower, and short circuit.

**GENERAL**

Provide disconnect switches for loads required by code. Review HVAC and Plumbing specifications to determine what equipment is furnished with disconnect switches. Install disconnect switches whether furnished under this contract or not. It is the Electrical Contractors responsibility to determine the need for a disconnect switch for each load. The contractors shall include in their bid the code required disconnect switches whether indicated on the drawings or not.

**PART 2 - PRODUCTS**

**DISCONNECT SWITCHES**

Fusible Switch Assemblies: NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: designed to accommodate Class R, Class J or Class CC (motors) cartridge type fuses.

No fusible Switch Assemblies: NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

**Enclosure:**

Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish.

Outdoors: NEMA 3R code gauge zinc coated steel with baked enamel finish. or NEMA 4X, 304 stainless steel with brushed finish, when indicated on drawings.

Corrosive Areas, Kitchen/Food service areas, Therapeutic/Pool spaces and Interior Damp/Wet locations: NEMA 4X, 304 stainless steel with brushed finish.

Provide manufacturer's equipment ground kit in all disconnect switches.

In applications where the switch serves as the service entrance disconnect, provide service ground kit, label as service disconnect and provide UL listing for service disconnect.

**FUSES**

Fuses 600 Amperes and Less: Dual element, time delay, [250] [600] volt, UL Class [RK 1.] [RK 5.] [J.] Interrupting Rating: 200,000 rms amperes.

Fuses 601 Amperes and Larger: Low Peak, time delay, 600 volt, UL Class L. Interrupting Rating: 200,000 rms amperes.

Fuses 30 Amperes and less: Time-Delay, 600 volt, UL Class CC. Interrupting rating: 200,000 rms amperes.

Provide three (3) spares of each size and type fuse.

Provide cabinet/enclosure for spare fuses sized to accommodate all required spare fuses for entire facility. Cabinet shall have hinged and latched cover. Label cabinet "Spare Fuses". Locate cabinet in main electrical room.

### **PART 3 - EXECUTION**

#### **INSTALLATION**

Install disconnect switches where indicated on Drawings or required by NEC.

Provide label on inside of disconnect cover identifying the type and size of fuse to be utilized.

VFD installations; Provide aux contact to de energize VFD when operating local disconnect.

Generator installations; Provide monitoring micro switches for audio/ visual alarm indication at generator control panel and remote annunciator panels for disconnects serving the emergency side of each automatic transfer switches.

END OF SECTION

## **SECTION 26 51 13**

### **INTERIOR LIGHTING FIXTURES, LAMPS, AND BALLASTS**

#### **PART 1 - GENERAL**

##### **SCOPE**

The work under this section includes interior luminaires and accessories, exit signs, and building-mounted exterior lighting. Included are the following topics:

##### **PART 1 - GENERAL**

- Scope
- Reference Standards
- Submittals
- Definitions

##### **PART 2 - PRODUCTS**

- Interior Luminaires and Accessories
- LED Luminaires
- LED Drivers

##### **PART 3 - EXECUTION**

- Installation
- Adjusting and Cleaning

##### **REFERENCE STANDARDS**

RoHS – Restriction of Hazardous Substances. Council of the European Union (EC) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

LM-79-08 (or latest) – IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.

LM-80-08 (or latest) – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

TM-21-11 (or latest) – IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

NEMA SSL 1-2010 (or latest) – Electronic Drivers for LED Devices, Arrays, or Systems.

##### **SUBMITTALS**

Include outline drawings, lamp and ballast data, support points, weights, accessory information and performance data for each luminaire type.

For each luminaire type, submit luminaire information including catalog cuts with highlighted catalog numbers and required accessories:

- Luminaire:
  - Manufacturer and catalog number,
  - Type (identification) as indicated on the plans and schedule,
  - Delivered lumens,
  - Input watts,
  - Efficacy,
  - Color rendering index.
- Driver:
  - Manufacturer and catalog number,
  - Type
  - Power Factor, Crest Factor, THD, etc.

##### **DEFINITIONS**

Driver: The power supply used to power LED luminaires, modules, or arrays.

L70, L<sub>70</sub>, or L<sub>70%</sub>: The reported life of an LED component or system to reach 70% lumen maintenance, or 70% of the LED's original light output.

LED luminaire failure: Negligible light output from more than 10 percent of the LEDs, or less than 70 percent of the listed lumen output constitutes luminaire failure.

#### **PART 2 – PRODUCTS**

##### **INTERIOR LUMINAIRES AND ACCESSORIES**

-All luminaires shall be manufactured to IEC 60598-1 and 60598-2.

-All materials and installation shall be in accordance with the latest revision of electrical code adopted by the local municipality and all applicable federal, state and other codes and regulations.

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- All luminaires supplied by the contractor shall be photometrically tested.
- Luminaires shall not be suspended by their flexible cord. A separate means of suspension shall be provided.
- All flexible cords shall be anchored at both ends such that the cord is free from strain.
- Diffusers shall be restrained to prevent them from falling out of the body of the luminaires under normal conditions and when re-lamping.
- Luminaires fitted with high frequency or electronic control gear shall be disconnected before the circuit -is tested for insulation resistance.
- All luminaires designed for internal use shall be constructed to IP 20 and be Class 1 unless otherwise stated.
- All luminaires designed for external use shall be constructed to minimum classification of IP 44 and be class 1 unless otherwise stated.
- All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability or function.
- All fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters Laboratories, Inc. for the applications and mounting conditions specified. Recessed fixtures installed in insulated ceilings shall be provided with thermal protection.

All lamps shall be new.

**LED LUMINAIRES**

- LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
  - Minimum Light Output.
  - Zonal Lumen Requirements.
  - Minimum Luminaire Efficacy.
  - Minimum CRI.
  - L70 Lumen Maintenance.
  - Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.

*Additional requirements:*

- Color Temperature of 3000K-4100K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
- Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
- Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
- Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- Luminaire and driver shall be furnished from a single manufacturer to ensure compatibility.
- Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -40°F to 104°F (-40°C to 40°C).
- Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- Luminaire shall have a maximum Total Harmonic Distortion (THD) of ≤20% at full input power and across specified voltage range.
- All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- All luminaires shall be provided with knockouts for conduit connections.
- The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- Provide all of the following data on submittals:
  - Delivered lumens
  - Input watts
  - Efficacy
  - Color rendering index.

*LED Luminaires used for Emergency Egress Lighting:*

- The failure of one LED shall not affect the operation of the remaining LEDs.

*Emergency LED Luminaire Compatibility with Inverters:*

- Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.

## **LED DRIVERS**

**General:**

- Provide driver type (non-dimmed, etc.) as indicated on the luminaire schedule on the drawings.
- Minimum Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
- Driver shall have a rated life of 50,000 hours, minimum.
- Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- Driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- Driver shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- Driver shall have a maximum Total Harmonic Distortion (THD) of  $\leq 20\%$  at full input power and across specified voltage range.
- Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- Provide all of the following data on submittals:
  - Input watts
  - Power Factor (pf)
  - Crest Factor (cf) at full input power
  - Total Harmonic Distortion (THD).

## **PART 3 - EXECUTION**

### **INSTALLATION**

Verify ceiling types with Architectural plans or with existing ceilings. Verify specified luminaires are compatible with specified ceiling type(s) prior to ordering luminaires.

Install in accordance with manufacturer's instructions.

Install suspended luminaires using aircraft cable, or pendants supported from swivel hangers. Heavy duty chain supports may be used where indicated on the luminaire schedule. Provide aircraft cable, pendants, or chain lengths required to suspend luminaire at indicated height. All aircraft cables or pendant supported luminaires shall have an independent support to structure at all cable or pendant support locations. When chain is used, tie-wrap the luminaire wiring method to the chain.

Support luminaires larger than 2 x 4 foot (600 x 1200 mm) size independent of ceiling framing.

Provide independent support for all luminaires over 50 lbs.

Locate ceiling luminaires as indicated on reflected ceiling plan.

Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

Locate ceiling luminaires as indicated on reflected ceiling plan.

Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

The Contractor shall install luminaire supports as required. Luminaire installations with luminaires supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all luminaires adequately, providing extra steel work for the support of luminaires if required. Any components necessary for mounting luminaires shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.

Install recessed luminaires to permit removal from below.

Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

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Install code required hardware to secure recessed grid-supported luminaires in place.

Install wall mounted luminaires and exit signs at height as scheduled. Use pendants supported from swivel hangers in exposed ceiling/structure locations where necessary to mount exit signs at the specified height.

Install accessories furnished with each luminaire.

Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

Bond luminaires and metal accessories to branch circuit equipment grounding conductor.

Install specified lamps in each luminaire and exit sign.

HID High-Bay or Low-Bay Luminaires: Use power hook hangers rated 500 pounds (225 kg) minimum and provide safety chain between ballast and structure. Also provide safety chain between reflector and ballast.

All new luminaires shall be operational at the Substantial Completion of the project.

**ADJUSTING AND CLEANING**

Align luminaires and clean lenses and diffusers at completion of Work. Clean paint splatters, dirt, and debris from installed luminaires.

Touch up luminaire finish at completion of work.

END OF SECTION



**SECTION 26 56 29  
SITE LIGHTING**

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes exterior luminaires and accessories, poles, and foundations. Also included are the following topics:

**PART 1 - GENERAL**

- Scope
- Reference Standards
- Definitions
- Submittals

**PART 2 - PRODUCTS**

- Luminaires
- LED Luminaires
- LED Drivers

**PART 3 - EXECUTION**

- Installation
- Field Quality Control

**REFERENCE STANDARDS**

Wisconsin Administrative Code SPS 362.1807 Shallow Post Foundations

International Building Code IBC 1807.3 Embedded Posts and Poles

RoHS – Restriction of Hazardous Substances. Council of the European Union (EC) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

LM-79-08 (or latest) – IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.

LM-80-08 (or latest) – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

TM-21-11 (or latest) – IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

NEMA SSL 1-2010 (or latest) – Electronic Drivers for LED Devices, Arrays, or Systems.

**DEFINITIONS**

Driver: The power supply used to power LED luminaires, modules, or arrays.

L70, L<sub>70</sub>, or L<sub>70%</sub>: The reported life of an LED component or system to reach 70% lumen maintenance, or 70% of the LEDs original light output.

LEDs: Broadly defined as complete luminaire with light emitting diode (LED) packages, modules, light bars, or arrays, complete with driver.

LED luminaire failure: Negligible light output from more than 10 percent of the LEDs, or less than 70 percent of the listed lumen output constitutes luminaire failure.

**SUBMITTALS**

Shop Drawings: Indicate dimensions and components for each luminaire, pole, and base.

Product Data:

For each luminaire type, submit luminaire information including catalog cuts with highlighted catalog numbers, and required accessories:

- Luminaire:
  - Manufacturer and catalog number,
  - Type (identification) as indicated on the plans and schedule,
  - Delivered lumens,
  - Input watts,
  - Efficacy,
  - Color rendering index,
  - Performance data, and

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- Effective Projected Area (EPA).
- Driver:
  - Manufacturer and catalog number,
  - Type
  - Power Factor, Crest Factor, THD, etc.
- Pole (if applicable):
  - Diameter
  - Height
  - Pole thickness
  - Weight

**Manufacturer's Instructions:**

Indicate application conditions and limitations of use stipulated by product testing agency specified under "Regulatory Requirements".

Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

**Light Layout:** Provide a computer-generated factory point-by-point foot-candle layout of the project for each area involved.

## **PART 2 - PRODUCTS**

### **LUMINAIRES**

See the Luminaire Schedule on the drawings for type of luminaires and catalog numbers. Catalog numbers are shown on the drawings for quality and performance requirements only. Luminaires manufactured by others are equally acceptable provided they meet or exceed the performance of the indicated luminaires and meet the intent of the design.

Luminaire shall be certified by a Nationally Recognized Testing Laboratory (UL, ETL, or IEC).

Provide luminaires with quick-connect disconnecting means, similar to Thomas and Betts Sta-Kon.

### **LED LUMINAIRES**

- LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
  - Minimum Light Output.
  - Zonal Lumen Requirements.
  - Minimum Luminaire Efficacy.
  - Minimum CRI.
  - L70 Lumen Maintenance.
  - Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.

*Additional requirements:*

- Color Temperature of 3000K-4100K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
- Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
- Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
- Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- Luminaire and driver shall be furnished from a single manufacturer to ensure compatibility.
- Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

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- All luminaires shall be provided with knockouts for conduit connections.
- The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- Provide all of the following data on submittals:
  - Delivered lumens
  - Input watts
  - Efficacy
  - Color rendering index.

**LED DRIVERS**

General:

- Provide driver type as indicated on the luminaire schedule on the drawings.
- Minimum Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
- Driver shall have a rated life of 50,000 hours, minimum.
- Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- Driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- Driver shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- Driver shall have a maximum Total Harmonic Distortion (THD) of  $\leq 20\%$  at full input power and across specified voltage range.
- Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- Provide all of the following data on submittals:
  - Input watts
  - Power Factor (pf)
  - Crest Factor (cf) at full input power
  - Total Harmonic Distortion (THD).

**PART 3 - EXECUTION**

**INSTALLATION**

Install in accordance with manufacturers' instructions.

Minimum underground conduit size is 1 inch.

Protect anchor bolts 2 inches (50 mm) minimum above base.

Install all anchor bolts and handhole fasteners with anti-seize compound.

Install poles plumb. Provide shims or double nuts to adjust plumb.

Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

Bond each luminaire, each metal accessory, the UFER ground conductor and the pole to the branch circuit equipment ground conductor with a separate ground wire sized per NEC or as shown on the drawings

**FIELD QUALITY CONTROL**

Operate each luminaire after installation and connection. Inspect for improper connections and operation.

END OF SECTION

## **4.4 Mechanical Specifications**

### **Table of Content**

#### **Heating Ventilating and Air Conditioning**

Section 233413	Axial HVAC Fans
Section 238219	Concealed Air Conditioning system
Section 233113	Metal Duct
Section 233300	Air Duct Accessories
Section 233713	Diffusers, Registers, and Grilles
Section 2334163	Centrifugal HVAC Fans
Section 238126	Split Air Conditioning System
Section 232300	Refrigerant Piping

#### **Fire Fighting**

Section 104416	Fire Extinguishers
Section 212113.13	Fire search system co2
Section 211200	Fire-Suppression Standpipes
Section 213113	Electric-Drive, Centrifugal Fire Pumps
Section 213116	Diesel-Drive, Centrifugal Fire Pumps

#### **Plumbing**

Section 220523	General-Duty Valves for Plumbing Piping
Section 221116	Domestic Water Piping
Section 221316	Sanitary Waste and Vent Piping
Section 221423	Storm Drainage Piping
Section 223300	Electric Domestic Water Heaters
Section 224000	Plumbing Fixtures

## SECTION 233413 - AXIAL FANS

### GENERAL

#### 85.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 85.2 SUMMARY

- A. This Section includes the following:
  - Propeller fans.
  - Axial and tubeaxial fans.
  - Vaneaxial fans.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - Division 15 Section "Vibration Control" for vibration hangers and supports.
  - Division 15 Section "Control Systems Equipment" for control devices.
  - Division 16 Section "Disconnects and Circuit Breakers" for disconnect switches.
  - Division 16 Section "Motor Controllers" for motor starters.
  - Division 16 Section "Motor-Control Centers" for starters and fusible switches.

#### 85.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Project Altitude: Base air ratings on sea-level conditions.
- C. Operating Limits: Classify according to AMCA 99.
- D. Fan Unit Schedule: The following information is described in an equipment schedule at the end of this Section.
- E. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.
  - Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
  - Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

#### 85.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:
  - Certified fan performance curves with system operating conditions indicated.

Certified fan sound power ratings.  
Motor ratings and electrical characteristics plus motor and electrical accessories.  
Material gages and finishes, including color charts.  
Dampers, including housings, linkages, and operators.

- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Coordination Drawings, including floor plans and sections drawn accurately to scale. Submit with Shop Drawings. Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- E. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- F. Maintenance data for air-handling units to include in the operation and maintenance manual specified in Division 1 and in Division 15 Section "Basic Mechanical Requirements."

#### 85.5 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.  
Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

- C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.
- D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

#### 85.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Lift and support units with the manufacturer's designated lifting or supporting points.

#### 85.7 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.
- B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

#### 85.8 COORDINATION AND SCHEDULING

- A. Coordinate the size and location of concrete housekeeping pads. Cast anchor-bolt inserts into pad. Concrete reinforcement and formwork requirements are specified in Division 3 Sections.
- B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

#### 85.9 EXTRA MATERIALS

- A. Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

### PRODUCTS

#### 85.10 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

##### Propeller Fans:

- a. Acme Engineering and Mfg. Corp.
- b. Aerovent, Inc.
- c. Airmaster Fan Co.
- d. American Coolair Corp.
- e. Ammerman Company, Inc.
- f. Bayley Fan Group.
- g. Buffalo Forge Co.
- h. Carnes Co.
- i. Chelsea Fans and Blowers, Inc.
- j. Cincinnati Fan and Ventilator Co.
- k. Cook (Loren) Co.
- l. Delhi Industries, Inc.
- m. Essick Air Products, Breidert.
- n. General Resource Corp.
- o. Greenheck Fan Corp.
- p. Harrow Co.; Leigh Div.
- q. Hartzell Fan, Inc.
- r. ILG Industries, Inc.
- s. Jenn Industries Inc.
- t. King Co. (The).

- u. NuTone Inc.
- v. Peerless-Winsmith, Inc.
- w. Penn Ventilator Co., Inc.
- x. Quietaire Corp.
- y. Stanley Industrial Corp.
- z. Thybar Corp.; Thycurb Div.

Axial/Tubeaxial Fans:

- aa. Aerovent, Inc.
- bb. Airmaster Fan Co.
- cc. American Coolair Corp.
- dd. Bayley Fan Group.
- ee. Buffalo Forge Co.
- ff. Carrier Corp.
- gg. Chicago Blower Corp.
- hh. Cincinnati Fan and Ventilator Co.
- ii. General Resource Corp.
- jj. Hartzell Fan, Inc.
- kk. Joy Technologies Inc.
- ll. McQuay International; Barry Blower Div.
- mm. New York Blower Co.
- nn. Peerless-Winsmith, Inc.
- oo. Penn Ventilator Co., Inc.
- pp. Snyder General Commercial Products.
- qq. Strobic Air Corp.
- rr. Trane Co. (The).

Vaneaxial Fans:

- ss. Aerovent, Inc.
- tt. Airmaster Fan Co.
- uu. American Coolair Corp.
- vv. Bayley Fan Group.
- ww. Buffalo Forge Co.
- xx. Carrier Corp.
- yy. Chicago Blower Corp.
- zz. Cincinnati Fan and Ventilator Co.



- aaa. General Resource Corp.
- bbb. Hartzell Fan, Inc.
- ccc. Joy Technologies Inc.
- ddd. McQuay International; Barry Blower Div.
- eee. New York Blower Co.
- fff. Peerless-Winsmith, Inc.
- ggg. Penn Ventilator Co., Inc.
- hhh. Snyder General Commercial Products.
- iii. Strobic Air Corp.
- jjj. Trane Co. (The).

#### 85.11 PROPELLER FANS

- A. Description: Belt-driven or direct-drive propeller fans, as indicated, consisting of fan blades, hub, housing, orifice ring, motor, drive, and accessories.
- B. Housings: Galvanized steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat after assembly.
- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- D. Cast-Aluminum Fan Wheels: Replaceable, cast-aluminum blades fastened to cast-aluminum hub. Factory set pitch angle of blades.
- E. Extruded-Aluminum Fan Wheels: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub. Factory set pitch angle of blades.
- F. Belt-Driven Drive Assembly: Resiliently mounted to the housing, statically and dynamically balanced and selected for continuous operation at the maximum rated fan speed and motor horsepower (HP), with final alignment and belt adjustment made after installation.

Service Factor Based on Fan Motor: 1.4.

Fan Shaft: Turned, ground, and polished steel keyed to wheel hub.

Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

- a. Ball-Bearing Rated Life: AFBMA 9, L-10 of 100,000 hours.

Pulleys: Cast iron with split, tapered bushing, dynamically balanced at factory.

Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Fabricate of steel for motors mounted on the outside of the fan cabinet.

- G. Accessories: The following accessories are required as indicated:

Gravity Shutters: Aluminum blades in aluminum frame, interlocked blades with nylon bearings.

Motor-Side Back Guard: Galvanized steel, conforming to OSHA specifications, removable for maintenance.

Wall Sleeve: Galvanized steel to match fan and accessory size.

Weathershield Hood: Galvanized steel to match fan and accessory size.

Weathershield Front Guard: Galvanized steel with expanded metal screen.  
Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.  
Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

#### 85.12 VANEAXIAL FANS

- A. Description: Vaneaxial fans consisting of fan wheel and housing, straightening vane section, factory-mounted motor, an inlet cone section, and accessories. Variable features indicated in equipment schedule include belt driven or direct drive as indicated, and variable or adjustable pitch.

Variable-Pitch Fans: Internally mounted pneumatic actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator for variable-volume operation.

- B. Housings: Steel with inlet bell and diffuser sections.

Inlet and Outlet Connections: Outer mounting frame and companion flanges; inlet cone shall be welded to the fan raceway.

Guide Vane Section: Integral guide vanes downstream from the fan wheel designed to straighten the airflow.

- C. Wheels: Cast-aluminum, axial-flow type, with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid steel key.

- D. Fan Hub and Blade-Bearing Assemblies: Cast aluminum, machined and fitted with threaded bearing wells to receive blade-bearing assemblies.

Blades: Replaceable, cast aluminum; factory mounted and balanced to the hub assembly.

Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.

- E. Shaft Bearings: Radial, self-aligning ball or roller bearings.

Ball-Bearing Rated Life: AFBMA 9, L-10 of 100,000 hours.

Roller-Bearing Rated Life: AFBMA 11, L-10 of 100,000 hours.

- F. Direct-Drive Units: Motor encased in housing, out of air stream, factory wired to disconnect located on outside of fan housing.

- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

Service Factor Based on Fan Motor: 1.4.

Pulleys: Cast iron with split, tapered bushing, dynamically balanced at factory.

Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Fabricate of steel for motors mounted on the outside of the fan cabinet.

Motor Mount: Adjustable base.

- H. Accessories: The following accessories are required as indicated:

Companion Flanges: Rolled-steel flanges.

Inlet and Outlet Screens: Wire mesh screen on fans not connected to ductwork.

Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of the fan or direct mounted to the discharge diffuser section.

Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in other Division 15 Sections.

Flow Measurement Port: Pressure measurement taps installed in the inlet of the fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in other Division 15 Sections.

Inlet Vanes: Adjustable; having peripheral control linkage operated from outside of the air stream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation as indicated.

#### 85.13 MOTORS

- A. Refer to Division 15 Section "Motors" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: The following features are required as indicated:

Open dripproof motors where satisfactorily housed or remotely located during operation.

Guarded dripproof motors where exposed to contact by employees or building occupants.

#### 85.14 FACTORY FINISHES

- A. Sheet Metal Parts: Prime coat before final assembly.
- B. Exterior Surfaces: Baked-enamel finish coat after assembly.

#### 85.15 SOURCE QUALITY CONTROL

- A. Testing Requirements: The following factory tests are required as indicated:

Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.

Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

### EXECUTION

#### 85.16 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the fans. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 85.17 INSTALLATION

- A. Install fans according to manufacturer's written instructions.
- B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Division 15 Section "Vibration Control."
- C. Suspend units from structure using threaded steel rods and vibration isolation springs. Vibration-control devices are specified in Division 15 Section "Vibration Control."

- D. Install units with clearances for service and maintenance.
- E. Label fans according to requirements specified in Division 15 Section "Mechanical Identification."

#### 85.18 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connector.
- B. Electrical: Conform to applicable requirements in Division 16 Sections.
- C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

#### 85.19 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

#### 85.20 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

#### 85.21 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

#### 85.22 COMMISSIONING

- A. Final Checks before Startup: Perform the following operations and checks before startup:
  - Verify that shipping, blocking, and bracing are removed.
  - Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
  - Perform cleaning and adjusting specified in this Section.
  - Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - Verify lubrication for bearings and other moving parts.
  - Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
- B. Starting procedures for fans are as follows:

Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

Measure and record motor voltage and amperage.

- C. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
- D. Replace fan and motor pulleys as required to achieve design conditions.

85.23 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
- C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.
- D. Demonstrate operation of products specified in this Section. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each product.

END OF SECTION 233413

## **SECTION 238219 – Concealed Air Conditioning System**

### **GENERAL**

#### **85.24 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **85.25 SUMMARY**

- A. This Section includes fan-coil units with water coils for heating and cooling.
- B. This Section includes fan-coil units with steam heating and water cooling coils.
- C. This Section includes fan-coil units with electric-resistance heating and water cooling coils.

#### **85.26 SUBMITTALS**

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of fan-coil units.

#### **85.27 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing fan-coil units similar to those indicated for this Project and that have a record of successful in-service performance.
- B. Comply with ARI 440 for testing and rating units.
- C. Comply with ASHRAE 33 for testing air coils.
- D. Comply with NFPA 70 for components and installation.
- E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

85.28 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

Fan-Coil Unit Filters: Furnish one spare filter for each filter installed.

PRODUCTS

85.29 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Dunham-Bush, Inc.  
International Environmental Corp.  
McQuay International.  
United Technologies Corp; Carrier Corp. Div.  
York International Corp.; Applied Systems Div.

85.30 MATERIALS

- A. Chassis: Galvanized steel with flanged edges.
- B. Coil Section Insulation: Faced, heavy-density, glass-fiber insulation over entire section.
- C. Drain Pans: Galvanized steel, with connection for drain. Drain pan insulated with polystyrene or polyurethane insulation.
- D. Cabinet: Galvanized steel with removable panels.

Vertical Unit Front Panels: Galvanized steel with channel-formed edges, removable for servicing, and with insulation on back of panel.

Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge, with safety chain.

- E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer.

85.31 STEAM COILS

- A. Fin-and-Tube Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm). Leak test to 300 psig (2068 kPa) underwater.

85.32 ELECTRIC-RESISTANCE HEATING ELEMENTS

- A. Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium-oxide insulating refractory and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends are enclosed in terminal box. Fin surface temperature does not exceed 550 deg F (288 deg C) at any point during normal operation.

Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for overtemperature protection of heaters.

85.33 FAN

- A. Centrifugal fan, with forward-curved, double-width wheels of reinforced fiberglass, in galvanized steel fan scrolls, directly connected to manufacturer's standard motor.

85.34 ACCESSORIES

- A. Aluminum wall boxes with integral eliminators and insect screen.
- B. Discharge grille panels fabricated of galvanized steel with stamped integral grilles and access doors.
- C. Steel subbase, height as indicated.
- D. Plastic motor-oiler tubes extending to beneath top discharge grille.
- E. Steel recessing flanges for recessing fan-coil units into wall or ceiling.
- F. Wiring Terminations: Match conductor materials and sizes indicated. Connect motor to chassis wiring with plug connection.
- G. Filters: 1-inch- (25-mm-) thick, throwaway filters in fiberboard frames.
- H. Dampers: Steel damper blades with polyurethane stop across entire blade length, operated by factory-mounted electric operators for 25 percent open cycle.

EXECUTION

85.35 EXAMINATION

- A. Examine substrates and supports to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance of fan-coil units. Do not proceed with installation until unsatisfactory conditions have been corrected.

85.36 INSTALLATION

- A. Install fan-coil units as indicated, to comply with manufacturer's written instructions and NFPA 90A.
- B. Connect fan-coil units and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
- C. Steam and Condensate Piping: Conform to applicable requirements of Division 15 Section "Steam and Condensate Piping." Connect to deaerator tapings with shutoff valves and unions or flanges at each connection.
- D. Connect fan-coil units to steam piping according to Division 15 Section "Steam and Condensate Piping." Provide shutoff valve and union or flange at each connection.
- E. Connect fan-coil units to hydronic piping according to Division 15 Section "Hydronic Piping." Provide shutoff valve and union or flange at each connection.



85.37 FIELD QUALITY CONTROL

- A. Testing: After installing fan-coil units and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Remove and replace malfunctioning units with new units, and retest.

85.38 CLEANING

- A. Replace filters in each fan-coil unit.

85.39 COMMISSIONING

- A. Startup Services: Engage a factory-authorized service representative to provide startup service.
- B. Operate fan motor to verify proper rotation.
- C. Operate electric heating elements through each stage to verify proper operation and electrical connections.
- D. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

END OF SECTION 238219

## SECTION 233113 - METAL DUCTS

### GENERAL

#### 85.40 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 85.41 SUMMARY

- A. This Section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2490 Pa).

- B. Related Sections include the following:

Division 7 Section "Joint Sealants" for fire-resistant sealants for use around duct penetrations and fire-damper installations in fire-rated floors, partitions, and walls.

Division 8 Section "Access Doors" for wall- and ceiling-mounted access doors for access to concealed ducts.

Division 10 Section "Louvers and Vents" for intake and relief louvers and vents connected to ducts and installed in exterior walls.

Division 15 Section "Mechanical Insulation" for duct insulation.

Division 15 Section "Fibrous-Glass Ducts."

Division 15 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.

Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounted access doors and panels, turning vanes, and flexible ducts.

Division 15 Section "Air Terminals" for constant-volume and variable-air-volume control boxes, and reheat boxes.

Division 15 Section "Diffusers, Registers, and Grilles."

Division 15 Section "Control Systems Equipment" for automatic volume-control dampers and operators.

Division 15 Section "Testing, Adjusting, and Balancing" for air balancing and final adjusting of manual-volume dampers.

#### 85.42 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula  $\text{Btu} \times \text{in./h} \times \text{sq. ft.} \times \text{deg F}$  or  $\text{W/m} \times \text{K}$  at the temperature differences specified. Values are expressed as Btu or W.

Example: Apparent Thermal Conductivity (k-Value): 0.26 or 0.037.

#### 85.43 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

#### 85.44 SUBMITTALS

- A. Product Data: For duct liner and sealing materials.
- B. Shop Drawings: Show details of the following:
  - Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - Duct layout indicating pressure classifications and sizes on plans.
  - Fittings.
  - Reinforcement and spacing.
  - Seam and joint construction.
  - Penetrations through fire-rated and other partitions.
  - Terminal unit, coil, and humidifier installations.
  - Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.
- C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
  - Ceiling suspension assembly members.
  - Other systems installed in same space as ducts.
  - Ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
  - Coordination with ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.
- D. Welding Certificates: Copies of certificates indicating welding procedures and personnel comply with requirements in "Quality Assurance" Article.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

#### 85.45 QUALITY ASSURANCE

- A. Welding Standards: Qualify welding procedures and welding personnel to perform welding processes for this Project according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports; AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members; and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.
- C. Comply with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems," unless otherwise indicated.
- D. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Chapter 3, "Duct System," for range hood ducts, unless otherwise indicated.
- E. Mockups: Before installing duct systems, erect mockups representing system pressure classifications higher than 2-inch wg (500 Pa). Build mockups to comply with the following requirements, using materials indicated for completed Work:

Locate mockups in the locations and of the size indicated or, if not indicated, as directed by Architect.  
Mockup may be a representative section of the actual duct system.  
Include the minimum number of each of the following features and fittings:

- a. Five transverse joints.
- b. One access door.
- c. Two typical branch connections, each with at least one elbow.
- d. Two typical flexible duct or flexible connector connections for each duct and apparatus.

Perform tests specified in "Field Quality Control" Article. Modify mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

Obtain Architect's approval of mockups before starting Work.

Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

When directed, demolish and remove mockups from Project site.

Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

#### 85.46 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle sealant and firestopping materials according to manufacturer's written recommendations.
- C. Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.

### PRODUCTS

#### 85.47 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. PVC-Coated Galvanized Steel: UL 181, Class 1 listing. Lock-forming-quality, galvanized, sheet steel with ASTM A 653/A 653M, G90 (Z275) coating designation; factory-applied, 4-mil (0.10-mm) PVC coating on exposed surfaces of ducts and fittings (exterior of ducts and fittings for underground applications and interior of ducts and fittings for fume-handling applications) and with factory-applied, 2-mil (0.05-mm) PVC coating on reverse side of ducts and fittings.
- C. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.
- D. Stainless Steel: ASTM A 480/A 480M, Type 316, sheet form with No. 4 finish for surfaces of ducts exposed to view; and Type 304, sheet form with No. 1 finish for concealed ducts.
- E. Aluminum Sheets: ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts.

- F. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

#### 85.48 DUCT LINER

- A. General: Comply with NFPA 90A or NFPA 90B and NAIMA's "Fibrous Glass Duct Liner Standard."
- B. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.

Thickness: 1/2 inch (13 mm).

Thickness: 1 inch (25 mm).

Thickness: 1-1/2 inches (38 mm).

Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.

Fire-Hazard Classification: Maximum flame-spread rating of 25 and smoke-developed rating of 50, when tested according to ASTM C 411.

Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.

Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

- a. Tensile Strength: Indefinitely sustain a 50-lb- (23-kg-) tensile, dead-load test perpendicular to duct wall.
- b. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch (3 mm) into airstream.
- c. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

#### 85.49 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber fabric reinforced.

Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with tape to form a hard, durable, airtight seal.

Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 75 percent solids.

Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

#### 85.50 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for building materials.

Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.

Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

- B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.

Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.

Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.

- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.

Supports for Stainless-Steel Ducts: Stainless-steel support materials.

Supports for Aluminum Ducts: Aluminum support materials, unless materials are electrolytically separated from ductwork.

#### 85.51 RECTANGULAR DUCT FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

- B. Fabricate range hood exhaust ducts with 0.0598-inch- (1.5-mm-) thick, carbon-steel sheet for concealed ducts and 0.0500-inch- (1.3-mm-) thick stainless steel for exposed ducts. Weld and flange seams and joints. Comply with NFPA 96.
- C. Fabricate dishwasher hood exhaust ducts with 0.0500-inch- (1.3-mm-) thick stainless steel. Weld and flange seams and joints.
- D. Acid-Resistant Ducts: PVC-coated galvanized steel.
- E. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:

Supply Ducts: 3-inch wg (750 Pa).

Return Ducts: 2-inch wg (500 Pa), negative pressure.

Exhaust Ducts: 2-inch wg (500 Pa), negative pressure.

- F. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of unbraced panel area, unless ducts are lined.

#### 85.52 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness are prohibited.
- B. Apply adhesive to liner facing in direction of airflow not receiving metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

- E. Do not apply liners in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
- G. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely around perimeter; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
- H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profile or are integrally formed from duct wall. Fabricate edge facings at the following locations:  
  
Fan discharge.  
Intervals of lined duct preceding unlined duct.  
Upstream edges of transverse joints in ducts.
- I. Secure insulation liner with perforated sheet metal liner of same metal thickness as specified for duct, secured to ducts with mechanical fasteners that maintain metal liner distance from duct without compressing insulation.  
  
Sheet Metal Liner Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.
- J. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire-damper sleeve.

#### 85.53 ROUND AND FLAT-OVAL DUCT FABRICATION

- A. General: Diameter as applied to flat-oval ducts in this Article is the diameter of the size of round duct that has a circumference equal to perimeter of a given size of flat-oval duct.
- B. Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- C. Flat-Oval Ducts: Fabricate supply ducts with standard spiral lock seams or with butt-welded longitudinal seams according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- D. Double-Wall (Insulated) Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.

Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.

Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths 2 inches (50 mm) longer than inner shell and insulation, and in metal thickness specified for single-wall duct.

Insulation: 1-inch- (25-mm-) thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to inner liner diameter.

Solid Inner Liner: Fabricate round and flat-oval inner liners with solid sheet metal of thickness listed below:

Perforated Inner Liner: Fabricate round and flat-oval inner liners with sheet metal having 3/32-inch- (2.4-mm-) diameter perforations, with an overall open area of 23 percent. Use the following sheet metal thicknesses and seam construction:

- a. Ducts 3 to 8 Inches (75 to 200 mm) in Diameter: 0.019 inch (0.5 mm) with standard spiral seam construction.

- b. Ducts 9 to 42 Inches (225 to 1070 mm) in Diameter: 0.019 inch (0.5 mm) with single-rib spiral seam construction.
- c. Ducts 44 to 60 Inches (1120 to 1525 mm) in Diameter: 0.022 inch (0.55 mm) with single-rib spiral seam construction.
- d. Ducts 62 to 88 Inches (1575 to 2235 mm) in Diameter: 0.034 inch (0.85 mm) with standard spiral seam construction.

Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

#### 85.54 ROUND AND FLAT-OVAL SUPPLY AND EXHAUST FITTING FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate bend radius of die-formed, gored, and pleated elbows one and one-half times elbow diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):

- a. Ducts 3 to 26 Inches (75 to 660 mm) in Diameter: 0.028 inch (0.7 mm).
- b. Ducts 27 to 36 Inches (685 to 915 mm) in Diameter: 0.034 inch (0.85 mm).
- c. Ducts 37 to 50 Inches (940 to 1270 mm) in Diameter: 0.040 inch (1.0 mm).
- d. Ducts 52 to 60 Inches (1320 to 1525 mm) in Diameter: 0.052 inch (1.3 mm).
- e. Ducts 62 to 84 Inches (1575 to 2130 mm) in Diameter: 0.064 inch (1.6 mm).

Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg (500 to 2490 Pa):

- f. Ducts 3 to 14 Inches (75 to 355 mm) in Diameter: 0.028 inch (0.7 mm).
- g. Ducts 15 to 26 Inches (380 to 660 mm) in Diameter: 0.034 inch (0.85 mm).
- h. Ducts 27 to 50 Inches (685 to 1270 mm) in Diameter: 0.040 inch (1.0 mm).
- i. Ducts 52 to 60 Inches (1320 to 1525 mm) in Diameter: 0.052 inch (1.3 mm).
- j. Ducts 62 to 84 Inches (1575 to 2130 mm) in Diameter: 0.064 inch (1.6 mm).

Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal seam flat-oval duct.

90-Degree, Two-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material-handling classes A and B; and only where space restrictions do not permit using 1.5 bend radius elbows. Fabricate with single-thickness turning vanes.

Round Elbows, 8 Inches (200 mm) and Smaller: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.



Round Elbows, 9 through 14 Inches (225 through 355 mm): Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees, unless space restrictions require a mitered elbow. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.

Round Elbows, Larger Than 14 Inches (355 mm), and All Flat-Oval Elbows: Fabricate gored elbows, unless space restrictions require a mitered elbow.

Die-Formed Elbows for Sizes through 8 Inches (200 mm) and All Pressures: 0.040 inch (1.0 mm) thick with two-piece welded construction.

Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

Flat-Oval Elbow Metal Thickness: Same as longitudinal seam flat-oval duct specified above.

Pleated Elbows for Sizes through 14 Inches (355 mm) and Pressures through 10-Inch wg (2490 Pa): 0.022 inch (0.55 mm).

- D. Double-Wall (Insulated) Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.

Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.

Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths 2 inches (50 mm) longer than inner shell and insulation. Use the same metal thicknesses for outer duct as for uninsulated fittings.

Insulation: 1-inch- (25-mm-) thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to nominal single-wall size.

Solid Inner Liner: Fabricate round and flat-oval inner liners with solid sheet metal of thickness listed below:

Perforated Inner Liner: Fabricate round and flat-oval inner liners with sheet metal having 3/32-inch- (2.4-mm-) diameter perforations, with an overall open area of 23 percent. Use the following sheet metal thicknesses:

- a. Ducts 3 to 34 Inches (75 to 865 mm) in Diameter: 0.028 inch (0.7 mm).
- b. Ducts 35 to 58 Inches (890 to 1475 mm) in Diameter: 0.034 inch (0.85 mm).
- c. Ducts 60 to 88 Inches (1525 to 2235 mm) in Diameter: 0.040 inch (1.0 mm).

Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

- E. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

Round Elbows 4 to 8 Inches (100 to 200 mm) in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with a PVC aerosol spray.

Round Elbows 9 to 26 Inches (230 to 660 mm) in Diameter: Standing seam construction.

Round Elbows 28 to 60 Inches (710 to 1525 mm) in Diameter: Standard gore construction, riveted and bonded.

Other Fittings: Riveted and bonded joints.

Couplings: Slip-joint construction with a minimum 2-inch (50-mm) insertion length.

## EXECUTION

### 85.55 DUCT INSTALLATION, GENERAL

- A. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.
- B. Construct and install each duct system for the specific duct pressure classification indicated.
- C. Install round and flat-oval ducts in lengths not less than 12 feet (3.7 m), unless interrupted by fittings.

- D. Install ducts with fewest possible joints.
- E. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- F. Install couplings tight to duct wall surface with a minimum of projections into duct.
- G. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches (38 mm).
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Firestopping."

#### 85.56 PVC-COATED DUCT INSTALLATION

- A. Install PVC-coated duct and fittings according to manufacturer's written instructions.
- B. Seal all joints and seams. Apply sealer to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- C. Secure couplings with sheet metal screws. Install screws at an interval of 12 inches (300 mm), with a minimum of three screws in each coupling.
- D. Repair damage to PVC coating with manufacturer's recommended materials.

#### 85.57 UNDERSLAB DUCT INSTALLATIONS

- A. Verify undamaged conditions of duct before enclosure with fill or encasement.
- B. Install underslab ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and as indicated.
- C. Protect ducts from damage by equipment used in placing concrete on or around ducts.
- D. Protect duct openings.

85.58 RANGE HOOD EXHAUST DUCT INSTALLATIONS

- A. Install ducts to allow for thermal expansion of ductwork through 2000 deg F (1100 deg C) temperature range.
- B. Install ducts without dips or traps that may collect residues, unless traps have continuous or automatic residue removal.
- C. Install access openings at each change in direction and at 50-foot (15-m) intervals; locate on sides of duct a minimum of 1-1/2 inches (38 mm) from bottom; and fit with grease-tight covers of same material as duct.
- D. Do not penetrate fire-rated assemblies.

85.59 DISHWASHER EXHAUST DUCT INSTALLATIONS

- A. Install dishwasher exhaust ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

85.60 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Pressure Classification Less Than 2-Inch wg (500 Pa): Transverse joints.
- C. Seal externally insulated ducts before insulation installation.

85.61 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 feet (5 m) and at each floor.
- D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- E. Install concrete inserts before placing concrete.
- F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

85.62 CONNECTIONS

- A. Connect equipment with flexible connectors according to Division 15 Section "Duct Accessories."
- B. For branch, outlet and inlet, and terminal unit connections, comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

85.63 FIELD QUALITY CONTROL

- A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.
- B. Conduct tests, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
- D. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (500 Pa) (both positive and negative pressures), and Leakage Classification 6 for pressure classifications from 2- to 10-inch wg (500 to 2490 Pa).
- E. Remake leaking joints and retest until leakage is less than maximum allowable.
- F. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

85.64 ADJUSTING

- A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.
- B. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for detailed procedures.

85.65 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.

END OF SECTION 233113

## SECTION 233300 - DUCT ACCESSORIES

### GENERAL

#### 85.66 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 85.67 SUMMARY

- A. This Section includes the following:

- Backdraft dampers.
- Manual-volume dampers.
- Fire and smoke dampers.
- Duct silencers.
- Turning vanes.
- Duct-mounted access doors and panels.
- Flexible ducts.
- Flexible connectors.
- Duct accessory hardware.

- B. Related Sections include the following:

- Division 8 Section "Access Doors" for wall- and ceiling-mounted access doors and panels.
- Division 10 Section "Louvers and Vents" for intake and relief louvers and vents connected to ducts and installed in exterior walls.
- Division 15 Section "Air Terminals" for constant-volume and variable-air-volume control boxes, and reheat boxes.
- Division 15 Section "Diffusers, Registers, and Grilles."
- Division 15 Section "Control Systems Equipment" for electric and pneumatic damper actuators.
- Division 16 Section "Fire Alarm Systems" for duct-mounted fire and smoke detectors.

#### 85.68 SUBMITTALS

- A. Product Data: For the following:

- Backdraft dampers.
- Manual-volume dampers.
- Fire and smoke dampers.
- Duct silencers.
- Duct-mounted access doors and panels.
- Flexible ducts.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:

- Special fittings and manual- and automatic-volume-damper installations.
- Fire- and smoke-damper installations, including sleeves and duct-mounted access doors and panels.

- C. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

#### 85.69 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA standards:  
  
NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."  
NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

#### 85.70 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

Fusible Links: Furnish quantity equal to 10 percent of amount installed.

### PRODUCTS

#### 85.71 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- C. Aluminum Sheets: ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish for ducts exposed to view and mill finish for concealed ducts.
- D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

#### 85.72 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installations.
- B. Frame: 0.052-inch- (1.3-mm-) thick, galvanized, sheet steel, with welded corners and mounting flange.
- C. Frame: 0.052-inch- (1.3-mm-) thick, galvanized, sheet steel, with welded corners.
- D. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum, with mounting flange.
- E. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum.
- F. Blades: 0.025-inch- (0.6-mm-) thick, roll-formed aluminum.
- G. Blades: 0.050-inch- (1.2-mm-) thick aluminum sheet.

- H. Blade Seals: Felt.
- I. Blade Seals: Vinyl.
- J. Blade Seals: Neoprene.
- K. Blade Axles: Nonferrous.
- L. Blade Axles: Galvanized steel.
- M. Tie Bars and Brackets: Aluminum.
- N. Tie Bars and Brackets: Galvanized steel.
- O. Return Spring: Adjustable tension.

#### 85.73 MANUAL-VOLUME DAMPERS

- A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

Pressure Classifications of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

- B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.

Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

Aluminum Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized, sheet steel.

Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.

Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

Blade Axles: Nonferrous.

Blade Axles: Galvanized steel.

Tie Bars and Brackets: Aluminum.

Tie Bars and Brackets: Galvanized steel.

- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
- E. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, and suitable for horizontal or vertical applications.

Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

Aluminum Frames: Hat-shaped, 0.063-inch- (1.6-mm-) thick, extruded-aluminum channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized, sheet steel.

Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.

Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

Blade Seals: Felt.

Blade Seals: Vinyl.

Blade Seals: Neoprene.

Blade Axles: Nonferrous.

Blade Axles: Galvanized steel.

Tie Bars and Brackets: Aluminum.

Tie Bars and Brackets: Galvanized steel.

- F. High-Performance Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

Steel Frames: Hat-shaped, galvanized steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

Aluminum Frames: Hat-shaped, 0.125-inch- (3-mm-) thick, extruded-aluminum channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

Steel Blades: 0.052-inch- (1.3-mm-) thick, galvanized, sheet steel; airfoil shaped.

Extruded-Aluminum Blades: Minimum of 0.081-inch- (2-mm-) thick, 6063T extruded aluminum.

Blade Seals: Dual-durometer vinyl on blade edges; metallic compression on jambs.

Blade Axles: Nonferrous.

Blade Axles: Galvanized steel.

Tie Bars and Brackets: Aluminum.

Tie Bars and Brackets: Galvanized steel.

- G. Jackshaft: 1-inch- (25-mm-) diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.

- H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

#### 85.74 DUCT SILENCERS

- A. General: Factory-fabricated and -tested, round or rectangular silencer with performance characteristics and physical requirements as indicated.

- B. Fire Performance: Adhesives, sealers, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame spread and 50 for smoke developed when tested according to ASTM E 84.

- C. Rectangular Units: Fabricate casings with a minimum of 0.034-inch- (0.85-mm-) thick, solid sheet metal for outer casing and 0.022-inch- (0.55-mm-) thick, perforated sheet metal for inner casing.

- D. Round Units: Casings with sheet metal thicknesses for diameters listed below:

Up to 24 Inches (600 mm): 0.034 inch (0.85 mm).

26 through 40 Inches (660 through 1000 mm): 0.040 inch (1.0 mm).

42 through 52 Inches (1060 through 1300 mm): 0.052 inch (1.3 mm).



54 through 60 Inches (1370 through 1500 mm): 0.064 inch (1.62 mm).

Casings fabricated of spiral lock-seam duct may be one size thinner than that indicated.

Interior Partitions and Baffles: At least 0.034 inch (0.85 mm) and designed for minimum aerodynamic losses.

- E. Sheet Metal Perforations: 1/8-inch (3-mm) diameter for inner casing and baffle sheet metal.
- F. Fibrous Acoustic-Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
- G. Nonfibrous Acoustic-Fill Material: Moisture-proof nonfibrous material.
- H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.

Do not use nuts, bolts, and sheet metal screws for unit assemblies.

Lock form and seal or continuously weld joints.

Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.

Reinforcement: Cross or trapeze angles for rigid suspension.

- I. Source Quality Control: Perform the following factory tests:

Acoustic Performance: Test according to ASTM E 477, with airflow in both directions through silencer.

Record acoustic ratings, including dynamic insertion loss and self-noise power levels, for both forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions) with an airflow of at least 2000-fpm (10-m/s) face velocity.

Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

## 85.75 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch- (38-mm-) wide, curved blades set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into side strips suitable for mounting in ducts.
- C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

## 85.76 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Fabricate doors and panels airtight and suitable for duct pressure class.
- B. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

85.77 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.
- C. Extra-Wide Metal-Edged Connectors: Factory fabricated with a strip of fabric 5-3/4 inches (146 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.
- D. Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 4-3/8-inch- (111-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.
- E. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.

Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

Tensile Strength: 480 lbf/inch (84 N/mm) in the warp, and 360 lbf/inch (63 N/mm) in the filling.

- F. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.

Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

Tensile Strength: 530 lbf/inch (93 N/mm) in the warp, and 440 lbf/inch (77 N/mm) in the filling.

- G. High-Temperature System Flexible Connectors: Glass fabric coated with silicone rubber and having a minimum weight of 16 oz./sq. yd. (542 g/sq. m) and tensile strength of 285 lbf/inch (50 N/mm) in the warp, and 185 lbf/inch (32 N/mm) in the filling.

- H. High-Corrosive-Environment System Flexible Connectors: Glass fabric coated with a chemical-resistant coating.

Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).

Tensile Strength: 450 lbf/inch (79 N/mm) in the warp, and 340 lbf/inch (60 N/mm) in the filling.

85.78 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts, Uninsulated: Spiral-wound steel spring with flameproof vinyl sheathing.
- C. Flexible Ducts, Uninsulated: Corrugated aluminum.
- D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch- (38-mm-) thick, glass-fiber insulation around a continuous inner liner.

Reinforcement: Steel-wire helix encapsulated in inner liner.

Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.

Outer Jacket: Polyethylene film.

Inner Liner: Polyethylene film.

- E. Pressure Rating: 6-inch wg (1500 Pa) positive, 1/2-inch wg (125 Pa) negative.

85.79      ACCESSORY HARDWARE

- A.     Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.
- B.     Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch (6-mm), zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C.     Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches (75 to 450 mm) to suit duct size.
- D.     Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

EXECUTION

85.80      INSTALLATION

- A.     Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and NAIMA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.
- B.     Install volume dampers in lined duct; avoid damage to and erosion of duct liner.
- C.     Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D.     Install fire and smoke dampers according to manufacturer's UL-approved written instructions.  
  
         Install fusible links in fire dampers.
- E.     Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, turning vanes, and equipment.  
  
         Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.  
         Install access panels on side of duct where adequate clearance is available.
- F.     Label access doors according to Division 15 Section "Mechanical Identification."

85.81      ADJUSTING

- A.     Adjust duct accessories for proper settings.
- B.     Adjust fire and smoke dampers for proper action.
- C.     Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

**END OF SECTION 233300**

## SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

### GENERAL

#### 85.82 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 85.83 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
  - Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  - Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
  - Division 15 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers, and grilles.

#### 85.84 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C. Register: A combination grille and damper assembly over an air opening.

#### 85.85 SUBMITTALS

- A. Product Data: For each model indicated, include the following:
  - Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
  - Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
  - Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
  - Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.
- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.
- D. Samples for Verification: Of diffusers, registers, and grilles, in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

#### 85.86 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

#### PRODUCTS

#### 85.87 MANUFACTURED UNITS

- A. Diffusers, registers, and grilles are scheduled at the end of this Section.
- B. Diffusers, registers, and grilles are scheduled on Drawings.

#### 85.88 SOURCE QUALITY CONTROL

- A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

#### EXECUTION

#### 85.89 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 85.90 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

#### 85.91 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

85.92 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

85.93 DIFFUSER SCHEDULE

- A. Diffuser [#]: **<INSERT CONCISE DIFFUSER DESCRIPTION>**.

Available Products: Subject to compliance with requirements, diffusers that may be incorporated into the Work include, but are not limited to, the following.

Products: Subject to compliance with requirements, provide one of the following:

- a. **<PRODUCT NAME;>**Air Systems Components; Krueger Div.
- b. **<PRODUCT NAME;>**Anemostat Products; Dynamics Corp. of America.
- c. **<PRODUCT NAME;>**Carnes Co. Inc.
- d. **<PRODUCT NAME;>**Hart and Cooley, Inc.; Hart and Cooley Div.
- e. **<PRODUCT NAME;>**Hart and Cooley, Inc.; Tuttle and Bailey Div.
- f. **<PRODUCT NAME;>**Nailor Industries Inc.
- g. **<PRODUCT NAME;>**Titus.

Material: [Steel.] [Aluminum.]

Finish: [Baked enamel, white.] [Baked enamel, color selected by Architect.] [Anodized aluminum.]

Duct Connection: [Round.] [Square.]

Duct Connection Size: **<INSERT SIZE IN INCHES (mm)>**.

Face Size: **<INSERT SIZE IN INCHES (mm)>**.

Maximum Noise-Criterion Rating: **<INSERT MAXIMUM RATING>**.

Face Style: [Round.] [Square.] [Rectangular.] [Panel.] [Perforated.] [Linear.] [Troffer.]

Mounting: [Stepped down.] [Flush.] [Lay in.] [Snap in.] [Spline.] [Plaster frame.]

Pattern: [Fixed.] [2 position.] [Adjustable.] [one way.] [2 way.] [3 way.] [4 way.] [induction.]

Dampers: [Opposed blade.] [Butterfly.] [Fire/smoke.] [Combination volume and pattern control.]

Accessories: Include the following:

- h. Equalizer deflectors.
- i. Smudge ring.
- j. Plaster ring.
- k. Extractor.
- l. Blank-off panel.
- m. Operating keys.

85.94 REGISTER SCHEDULE

- 85.95 Modify register schedule to suit Project. Do not duplicate requirements in Section Text. Remove brackets and uppercase editor's notes after editing schedule. Refer to a completed example in the Evaluations for an explanation on how to use schedules.

A. Register [#]: <INSERT CONCISE REGISTER DESCRIPTION>.

Available Products: Subject to compliance with requirements, registers that may be incorporated into the Work include, but are not limited to, the following:

Products: Subject to compliance with requirements, provide one of the following:

- a. <PRODUCT NAME;>Air Systems Components; Krueger Div.
- b. <PRODUCT NAME;>Anemostat Products; Dynamics Corp. of America.
- c. <PRODUCT NAME;>Carnes Co. Inc.
- d. <PRODUCT NAME;>Hart and Cooley, Inc.; Hart and Cooley Div.
- e. <PRODUCT NAME;>Hart and Cooley, Inc.; Tuttle and Bailey Div.
- f. <PRODUCT NAME;>Nailor Industries Inc.
- g. <PRODUCT NAME;>Titus.

Material: [Steel.] [Aluminum.]

Finish: [Baked enamel, white.] [Baked enamel, color selected by Architect.] [Anodized aluminum.]

Face Blade Arrangement: [Fixed horizontal.] [Adjustable horizontal.] [Fixed vertical.] [Adjustable vertical.]

Rear Blade Arrangement: [Fixed horizontal.] [Adjustable horizontal.] [Fixed vertical.] [Adjustable vertical.]

Frame: [1-1/4 inches (32 mm) wide.] [1 inch (25 mm) wide.] [Filter.] [<INSERT FRAME SIZE AND STYLE>.]

Mounting: [Countersunk screw.] [Concealed.] [Lay in.]

Damper Type: [Adjustable opposed-blade assembly.] [Opposed blade with spring closing and UL-listed fusible link for 160 deg F (71 deg C).]

Accessories: Include plaster frame.

85.96 GRILLE SCHEDULE

A. Grille [#]: <INSERT CONCISE GRILLE DESCRIPTION>.

Available Products: Subject to compliance with requirements, grilles that may be incorporated into the Work include, but are not limited to, the following:

Products: Subject to compliance with requirements, provide one of the following:

- a. <PRODUCT NAME;>Air Systems Components; Krueger Div.
- b. <PRODUCT NAME;>Anemostat Products; Dynamics Corp. of America.
- c. <PRODUCT NAME;>Carnes Co. Inc.
- d. <PRODUCT NAME;>Hart and Cooley, Inc.; Hart and Cooley Div.
- e. <PRODUCT NAME;>Hart and Cooley, Inc.; Tuttle and Bailey Div.
- f. <PRODUCT NAME;>Nailor Industries Inc.
- g. <PRODUCT NAME;>Titus.

Material: [Steel.] [Aluminum.]

Finish: [Baked enamel, white.] [Baked enamel, color selected by Architect.] [Anodized aluminum.]

Face Blade Arrangement: [Fixed horizontal.] [Adjustable horizontal.] [Fixed vertical.] [Adjustable vertical.]

Rear Blade Arrangement: [Fixed horizontal.] [Adjustable horizontal.] [Fixed vertical.] [Adjustable vertical.]

Frame: [1-1/4 inches (32 mm) wide.] [1 inch (25 mm) wide.] [Filter.] [<INSERT FRAME SIZE AND STYLE>.]

Mounting: [Countersunk screw.] [Concealed.] [Lay in.]

Accessories: Include plaster frame.

**END OF SECTION 233713**



## SECTION 233416 - CENTRIFUGAL FANS

### GENERAL

#### 85.97 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 85.98 SUMMARY

- A. This Section includes centrifugal fans for indoor installations.
- B. Related Sections: The following Sections contain requirements that relate to this Section:

Division 15 Section "Vibration Control" for vibration hangers and supports.

Division 15 Section "Control Systems Equipment" for control devices.

Division 16 Section "Disconnects and Circuit Breakers" for disconnect switches.

Division 16 Section "Motor Controllers" for motor starters.

Division 16 Section "Motor-Control Centers" for starters and fusible switches.

#### 85.99 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Project Altitude: Base air ratings on sea-level conditions.
- C. Operating Limits: Classify according to AMCA 99.
- D. Fan Unit Schedule: The following information is described in an equipment schedule at the end of this Section.
- E. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.

Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

#### 85.100 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:

Certified fan performance curves with system operating conditions indicated.

Certified fan sound power ratings.

Motor ratings and electrical characteristics plus motor and electrical accessories.

Material gages and finishes, including color charts.

Dampers, including housings, linkages, and operators.

- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Coordination Drawings, including floor plans and sections drawn accurately to scale. Submit with Shop Drawings. Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- E. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- F. Maintenance data for fans to include in the operation and maintenance manual specified in Division 1 and in Division 15 Section "Basic Mechanical Requirements."

#### 85.101 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.  
 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

- C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.
- D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

#### 85.102 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units as required for movement to the final location following manufacturer's written instructions.
- C. Lift and support units with the manufacturer's designated lifting or supporting points.

#### 85.103 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.
- B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

#### 85.104 COORDINATION AND SCHEDULING

- A. Coordinate the size and location of concrete housekeeping pads. Cast anchor-bolt inserts into pad. Concrete reinforcement and formwork requirements are specified in Division 3 Sections.

- B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

#### 85.105 EXTRA MATERIALS

- A. Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

### PRODUCTS

#### 85.106 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering centrifugal fans that may be incorporated in the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide centrifugal fans by one of the following:

ABB Garden City Fan Company.  
Acme Engineering and Mfg. Corp.  
Aerovent, Inc.  
Airmaster Fan Co.  
American Coolair Corp.  
Ammerman Company, Inc.  
Bayley Fan Group.  
Buffalo Forge Co.  
Carnes Co.  
Carrier Corp.  
Central Blower Co.  
Chicago Blower Corp.  
Cincinnati Fan and Ventilator Co.  
CML Northern Blower, Inc.  
Cook (Loren) Co.  
Dayton Electric Manufacturing.  
General Resource Corp.  
Greenheck Fan Corp.  
Hartzell Fan, Inc.  
ILG Industries, Inc.  
Industrial Air Division.  
Joy Technologies Inc.  
McQuay International; Barry Blower Div.  
New York Blower Co.  
Novenco Fans Inc.  
Peerless-Winsmith, Inc.  
Penn Ventilator Co., Inc.  
Snyder General Commercial Products.  
Strobic Air Corp.  
Trane Co. (The).  
Twin City Fan and Blower Co.

#### 85.107 FAN UNITS

- A. Factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

- B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

#### 85.108 HOUSINGS

- A. Materials and Fabrication: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and doors or panels to allow access to internal parts and components. Use galvanized steel to fabricate fans downstream from humidifiers.

Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

Fabrication Class: AMCA 99 Class I, Class II, or Class III.

Horizontal Flanged Split Housing: Bolted construction.

Plug Fans: Fabricate without fan scroll and volute housing, with steel cabinet.

Tubular Centrifugal Fans: Fabricate tubular housing from formed- and reinforced-steel panels with welded seams and the following:

- a. Outlet guide vanes.
- b. Motor disconnect switch.
- c. Spun inlet cone with flange.
- d. Outlet flange.
- e. Brackets suitable for horizontal or vertical mounting.

#### 85.109 WHEELS

- A. Backward Inclined: Steel or aluminum construction with curved inlet flange, back plate, backwardly inclined blades welded or riveted to flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.
- B. Forward Curved: Black-enameled or galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; cast-steel hub swaged to back plate and fastened to shaft with set screws.
- C. Airfoil Wheel: Steel construction with smooth curved inlet flange; heavy back plate; hollow die-formed airfoil-shaped blades continuously welded at tip flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.

#### 85.110 SHAFTS

- A. Statically and dynamically balanced and selected for continuous operation at the maximum rated fan speed and motor horsepower (HP), with final alignment and belt adjustment made after installation.
- B. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
- C. Designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.

#### 85.111 BEARINGS

- A. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow- block-type ball bearings.

Ball-Bearing Rated Life: AFBMA 9, L-10 of 50,000 hours.  
Ball-Bearing Rated Life: AFBMA 9, L-10 of 120,000 hours.  
Roller-Bearing Rated Life: AFBMA 11, L-10 of 50,000 hours.  
Roller-Bearing Rated Life: AFBMA 11, L-10 of 120,000 hours.

- B. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block type; tapered roller bearings with double-locking collars and 2-piece, cast-iron housing.

Ball-Bearing Rated Life: AFBMA 9, L-10 of 50,000 hours.  
Ball-Bearing Rated Life: AFBMA 9, L-10 of 120,000 hours.  
Roller-Bearing Rated Life: AFBMA 11, L-10 of 50,000 hours.  
Roller-Bearing Rated Life: AFBMA 11, L-10 of 120,000 hours.

- C. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block type; ball or roller bearings with adapter mount and 2-piece, cast-iron housing.

Ball-Bearing Rated Life: AFBMA 9, L-10 of 50,000 hours.  
Ball-Bearing Rated Life: AFBMA 9, L-10 of 120,000 hours.  
Roller-Bearing Rated Life: AFBMA 11, L-10 of 50,000 hours.  
Roller-Bearing Rated Life: AFBMA 11, L-10 of 120,000 hours.

#### 85.112 BELT DRIVES

- A. Description: Factory mounted, with final alignment and belt adjustment made after installation.

Service Factor Based on Fan Motor: 1.5.  
Service Factor Based on Fan Motor: 1.4.  
Service Factor Based on Fan Motor: 1.2.

- B. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.

- C. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.

- D. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch- (2.7-mm-) thick, 3/4-inch (20-mm) diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

- E. Motor Mount: Adjustable for belt tensioning.

#### 85.113 ACCESSORIES

- A. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.

- B. Companion Flanges: Galvanized steel, for duct connections.

- C. Fixed Inlet Vanes: Steel, with fixed cantilevered vanes welded to inlet bell.

- D. Variable Inlet Vanes: Steel, with blades supported at both ends with 2 permanently lubricated bearings. Variable mechanism terminating in single control lever with control shaft for double-width fans.

- E. Adjustable Inlet Vanes: Steel, with blades cantilevered with 2 permanently lubricated bearings. Variable mechanism out of air stream terminating in single control lever with control shaft for double-width fans.

Double-Width Fan Inlet Vanes: Connected for single operator.

- F. Discharge Dampers: Heavy-duty steel assembly with blades constructed of 2 plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.

Configuration: Parallel blade.

Configuration: Opposed blade.

- G. Inlet Screens: Galvanized steel welded grid screen, mounted inside shaft bearings.

- H. Scroll Drain Connection: 1-inch (DN25) steel pipe coupling welded to low point of fan scroll.

- I. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

- J. Spark-Resistant Construction: AMCA 99 construction, as indicated.

- K. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

- L. Weather Cover: Heavy-gage steel sheet with ventilation slots, bolted to housing.

#### 85.114 MOTORS

- A. Refer to Division 15 Section "Motors" for general requirements for factory-installed motors.

- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

- C. Enclosure Type: The following features are required as indicated:

Open dripproof motors where satisfactorily housed or remotely located during operation.

Guarded dripproof motors where exposed to contact by employees or building occupants.

#### 85.115 FACTORY FINISHES

- A. Sheet Metal Parts: Enamel or prime coat before assembly. Do not prime coat aluminum parts.

- B. Factory Finish for Fans Downstream from Humidifiers: Enamel or prime coat before assembly with 2 coats of paint. Prime coating on aluminum parts is not required.

#### 85.116 SOURCE QUALITY CONTROL

- A. Testing Requirements: The following factory tests are required as indicated:

Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.

Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

## EXECUTION

### 85.117 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the fans. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 85.118 INSTALLATION

- A. Install fans according to manufacturer's written instructions.
- B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Division 15 Section "Vibration Control."

Support floor-mounted units on concrete housekeeping bases using neoprene pads. Secure units to anchor bolts installed in concrete housekeeping base.

Support floor-mounted units on concrete housekeeping bases using housed spring isolators. Secure units to anchor bolts installed in concrete housekeeping base.

- C. Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs. Vibration-control devices are specified in Division 15 Section "Vibration Control."
- D. Install units with clearances for service and maintenance.
- E. Label fans according to requirements specified in Division 15 Section "Mechanical Identification."

### 85.119 HOUSEKEEPING BASES

- A. Construct concrete housekeeping pads as follows:

Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 4 inches (100 mm) larger, in both directions, than the overall dimensions of the supported unit.

Form concrete pads with steel channels conforming to ASTM A 36 (ASTM A 36M), size and location as indicated. Miter and weld corner and provide cross bracing. Anchor or key to floor slab.

Form concrete pads with framing lumber with form-release compounds. Chamfer top edge and corners of pad.

Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.

Place concrete and allow to cure before installing units. Use portland cement conforming to ASTM C 150, 4000-psi (27 MPa) compressive strength, and normal-weight aggregate.

Clean exposed steel form according to SSPC Surface Preparation Specifications SP 2 or SP 3 and apply 2 coats of rust-preventive metal primer.

### 85.120 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Electrical: Conform to applicable requirements in Division 16 Sections.
- C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

85.121 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, alignment of fan shaft and motor shaft, alignment of pulleys, belt adjustments, and lubrication, and to report results in writing.

85.122 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

85.123 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

85.124 COMMISSIONING

- A. Final Checks before Startup: Perform the following operations and checks before startup:
  - Verify that shipping, blocking, and bracing are removed.
  - Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
  - Perform cleaning and adjusting specified in this Section.
  - Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - Verify lubrication for bearings and other moving parts.
  - Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
- B. Starting procedures for fans are as follows:
  - Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
  - Measure and record motor voltage and amperage.
- C. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
- D. Replace fan and motor pulleys as required to achieve design conditions.

85.125 DEMONSTRATION



- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
- C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.
- D. Demonstrate operation of fans. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each fan.

END OF SECTION

## **SECTION 233416 - CENTRIFUGAL FANS**

### **GENERAL**

#### **85.126 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## **SECTION 238126**

### **SPLIT-SYSTEM DUCTLESS AIR-CONDITIONERS**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items,

or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

### **RELATED WORK**

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 23 05 00 - Common Work Results for HVAC

Section 23 08 00 – Commissioning of HVAC

Section 23 23 00 – Refrigerant Piping

Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

### **REFERENCE**

Applicable provisions of Division 1 shall govern work under this section.

## REFERENCE STANDARDS

ARI 210/240	Unitary Air Conditioning and Heat Pump Equipment
ARI 365	Commercial and Industrial Unitary Air Conditioning Condensing Units
ASHRAE 15	Safety Standard for Refrigeration Systems
ASHRAE 90.1	(2004 edition) Energy Standard for Buildings Except Low Rise Residential Buildings
NEC	National Electrical Code
ASTM B117	Standard Practice for Operating Salt Spray (fog) Apparatus
UL	Underwriters Laboratory

## QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

Unit Energy Efficiency Ratio (EER), Seasonal Energy Efficiency Ratio (SEER), Integrated Energy Efficiency Ratio (IEER), and Heating Seasonal Performance Factor (HSPF) shall meet the minimum applicable requirements of ASHRAE 90.1 current edition.

Units that are labeled ENERGY STAR® will be acceptable.

Select units with performance that meets or exceeds the ASHRAE 90.1 (Current edition), FEMP energy efficiency requirements, and minimum rating listed in this specification section.

Unit rated performance in accordance with the latest edition of ARI Standard 365 or ARI Standard 210/240, whichever is applicable for the equipment.

Construct units in accordance with ASHRAE 15, UL standards and the NEC. Units shall carry the UL label.

Factory run and test units to see that each control device operates properly. Pressure test, evacuate, charge with holding charge of refrigerant and full oil charge prior to shipping from the factory.

## SUBMITTALS

Refer to division 1, General Conditions, Submittals

Submit air cooled condensing unit and evaporative unit shop drawings including the following information: specific manufacturer and model numbers, dimensional and weight data, required

clearances, materials of construction, capacities and ratings, efficiencies, stages of unloading capacity achievable without hot gas bypass, refrigerant type

and charge, component information, size and location of piping connections, electrical connections, wiring diagrams and information for all specialties and accessories.

Submit manufacturer's installation and start-up instructions, maintenance data, troubleshooting guide, parts lists, controls and accessories.

At substantial completion, submit warranty certificate and copy of start-up report.

#### OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

Delete the following if there are no additional requirements.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

[A/E and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.]

#### DELIVERY, STORAGE AND HANDLING

Comply with manufacturer's instructions for storing, rigging, unloading, and transporting units. Protect units from physical damage. Leave factory-shipping covers in place until installation.

Ship units to jobsite fully assembled.

#### WARRANTY

Provide a one year parts and labor warranty on the entire unit beginning upon substantial completion of project.

Provide a five year parts warranty on the compressor(s) beginning upon substantial completion of project.

#### PART 2 – PRODUCTS

## UNITS UP TO 3 TONS (10.5 kW)

Manufacturers: Carrier, Daikin, Friedrich, Mitsubishi, Toshiba, York, or approved equal.

Review unit application and the need for low ambient operation. Most units provide cooling down to 32 degrees F without the low ambient option. Currently Daikin SkyAir model is listed for operation down to -40 degrees F, Carrier 40MKCB and Mitsubishi series P are listed down to -20 degrees F while others operate down to 5 degrees F). Where the optional low ambient kit is required to meet the low ambient temperature, make sure that multiple manufacturers can meet this requirement in the size selected. If control of auxiliary heat is required, only Daikin, Carrier, and Mitsubishi currently offer this option and the unit may not be one of the ones providing low ambient.

## GENERAL

Provide a heating and cooling Heat Pump unit or Cooling Only unit with an indoor ceiling or wall mounted fan coil with matched outdoor condensing unit as scheduled.

Indoor fan coil units shall be complete with coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, R-410A or R32 refrigerant and integral Temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

Outdoor condensing unit shall be factory assembled suitable for ground, rooftop, or wall hung mounting. Units shall consist of a compressor, an air cooled coil, propeller type outdoor fan,

metering device(s), and control box. Units shall discharge air horizontally or vertically as shown on the drawings.

## INDOOR FAN COIL UNIT (Ceiling Mounted Cassette)

Unit cabinet shall be constructed of zinc coated steel. Provide fully insulated cabinet with discharge and inlet grilles. Grilles shall have hinges and can be opened to obtain access to the filters, indoor fan motor and control box.

Fans shall be centrifugal direct drive blower type with center intake and perimeter discharge on the unit. Automatic, motor driven air vanes shall be provided.

Coils shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wettability. A drip pan

under the coil shall have drain connections for hose attachment to remove condensate. Condensate pan shall be corrosion resistant.

Motors shall have permanently lubricated ball bearing with inherent overload protection. Fan motors shall a minimum of 3 speeds.

Unit shall have a filter track with factory supplied cleanable filters.

If unit requires outside air for ventilation add a fresh air intake and connect to unit. The maximum amount of fresh air cannot exceed 10% of the total supply air.

Provide fresh air intake duct connection.

Minimum performance shall be 16.0 SEER and 10.0 HSPF for units.

#### INDOOR FAN COIL UNIT (Wall/Ceiling Mounted)

Cabinet shall be constructed of a durable material with a galvanized steel sub-chassis. Unit shall be fully insulated for improved thermal and acoustic performance.

Unit cabinet discharge and inlet grilles shall be constructed of high-impact plastic.

Fans shall be direct drive blower type with air intake and discharge on the unit. Automatic, motor driven air sweep shall be provided.

Horizontal and/or vertical discharge louvers shall be adjustable.

Coils shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wettability. A drip pan under the coil shall have drain connections for hose attachment, on either the left or right hand side, to remove condensate. Condensate pan shall be corrosion resistant.

Motors shall have permanently lubricated ball bearing with inherent overload protection. Fan motors shall a minimum of 3 speeds.

Unit shall have filter track with factory supplied mildew proof cleanable filters.

If unit requires outside air for ventilation add a fresh air intake and connect to unit. The maximum amount of fresh air cannot exceed 10% of the total supply air.

Provide fresh air intake duct connection.

Minimum performance shall be 16.0 SEER and 10.0 HSPF for units.

#### AIR-COOLED CONDENSING UNIT

Unit cabinet shall be constructed of galvanized steel, bonderized, and coated with a baked enamel finish on the inside and outside. Unit cabinet shall be capable of withstanding 500 hour salt spray test per Federal Test Standard No. 141 (method 6061). Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fans, and control components. Outdoor compartment shall be isolated and have an acoustic lining.

Outdoor fans shall be direct drive propeller type and shall discharge air horizontally or vertically. Outdoor fan motors shall be totally enclosed, single phase motors with class B insulation and permanently lubricated bearings. Motor shall be protected by internal thermal overload protection and shafts shall have inherent corrosion resistance.

Fan blades shall be statically and dynamically balanced.

Outdoor fan openings shall be equipped with protective grille over fan.

Compressor shall be fully hermetic scroll or a rotary swing type variable speed compressor. Compressor shall be equipped with operating oil charge, and motor. Internal overloads shall protect the compressor from over temperature and over current. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere. Compressor assembly shall be installed on rubber vibration isolators. Compressors shall be provided with crankcase heater.

Outdoor coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed. Air cooled condenser coils shall be leak tested at 573 psig.

Refrigerant circuit components shall include service valves with service gage port connections on compressor suction and discharge lines, each with brass caps, accumulator, and a reversing valve (for heat pump units).

Provide the low ambient kit for units that will need to provide cooling year round.

Low Ambient Kit: Provide wind baffle and regulate fan motor cycles in response to saturated condensing temperature of the unit. The control shall be capable of starting and operation down to [0] [-13] [-20] degrees F ([ -17] [-25] [-28] degrees C) ambient air temperature. Installation of kit shall not require changing the outdoor fan motor.

If unit installation requires stacking of units or mounting units off of walls use the factory provided installation kits.

[Provide optional stacking kit for installation. (Not for Heat Pumps)]

[Provide optional wall mounting kit for installation.]

Condensing unit controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

A time delay control sequence.

Outdoor fan failure detection.

Compressor motor current and temperature overload protection.

Compressor low and high pressure protection.

## CONTROLS

Controls shall consist of a microprocessor based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 62 degrees F to 84 degrees F (16.7 degrees C to 28.9 degrees C). User interface with the unit shall be accomplished through a wired remote control (can be configured for degrees F or degrees C).

The unit shall have the following functions as a minimum:

An automatic restart after power failure at the same operating conditions as at failure.

A timer function to provide a minimum 24 hour timer cycle for system Auto Start/Stop.

Temperature sensing controls shall sense return air temperature.

Automatic air sweep control to provide on or off activation of air sweep louvers.

Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.

Fan only operation to provide room air circulation when no cooling or heating is required.

Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.

Evaporator fan speed control shall be user selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.

Automatic heating to cooling changeover. Control shall include dead band to prevent rapid mode cycling between heating and cooling.

A liquid level sensor in the condensate reservoir shall stop cooling operation if the liquid level in the reservoir is too high.

Engineers note: If unit is to be integrated into an existing system the unit must also have the capability to control an exterior source of heat. Unit may also need to be disabled to prevent cooling when the space is in heating mode. Discuss this with DFD.

[Provide Wired Thermostat for wall mounting.]

Engineers note: A wired thermostat may not be available in all unit sizes. Verify that it is available in the size of unit you are specifying

[Provide Auxiliary Heat control capability.]



[Provide Remote Shut-off control capability.]

## ELECTRICAL

Unit's electrical requirements shall be 208/230 volt, single phase, and 60 hertz.

Engineers note: Power wiring is typically connected to the outdoor unit. Power and control wiring is required between indoor and outdoor units. Coordinate with electrical so both connections are covered.

Division 26 contractor shall provide conduit for both the power and control wiring between indoor unit and outdoor unit.

All power and control wiring must be installed per NEC and all local electrical codes.

## COOLING COIL CONDENSATE PIPING

Provide ASTM B88, type L hard temper copper tubing with ASTM B145/ANSI B16.23 cast red bronze or ASTM B75/ANSI B16.29 wrought solder-type drainage fittings.

Galvanized steel pipe with cast iron drainage fittings may also be specified. Note that drainage pattern fittings are not the same as pressure fittings.

## INTEGRAL CONDENSATE PUMP

The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly and a remote sound shielded pump assembly.

## REFRIGERANT PIPING

Provide precharged refrigerant lines that can be oriented to connect to the side or back of unit. Both refrigerant lines shall be insulated.

It is not the intent of this specification to require a hard piped system on small air cooled condensing units that are typically provided by the manufacturer with precharged tubing. If precharged tubing is available in the proper length, it may be used. In that case, use the manufacturer's standard liquid line refrigerant specialties also. If, however, the application requires a special refrigerant piping system, use the following pipe specification.

Provide ASTM B88 type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR", with ANSI B16.22 wrought copper or forged brass solder-type fittings.

Pre charged tubing line sets may be used on systems 3 tons and less in size.

## PART 3 - EXECUTION

## INSTALLATION

Install units, piping and accessories in accordance with the manufacturer's written instructions and recommendations. Mount condensing unit(s) on a [precast concrete pad on grade] [poured concrete pad on grade] [roof mounted curb per DFD detail] [wall mounting kit] as indicated on the drawings.

For roof mounted units use a curb instead of rails. Run both the refrigeration piping and the electrical through the curb per DFD detail. This eliminates the problem of repairing and re-roofing between rails under small units.

Maintain adequate service access and airflow clearances for all components as recommended by the manufacturer and as indicated on the drawings.

Charge unit(s) with full oil charge and refrigerant charge based on the entire refrigeration system pipe size and length.

Provide all control wiring in conduit in compliance with Section 23 09 14 or Section 23 09 15 and Division 26 00 00 - Electrical.

If the temperature controls are to be provided by the temperature control contractor then modify the above sentence accordingly.

Coordinate installation of a service outlet with electrical engineer.

Coordinate power wiring requirements with Division 26 00 00 contractor.

## REFRIGERANT PIPING SIZING

The unit manufacturer shall verify the final refrigeration pipe sizing process to insure conformance to specific unit requirements such as maximum lengths, refrigerant velocities, unloading considerations and proper oil return. This contractor shall provide refrigeration piping drawings from the field which details the way the piping will actually be installed.

## REFRIGERANT PIPING

Refrigeration piping to be installed by firms who are experienced in installation of such piping and in accordance with the requirements of the International Mechanical Code, Chapter 11 and the Wisconsin Administrative Code Chapter SPS 345.

All brazing filler metals shall have a melting temperature above 1400 degrees F and contain a minimum of 6% silver.

Tubing to be new and delivered to the job site with the original mill end caps in place. Clean and polish all joints before brazing. Avoid prolonged heating and burning during brazing. Purge all lines with nitrogen during brazing. Provide manual shut-off and check valves as required.

No refrigerant is to be vented directly to the atmosphere except that which may escape through leaks in the system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of the refrigerant.

Leak test the system by charging the system to a pressure of 10 psig with refrigerant, with the compressor suction and discharge valves closed and with all other system valves open. Increase pressure to 300 psig with dry nitrogen. Rap all joints with a mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

After completion of the leak test, evacuate the system with a vacuum pump to an absolute pressure not exceeding 1500 microns while the system ambient temperature is above 60°F. Break the vacuum to 2 psig with the refrigerant to be used in the system. Repeat the evacuation process, again breaking the vacuum with refrigerant. Install a drier of the required size in the liquid line, open the compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns. Leave the vacuum pump running for not less than two hours without interruption. Raise the system pressure to 2 psig with refrigerant and remove the vacuum pump.

Charge refrigerant directly from original drums through a combination filter-drier. Each drier may be used for a maximum of three cylinders of refrigerant and then must be replaced with a fresh drier. Charge the system by means of a charging fitting in the liquid line. Weigh the refrigerant drum before charging so that an accurate record can be kept of the weight of refrigerant put in the system. If refrigerant is added to the system through the suction side of the compressor, charge in vapor form only.

## REFRIGERANT PIPING ACCESSORIES

Install accessories in accordance with the manufacturer's written instructions and recommendations.

## STARTUP

Adjust units for maximum operating efficiency, adjust all controls to required final settings and demonstrate that all components are functioning properly. Submit four copies of a written startup report following the initial startup. Include in the report: work done to the system, all readings taken, a statement certifying that the refrigeration stem(s) are leak free and a statement certifying that the unit(s) have been placed in proper running condition as recommended by the manufacturer and as intended in the drawings and specifications.

## CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

## FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied under specification Section 23 08 00 in accordance with the procedures defined for functional performance testing in Section 01 91 01 or 01 91 02.

## AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours.

END OF SECTION

## SECTION 23 23 00

### REFRIGERANT PIPING

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items,

or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

#### PART 1 - GENERAL

Scope

Related Work

Reference

Reference Standards

Shop Drawings

Quality Assurance

Delivery, Storage, and Handling

Design Criteria

#### PART 2 - PRODUCTS

Refrigerant Piping

Refrigerant Piping Accessories

#### PART 3 - EXECUTION

Preparation

Erection

Refrigerant Piping

Refrigerant Piping Accessories

Construction Verification Items

## RELATED WORK

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

Section 23 07 00 - HVAC Insulation

Section 23 08 00 – Commissioning of HVAC

## REFERENCE

Applicable provisions of Division 1 govern work under this section.

## REFERENCE STANDARDS

Edit the following list so only the standards that are needed in your spec are included in it.

ANSI B16.22      Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings

ASTM B88        Seamless Copper Water Tube

ASTM B280      Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASHRAE 15      Safety Code for mechanical Refrigeration

## SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

COPPER TUBE:

Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

## QUALITY ASSURANCE

Order all copper refrigeration tube with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier; with soft straight lengths or coils identified with a tag indicating that the product was manufactured in accordance with ASTM B280; and with each hard temper straight length identified throughout its length by a blue colored marking not less than 3/16 inch in height and a legend at intervals of not greater than three feet that includes the designation "ACR" and pipe outside diameter.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

## DELIVERY, STORAGE, AND HANDLING

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. If end caps are not present on tube bearing the "ACR" designation, clean and re-cap in accordance with ASTM B280. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

## DESIGN CRITERIA

Use only new material, free of defects and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

## PART 2 - PRODUCTS

### REFRIGERANT PIPING

It is not the intent of this specification to require a hard piped system on small, 3-1/2 tons and less, air cooled condensing units that are typically provided by the manufacturer with precharged tubing. If precharged tubing is available in the proper length, it may be used. In that case, use the manufacturer's standard liquid line refrigerant

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to

specialties also. If, however, the application requires a special refrigerant piping system, use the following pipe specification.

ASTM B88 type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR", with ANSI B16.22 wrought copper or forged brass solder-type fittings.

Precharged tubing line sets may be used on systems 3-1/2 tons and less in size.

#### REFRIGERANT PIPING ACCESSORIES

Provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 450 psig and a maximum working temperature of 225 deg F. For systems using R-410A, provide all refrigerant

piping specialties with a maximum working pressure of full vacuum to 850 psig and a maximum working temperature of 225 deg F.

Flexible pipe connectors: Double braided bronze hose flexible pipe connectors with solder end connections.

Filter Dryers: For circuits 15 tons and over provide angle pattern filter dryers with replaceable core. For circuits below 15 tons provide straight pattern filter dryers without replaceable core.

Sight glasses: Two piece brass construction with solder end connections. Include color indicator for sensing moisture.

Solenoid Valves: Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, teflon diaphragm and solder end connections. Provide replaceable coil assembly.

Hot Gas Bypass Valves: Provide with integral solenoid valve, external equalizer connection and adjustable pilot assembly.

Thermostatic Expansion Valves: Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

Charging Valves: Provide 1/4" SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.

Check valves: Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.



## PART 3 - EXECUTION

### PREPARATION

Remove all foreign material from interior and exterior of pipe and fittings.

### ERECTION

clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

This requirement is based on NFPA 70, 2014 450-47.

Do not install piping running through any elevator shaft, public stairway, stair landing, or means of egress.

Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

### REFRIGERANT PIPING

Refrigeration piping to be installed by firms who are experienced in installation of such piping and in accordance with the requirements of the International Mechanical Code, Chapter 11 and the Wisconsin Administrative Code Chapter SPS 345.

All brazing filler metals shall have a melting temperature above 1400 degrees F and contain a minimum of 6% silver.

Tubing to be new and delivered to the job site with the original mill end caps in place. Clean and polish all joints before brazing. Avoid prolonged heating and burning during brazing. Purge all lines with nitrogen during brazing. Provide manual shut-off and check valves as required.

No refrigerant is to be vented directly to the atmosphere except that which may escape through leaks in the system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of the refrigerant.

Leak test the system by charging the system to a pressure of 10 psig with an HFC refrigerant, with the compressor suction and discharge valves closed and with all other system valves open. Increase pressure to 300 psig with dry nitrogen. Rap all joints with a mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

After completion of the leak test, evacuate the system with a vacuum pump to an absolute pressure not exceeding 1500 microns while the system ambient temperature is above 60°F. Break the vacuum to 2 psig with the refrigerant to be used in the system. Repeat the evacuation process, again breaking the vacuum with refrigerant. Install a drier of the required size in the liquid line, open the compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns. Leave the vacuum pump running for not less than two hours without interruption. Raise the system pressure to 2 psig with refrigerant and remove the vacuum pump.

Charge refrigerant directly from original drums through a combination filter-drier. Each drier may be used for a maximum of three cylinders of refrigerant and then must be replaced with a fresh drier. Charge the system by means of a charging fitting in the liquid line. Weigh the refrigerant drum before charging so that an accurate record can be kept of the weight of refrigerant put in the system. If refrigerant is added to the system through the suction side of the compressor, charge in vapor form only.

#### REFRIGERANT PIPING ACCESSORIES

Install accessories in accordance with the manufacturer's written instructions and recommendations.

#### CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION

## **SECTION 104416 FIRE EXTINGUISHERS**

### **PART 1 GENERAL**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **SUMMARY**

Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

Owner-Furnished Material: Hand-carried fire extinguishers.

Related Sections:

Division 10 Section 104413 "Fire Extinguisher Cabinets"

Division 21 Section 211200 "Fire-Suppression Standpipes"

#### **SUBMITTALS**

Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

#### **INFORMATIONAL SUBMITTALS**

Warranty: Sample of special warranty.

#### **CLOSEOUT SUBMITTALS**

Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

#### **QUALITY ASSURANCE**

NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

Provide fire extinguishers approved, listed, and labeled by FMG.

All Materials and works shall be performed in strict accordance with the stipulations of the Egyptian Standard Specifications (ES) Latest Edition.

#### **COORDINATION**

Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

#### **WARRANTY**

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

Failures include, but are not limited to, the following:

Failure of hydrostatic test according to NFPA 10.

Faulty operation of valves or release levers.

Warranty Period: as per manufacturer's warranty period and client requirement from date of Substantial Completion.

### **PART 2 PRODUCTS**

#### **PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS**

Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.

Manufacturers: Subject to compliance with requirements.

Basis-of-Design Product: Subject to compliance with requirements.

Valves: Manufacturer's standard.

Handles and Levers: Manufacturer's standard.

Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

Multipurpose Dry-Chemical Type: UL-rated 4-A:60-B:C, 4.0-kg and 6 kg nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container for a working temperature range of -20°C to 60°C.

Carbon Dioxide Type: UL-rated 10-B:C, 6-kg nominal capacity, with carbon dioxide in manufacturer's standard enameled-metal container with discharge horn, pressurized at approximately 5000 kPa at 21°C.

Pressurized, FFFP-Foam Type: UL-rated 3-A:20-B. (6-L) nominal capacity, with FFFP foam in stainless-steel container; with pressure-indicating gage.

Self actuated carbon dioxide firetrace :ULrated, CO2,6-kg nominal capacity, red glossy polyester coated seamless steel cylinder with polymer flexible tube.

Fire Blanket: UL-rated The blanket is provided with pull tapes for safe handling. Fire Blanket size 1.2 m x 1.2 m

#### **MOUNTING BRACKETS**

Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

Manufacturers: Subject to compliance with requirements.

Basis-of-Design Product: Subject to compliance with requirements.

Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

### PART 3 EXECUTION

#### EXAMINATION

Examine fire extinguishers for proper charging and tagging.

Remove and replace damaged, defective, or undercharged fire extinguishers.

Proceed with installation only after unsatisfactory conditions have been corrected.

#### INSTALLATION

General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.

Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

## **SECTION 212113.13    Carbon Dioxide Fire Search System**

### **2.3            Carbon Dioxide Fire Search System**

#### **2.3.1            Requirements**

- 2.3.1.1        Supply and install automatic CO<sub>2</sub> Fire Extinguishing systems wherever shown on the drawings and as detailed herein below.
- 2.3.1.2        The System shall be of the total flooding type and shall be designed in accordance with the requirements of the National Fire Protection Associations standard (NFPA) chapter 12 and the requirements of the authorities having jurisdiction.
- 2.3.1.3        Each CO<sub>2</sub> system shall be complete with storage cylinders, releasing devices, detection devices, alarm signals, piping network and a control panel with stand-by battery.
- 2.3.1.4        CO<sub>2</sub> detector with visual alarm located outside served area shall be provided to indicate CO<sub>2</sub> existence.
- 2.3.1.5        The equipment shall be approved and listed by the Underwriters Laboratories (UL).
- 2.3.1.6        All equipment shall be manufactured and supplied by one company or authorized distributor who shall be responsible for ensuring that all components are totally compatible and shall, when installation is finalized, provide a totally operational system in accordance with the specifications and drawings.

#### **2.3.2            System Description**

- 2.3.2.1        The total flooding system shall consist of a fixed supply of carbon dioxide normally connected to fixed piping network with nozzles arranged to discharge carbon dioxide into the protected panel.

#### **2.3.3            Plans and Approvals**

- 2.3.3.1        Plans and calculations shall be submitted for approval to the Engineer before the work starts. Their preparation shall be entrusted to none but fully experienced and qualified persons.
- 2.3.3.2        The details on the system shall include information's and calculations on the amount of CO<sub>2</sub>, the location and flow rate of each nozzle including equivalent orifice area, the location, size and equivalent lengths of the pipe, fittings and hose, and the location and size of the CO<sub>2</sub> storage facility. Information shall be submitted pertaining to the location and function of the detection devices, operating devices, auxiliary equipment, and electrical circuitry, if used. Sufficient information shall be indicated to identify properly the apparatus and devices used.

#### **2.3.4            CO<sub>2</sub> Storage Cylinders**

- 2.3.4.1        CO<sub>2</sub> cylinders shall be seamless and to be manufactured, tested, approved, equipped, and marked in accordance with the current specification of the American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels.
- 2.3.4.2        Securely mount all containers in an upright position.
- 2.3.4.3        Provide a mechanical method of actuation at the CO<sub>2</sub> cylinder location for emergency operation.
- 2.3.4.4        Each cylinder shall be provided with a safety device to relieve excess pressures safely in advance of the rated cylinder test pressure. Safety discs shall be accordingly fitted.
- 2.3.4.5        The ambient storage temperature of the total Hooding systems, shall not exceed 130° F (54° C) nor be less than 0° F (-18° C), having a natural vapour pressure of 300 psia, unless the system is designed for proper operation with storage temperature outside this range.
- 2.3.4.6        Storage container shall be located as near as possible to the hazard or hazards they protect, but they shall not be exposed to fire or explosion in these hazards.

#### **2.3.5            Releasing Devices**

- 2.3.5.1        CO<sub>2</sub> shall be discharged through the operation of a solenoid operated device which releases the agent through a differential pressure valve. Systems which employ explosive or pyrotechnic devices shall not be permitted.
- 2.3.5.2        CO<sub>2</sub> concentration of deep sealed fire suppression system shall be achieved within seven minutes but the rate shall be not less than that requires to develop a concentration of 30% in two minutes.
- 2.3.5.3        All agent storage containers shall be activated by either:
  - 2.3.5.3.1        Automatic operation.
  - 2.3.5.3.2        Manual Operation.
  - 2.3.5.3.3        Remote manual operation.

#### **2.3.7            Pressure Operated Switch**

- 2.3.7.1        A low pressure switch shall be provided as a positive indication of a CO<sub>2</sub> discharge. Pressure switch to be tied into control system to facilitate shutdown and alarm cycles. Pressure switch shall use system pressure for operation of switch.

#### **2.3.9            System Detection**

- 2.3.9.1        The detection and control system shall employ heat detectors and flame detector. A single detector activated shall cause an alarm signal to be generated. A second detector activated shall generate a pre-discharge signal and start the pre-discharge conditions.

- 2.3.9.1.1 Heat detectors: shall be installed in all areas where required either by the appropriate NFPA standard or the authorizing having jurisdiction.
  - 2.3.9.1.2 Flame Detectors: Radiant energy fire detection that is intended to detect flames and is designed to operate in dark or normally lit environments where sunlight or other ambient lighting is assumed.
  - 2.3.9.2 Location and spacing of detection's shall be the result of an engineering evaluation and to the recommendation of the equipment manufacturers.
  - 2.3.10 Electrical Control Equipment
  - 2.3.10.1 The Control panels to be used for the automatic fire detection and carbon dioxide fire suppression system shall be UL listed and FM approved and shall include the following:
    - 2.3.10.1.1 Class "B" parallel wiring of the detection circuits.
    - 2.3.10.1.2 Battery standby power of sufficient capacity for 24 hours of stand-by operation plus 30 minutes of the Alarm operation.
    - 2.3.10.1.3 Supervised audible visual output circuits.
    - 2.3.10.1.4 Fire Amp. rated auxiliary contacts as required to perform auxiliary functions relays shall an integral part of the system, UL listed as part of the controls.
    - 2.3.10.1.5 "Disable" switch with the corresponding releasing circuits trouble indication.
  - 2.3.11 Tests and Acceptance
  - 2.3.11.1 The final and acceptance shall be conducted in the presence of the Engineer/ Owner's representative and the governing authorities.
  - 2.3.11.2 Tests shall demonstrate that the entire control system functions as intended. All circuits shall be tested, automatic discharges manual discharge, equipment shutdown, alarm devices, and storage container pressure.
  - 2.3.11.3 In addition, supervision of each circuit shall be tested, Each detection device shall be tested according to the manufacturer's recommended procedures of NFPA 72E.
- PART 3 EXECUTION**
- 3.1 Maintenance Schedules**
- 3.1.1 Maintenance schedules shall be provided with each type of extinguishing systems. The schedules shall be in protective covers and shall detail all aspects of maintenance of extinguishing including details of weight checks, pressure test, discharge tests, internal and external visual checks, time periods for checks and action to be taken on finding a fault. The schedules will also contain full details for repairing, recharging and resetting extinguisher contents and re-ordering instructions.
- 3.2 Approved List of Manufacturers**
- 3.2.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

**End of Section**

**SECTION 211200  
FIRE-SUPPRESSION STANDPIPES**

**PART 1            GENERAL**

**RELATED DOCUMENTS**

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

**SUMMARY**

Section Includes:

Pipes, fittings, and specialties.

Fire-protection valves.

Hose connections.

Hose stations.

Monitors.

Alarm devices.

Manual control stations.

Control panels.

Pressure gages.

Related Sections:

Division 21 Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.

**DEFINITIONS**

- A. High-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).
- B. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

**1.02      SYSTEM DESCRIPTIONS**

- 1.03**      Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections ,with landing valve including 2 fire extinguisher dry powder 6kg Has open water-supply valve with pressure maintained and is capable of supplying water demand.

**1.04      PERFORMANCE REQUIREMENTS**

- A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig (1200- kPa) minimum working pressure.
- B. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 250-psig (1725-kPa) minimum working pressure.
- C. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.

1. Minimum residual pressure at each hose-connection outlet is as follows:
  - a. NPS 1-1/2 (DN 40) Hose Connections: 65 psig (450 kPa).
  - b. NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).
2. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:
  - a. NPS 1-1/2 (DN 40) Hose Connections: 100 psig (690 kPa).
  - b. NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).

#### **1.05 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.
  1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### **1.06 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Fire-suppression standpipes, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Domestic waterpiping.
  2. HVAC hydronicpiping.
  3. Drainage/Storm waterpiping.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Fire-hydrant flow test report.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Field quality-control reports.



## **1.07 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

## **1.08 QUALITY ASSURANCE**

### **A. Installer Qualifications:**

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

- a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

### **B. Welding Qualifications:** Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### **C. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **D. NFPA Standards:** Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

## **PART 2 PRODUCTS**

### **2.01 PIPING MATERIALS**

- ### **A.**
- Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

### **2.02 STEEL PIPE AND FITTINGS**

- ### **B.**
- Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type S, Grade B. Pipe ends may be factory or field formed to match joining method.
- ### **C.**
- Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type S; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- ### **D.**
- Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- ### **E.**
- Standard-Weight, Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, seamless steel pipe with threaded ends.
- ### **F.**
- Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- ### **G.**
- Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- ### **H.**
- Malleable- or Ductile-Iron Unions: UL 860.
- ### **I.**
- Cast-Iron Flanges: ASME B16.1, Class 125.
- ### **J.**
- Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- ### **K.**
- Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- ### **L.**
- Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements.
2. Pressure Rating: 175 psig (1200 kPa) or 250 psig (1725 kPa) minimum.
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable- iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. psig (1200 kPa).
5. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa).

M. Ball Valves:

1. Standard: UL 1091 except with ball instead of disc.
2. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
3. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
4. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

N. Bronze Butterfly  
Valves:

1. Standard: UL  
1  
0  
9  
1.
2. Pressure Rating: 175 psig (1200kPa).
3. Body Material: Bronze.
4. End Connections: Threaded.

O. Iron Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig (1200kPa).
3. Body Material: Cast or ductile iron.
4. Style: Lug or wafer.
5. End Connections: Grooved.

P. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

Q. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig (1200kPa).
3. Body Material: Bronze.
4. End Connections: Threaded.

R. Iron OSandY Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

S. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Valves NPS 2 (DN 50) and Smaller:
  - a. Valve Type: Ball or butterfly.
  - b. Body Material: Bronze.
  - c. End Connections: Threaded.
4. Valves NPS 2-1/2 (DN 65) and Larger:
  - a. Valve Type: Butterfly.
  - b. Body Material: Cast or ductile iron.
  - c. End Connections: Flanged, grooved, or wafer.
5. Valve Operation: Integral electrical, 220-V ac, prewired, single-circuit, supervisory switch indicating device.

T. NRS Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Body Material: Cast iron with indicator post flange.
4. Stem: Nonrising.
5. End Connections: Flanged or grooved.

U. Indicator Posts:

1. Standard: UL 789.
2. Type: Horizontal for wall mounting.
3. Body Material: Cast iron with extension rod and locking device.
4. Operation: Hand wheel.

## **2.03 TRIM AND DRAIN VALVES**

### **V. General Requirements:**

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

## **2.04 SPECIALTY VALVES**

### **W. General Requirements:**

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
  - a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
  - b. High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

### **X. Alarm Valves:**

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

### **Y. Pressure-Reducing Valves:**

1. UL 668 hose valve, with integral UL 1468 reducing device.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Material: Brass or bronze.
4. Inlet: Female pipe threads.
5. Outlet: Threaded with or without adapter having male hose threads.
6. Pattern: Angle or gate.
7. Finish: Rough brass or bronze.

### **Z. Automatic (Ball Drip) Drain Valves:**

1. Standard: UL 1726.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).

5. End Connections: Threaded.

## **2.05 HOSE CONNECTIONS**

### **AA. Adjustable-Valve Hose Connections:**

1. Standard: UL 668 hose valve, with integral UL 1468 restricting pressure-control device, for connecting fire hose.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Material: Brass or bronze.
4. Size: NPS 1-1/2 (DN 40), as indicated.
5. Inlet: Female pipe threads.
6. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
7. Pattern: Angle or gate.
8. Pressure-Control Device Type: Pressure restricting.
9. Design Outlet Pressure Setting: 65 psig (450 kPa) for DN 40.
10. Finish: Brass, chrome plated.

## **2.06 ALARM DEVICES**

### **BB. Alarm-device types shall match piping and equipment connections.**

### **CC. Water-Motor-Operated Alarm:**

1. Manufacturers: Subject to compliance with requirements
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch (250-mm) diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: NPS 1 (DN 25) drain connection.

### **DD. Electrically Operated Alarm Bell:**

1. Manufacturers: Subject to compliance with requirements
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 10-inch (250-mm) diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

### **EE. Water-Flow Indicators:**

1. Standard: UL 346.

2. Water-Flow Detector: Electrically supervised.

Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 220-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed

3. Type: Paddle operated.
4. Pressure Rating: 250 psig (1725 kPa).
5. Design Installation: Horizontal or vertical.

FF. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

GG. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

HH. Indicator-Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

## **2.07 MANUAL CONTROL STATIONS**

- II. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## **2.08 PRESSURE GAGES**

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

**3.01 PART 3 EXECUTION**

**3.02 PREPARATION**

- A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

**3.03 EXAMINATION**

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.04 SERVICE-ENTRANCE PIPING**

- A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building.

**3.05 PIPING INSTALLATION**

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.
- C. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install drain valves on standpipes. Extend drain piping to outside of building.
- E. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
- F. Install alarm devices in piping systems.
- G. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
- H. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- I. Drain dry-type standpipe system piping.
- J. Pressurize and check dry-type standpipe system piping and air-pressure maintenance devices.
- K. Fill wet-type standpipe system piping with water.
- L. Connect air compressor to the following piping and wiring:



1. Pressure gages and controls.
2. Electrical power system.
3. Fire-alarm devices, including low-pressure alarm.

### **3.06 JOINT CONSTRUCTION**

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved- end fittings according to AWWA C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved- end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### **3.07 VALVE AND SPECIALTIES INSTALLATION**

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.

### **3.08 HOSE-CONNECTION INSTALLATION**

- A. Install hose connections adjacent to standpipes.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 1-1/2 (DN 40) hose-connection valves with flow-restricting device.
- D. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device.
- E. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets."

### **3.09 HOSE-STATION INSTALLATION**

- A. Install freestanding hose stations for access and minimum passage restriction.
- B. Install NPS 1-1/2 (DN 40) hose-station valves with flow-restricting device unless otherwise indicated.
- C. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
- D. Install freestanding hose stations with support or bracket attached to standpipe.
- E. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets."
- F. Install hose-reel hose stations on wall with bracket.

### **3.10 MONITOR INSTALLATION**

- A. Install monitors on standpipe piping.

### **3.11 IDENTIFICATION**

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### **3.12 FIELD QUALITY CONTROL**

### **3.13 Perform tests and inspections.**

### **3.14 Tests and Inspections:**

- C. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.

F. Energize circuits to electrical equipment and devices.

END OF SECTION

## **SECTION 213113 ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMP**

### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### **1.02 SUMMARY**

- B. Section Includes:
  - 1. Horizontally mounted, multistage, split-case fire pumps.
  - 2. Fire-pump accessories and specialties.
  - 3. Flowmeter systems.

### **1.03 PERFORMANCE REQUIREMENTS**

- C. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- D. Pump Equipment, Accessory, and Specialty Pressure Rating: 185 psig minimum unless higher pressure rating is indicated.
- E. Pump pressure rating to be 1.5 times the fire fighting system operating pressure.
- F. Pumps should be UL/FM listed.

### **1.04 ACTION SUBMITTALS**

- G. Product Data: For each type of product. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- H. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

### **1.05 INFORMATIONAL SUBMITTALS**

- I. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification

is based and their installation requirements.

4. Product Certificates: For each type of fire pump, from manufacturer.
5. Source quality-control reports.
6. Field quality-control reports.

J. CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

**1.06 QUALITY ASSURANCE**

- K. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- L. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."
- M. All Materials and works shall be performed in strict accordance with the stipulations of the authority having jurisdiction.

**1.07 COORDINATION**

- N. Coordinate sizes and locations of concrete bases with actual equipment provided.

**2.01 PART 2 PRODUCTS**

**2.02 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS**

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

**2.03 HORIZONTALLY MOUNTED, MULTISTAGE, SPLIT-CASE FIRE PUMPS**

- D. Pump:
  - 1 Standard: UL 448 , for end-suction split case pumps for fire service.
  - 2 Number of Stages: Two.
  - 3 Casing: Axially split case, , cast iron, with ASME B16.1 pipe-flange connections.
  - 4 Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
  - 5 Wear Rings: Replaceable bronze.
  - 6 Shaft and Sleeve: Steel shaft with bronze sleeves.
    - a. Shaft Bearings: Grease-lubricated, ball bearings in cast-iron housing.
    - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
  - 7 Mounting: Pump and driver shafts are horizontal, with pump and driver on same base

E. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

F. Driver:

1 Standard: UL 1004A

2 Type: Electric motor; NEMA MG 1, polyphase Design B.

## **2.04 FIRE-PUMP ACCESSORIES AND SPECIALTIES**

G. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

H. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

I. Relief Valves:

1 Manufacturers: Subject to compliance with requirements

2 Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water- supply piping.

J. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

K. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

L. Discharge Cone: Closed or open type.

M. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.

N. Header Pipes and Fittings Refer to Division 21 Section 211313 "Wet Pipes Sprinkler Systems".

1. Automatic Drain Valve: UL 1726.

2. Manifold:

a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.

b. Body: Exposed type, brass, with number of outlets required by NFPA 20.

c. Escutcheon Plate: Brass or bronze; round.

d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.

e. Exposed Parts Finish: Polished or Rough or brass or , chrome plated .

f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

## **2.05 FLOWMETER SYSTEMS**

O. Description: UL-listed or FM-Approved, fire-pump flowmeter system able to indicate flow to not less than 175 percent of fire-pump rated capacity.

P. Pressure Rating: 185 psig (1275 kPa) minimum

Q. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.

- R. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
  - 1. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper or plastic tubing with copper or brass fittings and valves.
- S. Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

## **2.06 GROUT**

- T. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- U. Characteristics: Nonshrink and recommended for interior and exterior applications.
- V. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
- W. Packaging: Premixed and factory packaged.

## **2.07 SOURCE QUALITY CONTROL**

- X. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
  - 1. Verification of Performance: Rate fire pumps according to UL 448.
- Y. Fire pumps will be considered defective if they do not pass tests and inspections.
- Z. Prepare test and inspection reports.

## **3.01 PART 3 EXECUTION**

### **3.02 EXAMINATION**

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of firepumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.03 INSTALLATION**

- D. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- E. Equipment Mounting:

Install fire pumps on concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03

  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment
- F. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
  - G. Support piping and pumps separately, so weight of piping does not rest on pumps.
  - H. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211200 "Fire-Suppression Standpipes." Section 211313 "Wet-Pipe Sprinkler Systems."
  - I. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Section 211200 "Fire-Suppression Standpipes." Section 211313 "Wet-Pipe Sprinkler Systems."

#### **3.04 ALIGNMENT**

- A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

#### **3.05 CONNECTIONS**

- E. Comply with requirements for piping and valves specified in Division 21 Section 211200 "Fire- Suppression Standpipes." and Section 211313 "Wet-Pipe Sprinkler Systems.". Drawings indicate general arrangement of piping, fittings, and specialties.
- F. Install piping adjacent to pumps and equipment to allow service and maintenance.
- G. Connect relief-valve discharge to drainage piping or point of discharge.
- H. Connect flowmeter-system meters, sensors, and valves to tubing.
- I. Connect fire pumps to their controllers.

#### **3.06 FIELD QUALITY CONTROL**

Test each fire pump with its controller as a unit. Comply with requirements for electric-motor driver fire-pump controllers specified in Division 21 Section 213900 "Controllers for Fire-Pump Drivers."

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

#### **3.07 Perform tests and inspections.**



Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assisting testing.

### **3.08 Tests and Inspections:**

After installing components, assemblies, and equipment including controller, test for compliance with requirements.

Test according to NFPA 20 for acceptance and performance testing.

Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

Prepare test and inspection reports.

Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

#### **STARTUP SERVICE**

Engage a factory-authorized service representative to perform startup service.

Complete installation and startup checks according to manufacturer's written instructions.

#### **DEMONSTRATION**

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps

END OF SECTION

## **SECTION 213116 DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS**

### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### **1.02 SUMMARY**

- B. Section Includes:
  - 1. End-suction, horizontally mounted ,multistage, split-case fire pumps with diesel-engine drive.
  - 2. Fire-pump accessories and specialties.
  - 3. Flowmeter systems.

### **1.03 PERFORMANCE REQUIREMENTS**

- C. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to UBC 1997, Zone 2A.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- D. Pump Equipment, Accessory, and Specialty Pressure Rating: 250 psig (1725 kPa) minimum unless higher pressure rating is indicated.
- E. Pump pressure rating to be 1.5 times the fire fighting system operating pressure

### **1.04 ACTION SUBMITTALS**

- F. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire pump.
  - 2. Include rated capacities, operating characteristics, certified performance test curves, electrical characteristics, and furnished specialties and accessories.
- G. Shop Drawings: For fire pump.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

### **1.05 INFORMATIONAL SUBMITTALS**

- H. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of fire pump.
  - C. Source quality-control reports.
  - D. Field quality-control reports.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fire pumps to include in emergency, operation, and maintenance manuals.

#### **1.07 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

#### **1.08 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### **PART 2 PRODUCTS**

#### **2.01 PERFORMANCE REQUIREMENTS**

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement.
- C. Finish: Red paint applied to factory-assembled and -tested certificate unit before shipping.

#### **2.02 HORIZONTALLY MOUNTED, MULTISTAGE, SPLIT CASE FIRE PUMPS:**

- A. Pump:
  1. Standard: UL 448 for split-case pumps for fire service.
  2. Number Stages: Two.
  3. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
  4. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
  5. Wear Rings: Replaceable bronze.
  6. Shaft and Sleeve: Alloy-steel shaft with bronze sleeve.
    - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
    - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
  7. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

- l. Driver:
  - 1. Standard: UL 1247.
  - 2. Type: Diesel engine
  - 3. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
  - 4. Controls:
    - a. Adjustable governor.
    - b. Over-speed shutdown.
    - c. Manual reset, speed switch.
    - d. Instrument panel with tachometer, oil pressure gage, water temperature gage, and hour meter.
  - 5. Engine Cooling System: Factory-installed water piping, valves, strai pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
    - a. Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
  - 6. Engine-Jacket Water Heater: Factory-installed electric elements.
  - 7. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.
  - 8. Fuel System: Comply with NFPA 20.
    - a. Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.
  - 9. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
    - a. Exhaust Connector: Flexible type.
    - b. Exhaust Silencer: Industrial type.

## **2.03 FIRE-PUMP ACCESSORIES AND SPECIALTIES**

- A. Pipe sizes for pump test header, relief valves, and discharge cones as well as number and size of manifold hose valves are set by NFPA 20, so are not required in this article.
- B. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
- C. Circulation Relief Valves: UL 1478, bronze or cast iron, spring loaded; for installation in pump- discharge piping.
- D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
- E. Outlet Fitting: Concentric tapered reducer at pump-discharge outlet.
- F. Discharge Cone: Closed or open type.

G. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.

Header Pipe: ASTM A53/A53M, Schedule 40 galvanized steel, with ends threaded according to ASME B1.20.1.

2. Header Pipe Fittings: ASME B16.4 galvanized cast-iron threaded fittings.
3. Automatic Drain Valve: Complying with UL 1726.
4. Manifold:
  - a. Test Connections: Comply with UL 405, except provide outlets without clappers instead of inlets.
  - b. Body: Exposed type, brass or ductile iron, with number of outlets required by NFPA 20.
  - c. Escutcheon Plate: Brass or bronze; rectangular.
  - d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
  - e. Exposed Parts Finish: Polished brass
  - f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

## **2.04 FLOW METER SYSTEMS**

- H. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
- I. Pressure Rating: 250 psig (1725 kPa) .
- J. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
- K. Permanently Mounted Flowmeter: Compatible with flow sensor, with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
1. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper tubing with copper or brass fittings and valves.
- L. Portable Flowmeter: Compatible with flow sensor, with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

## **2.05 FUEL OIL STORAGE**

- M. Day Tank: UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float- controlled transfer pump and the following features:
1. Containment: Integral rupture basin, with a capacity of 150 percent of nominal capacity of day tank.
    - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
  2. Tank Capacity: As recommended by engine manufacturer
  3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-

mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.

4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
  5. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
- N. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
1. Tank level indicator.
  2. Capacity: Fuel for eight hours' continuous operation at 100 percent rated power output.
  3. Vandal-resistant fill cap.
  4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

## **2.06 Vortex Inhibitors**

- O. Vortex inhibitor for pump suction pipes or approved equal.

## **2.07 GROUT**

- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic- cement grout.
- C. Characteristics: Nonshrink and recommended for interior and exterior applications.
- D. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
- E. Packaging: Premixed and factory packaged.

## **2.08 SOURCE QUALITY CONTROL**

- P. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
1. Verification of Performance: Rate fire pumps according to UL 448.
- Q. Fire pumps will be considered defective if they do not pass tests and inspections.
- R. Prepare test and inspection reports.

## **3.01 PART 3 EXECUTION**

### **3.02 EXAMINATION**

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.03 INSTALLATION**

- D. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of

fire pumps, relief valves, and related components.

E. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03
2. Attach pumps to equipment base using anchor bolts.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

F. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

Support piping and pumps separately, so weight of piping does not rest on pumps.

- S. Install valves that are same size as connecting piping. Comply with requirements for fire- protection valves specified in Section 211200 "Fire-Suppression Standpipes." Section 211313 "Wet-Pipe Sprinkler Systems."
- T. Install pressure gages on fire-pump suction and discharge flange pressure-gageappings. Comply with requirements for pressure gages specified in Section 211200 "Fire-Suppression Standpipes." Section 211313 "Wet-Pipe Sprinkler Systems."
- U. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- V. Install fuel system according to NFPA 20.
- W. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.
- X. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.
- Y. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.
- G. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers that are not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### **3.04 ALIGNMENT**

- J. Align end-suction and split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- K. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place.

Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

- L. Align piping connections.
- M. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

### **3.05 CONNECTIONS**

- N. Comply with requirements for piping and valves specified in Section 211200 "Fire-Suppression Standpipes." Section 211313 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
- O. Install piping adjacent to pumps and equipment to allow service and maintenance.
- P. Connect relief-valve discharge to drainage piping or point of discharge.
- Q. Connect flowmeter-system meters, sensors, and valves to tubing.
- R. Connect fire pumps to their controllers.

### **3.06 IDENTIFICATION**

- S. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

### **3.07 FIELD QUALITY CONTROL**

- T. Test each fire pump with its controller as a unit. Comply with requirements for diesel-engine- driver fire-pump controllers specified in Division 21 Section 213900 "Controllers for Fire-Pump Drivers."
- U. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- V. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- W. Tests and Inspections:
  - 1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
  - 2. Test according to NFPA 20 for acceptance and performance testing.
  - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- X. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.



- Y. Prepare test and inspection reports.
- Z. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

**3.08     STARTUP SERVICE**

- AA. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

**3.09     DEMONSTRATION**

- BB. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain firepumps.

END OF SECTION

## **SECTION 22 05 23**

### **GENERAL DUTY VALVES FOR PLUMBING**

#### **PART 1 GENERAL**

- 1.1 General Requirements
- 1.2 Related Works Specified Elsewhere
- 1.3 Valves Pressure Rating
- 1.4 Quality Assurance and Control

#### **PART 2 PRODUCTS**

- 2.1 Gate Valves
- 2.2 Globe Valves
- 2.3 Check Valves (Spring Loaded Type)
- 2.4 Float Valves
- 2.5 Automatic Air Vents
- 2.6 Backflow Preventers
- 2.7 Pipe Expansion Joints
- 2.8 Ball Valves
- 2.9 Ball Valve with Coupling (Renal Dialysis)
- 2.10 Butterfly Valves

#### **4.4.1.1 2.11 Balancing Valves**

- 2.12 Water Pressure Reducing Valves
- 2.13 Temperature and Pressure Relief Valve
- 2.14 Strainers
- 2.15 Flexible Connectors

#### **4.4.1.2 2.16 Double Regulating Valves**

- 2.17 Accessories (Free Fall Device)
- 2.18 Thermostatic Mixing Valve

#### **PART 3 EXECUTION**

- 3.1 Installation of Valves
- 3.2 Approved List of Manufacturers

#### **PART 1 GENERAL**

##### **1.1 General Requirements**

- 1.1.1 Valves shall be installed only in vertical or horizontal positions unless otherwise required by the Drawings.
- 1.1.2 All valves shall be installed in accessible locations to facilitate easy removal for maintenance.
- 1.1.3 Valves shall be full-line size.
- 1.1.4 Valves 2 1/2" (65mm) dia. and smaller shall have threaded ends, valves 3" (75) dia. and larger shall have flanged ends.
- 1.1.5 All threaded end valves shall be installed with unions to facilitate the removal of the valve from the pipeline.
- 1.1.6 Gate valves shall be installed on both sides of every piece of equipment for all pipe-system connections, and where shown on the Drawings.

##### **1.3 Valves Pressure Rating**

- 1.3.1 Unless specified otherwise all valves, strainers, flexible connections, etc. shall be selected for pressure rating at least 1.5 times the operating pressure.
- 1.3.2 Contractor shall submit a schedule of all valves, strainers, etc., showing the required pressure rating for each fitting and shall indicate its location and service.

##### **1.4 Quality Assurance and Control**

- 1.4.1 All valves shall be kite marked to the applicable B.S. standard.
- 1.4.2 All valves shall be full line size.
- 1.4.3 All valves in steam lines shall be suitable for steam application.

#### **PART 2 PRODUCTS**

##### **2.1 Gate Valves**

- 2.1.1 Gate valves shall be all bronze with, non rising stem, flanged ends, bolted bonnet and bronze wedge disc faces and seats.
- 2.1.2 One gate valve shall be supplied and installed:

- a- At the supply and return from each equipment.
  - b- At the discharge and suction of each pump.
  - c- In general at all points shown on the Drawings and/or specified.
- 2.1.3 Copper alloy gate valves shall conform to BS 5154.
- 2.2 Globe Valves**
- 2.2.1 Globe valves shall be all bronze with, flanged ends rising stem, bolted bonnet, renewable composite disc and seat.
- 2.2.2 Copper alloy globe valves shall conform to BS 5154.
- 2.3 Check Valves (Spring Loaded Type)**
- 2.3.1 Check valves shall be of the non-slam spring loaded, globe type with the capability to absorb and dampen the shock wave from the piping system water hammer. Check valves 2" (50 mm) and smaller, shall be all bronze, screwed ends. Valves 2½" (65 mm) and larger, shall be cast iron, flanged ends.
- 2.3.2 One check valve shall be installed:
- a- At the discharge of each pump.
  - b- At all points shown on the Drawings and/or where specified.
- 2.3.3 Copper alloy check valves shall conform to BS 5154.
- 2.4 Float Valves**
- 2.4.1 Float valves 2" (50 mm) and smaller shall be all bronze, screwed ends, float operated. Valves 2 ½" (65 mm) and larger shall be cast iron body, flanged ends, float operated. Float shall be all copper and mounted at the end of a brass or copper rod, which actuates valve operation.
- 2.4.2 Copper floats shall conform to BS 1968.
- 2.5 Automatic Air Vents**
- 2.5.1 Supply and install all automatic air vents as shown on the Drawings and wherever specified in this book of specifications.
- 2.5.2 Automatic air vents of the spherical float type shall be installed at all high points in the piping. Vents shall have cast iron housing and bolted cover with gasket. Float shall be constructed of stainless steel. Vents shall be suitable for a maximum operating pressure of 150 psi (1030 Kpa). A ½" (15 mm) lock shield valve shall be directly installed ahead of each automatic air vent, and a ½" (15 mm) drain line shall be provided to discharge at a convenient point.
- 2.6 Backflow Preventers**
- 2.6.1 This type of valve shall be used on domestic water systems, wherever applicable.
- 2.6.2 Valve shall combine the double check valve protection effect together with an air gap venting to the atmosphere, working on the reduced pressure principle.
- 2.6.3 Valve shall be suitable for 125 psi (860 Kpa ) steam and 200 psi (1380 Kpa).
- 2.7 Pipe Expansion Joints**
- 2.7.1 Expansion joints shall be provided wherever pipes cross structural expansion joints and wherever required to prevent undue stresses caused by thermal expansion of the pipes.
- 2.7.2 Expansion joints shall be of the packless-bellow type with flanged or welded ends as suitable for the pipe application.
- 2.7.3 Bellows shall be of stainless steel and suitable for a pressure of 125 psi (860 Kpa) or the design working pressure, whichever is greater. Expansion joints shall be provided with guides to prevent any unnecessary misalignment of the pipe. Guides and anchor arrangements shall be per the recommendations of the expansion joints manufacturers.
- 2.8 Ball Valves**
- 2.8.1 Valves shall be cast red bronze, ASTM B584 Alloy 845 ball type for systems other than LPG, with threaded ends, Teflon stem packing seals, Teflon seats, "T" handle for 25 mm and smaller, insulated operating lever for 30mm and larger, and blowout proof silicone bronze stem. Valves shall be rated at 2,750 Kpa water working pressure.
- 2.9 Ball Valve with Coupling (For Renal Dialysis)**
- 2.9.1 Valves shall be of PVC, with union ends and EDPM seal. Each valve shall include a self sealing quick connection coupling made of polyamide plastic with viton seal and additional safety lock. The coupling shall be made threaded to DIN ISO228 and hose tail pipe of 9 mm diameter.
- 2.10 Butterfly Valves**
- 2.10.1 Valves shall be designed for a minimum of 700 kPa differential pressure with the down stream flanged removed through 300 mm size. Factory test date on differential pressure rating is required. Valves shall have cast iron body, conforming to ASTM A126 Class B body, aluminium bronze disc, in accordance with ASTM B148 alloy 954, and EPDM rubber seals. Valves 65 mm

through 150 mm shall be provided with lever. Valves 200 mm and larger shall be driven by a worm gear operator or screw driven operator with position indicator. Operators shall be fully enclosed in cast iron housing, watertight, and require no more than 150N rim pull. Operators shall be designed to withstand, without damage an input torque of 1.3 KN. Valves shall be rated for 1,000 kPA water working pressure.

- 2.10.2 Electric motor operated valve shall be provided with a motor reducer combination with an operating speed to suit the changeover operation. The operation shall have a high torque motor specifically designed for valve control service, limit switches, torque switches, local position indicators and provision for manual operation in case of power failure. Should power failure occur, valve disc position should be changed by positioning the clutch lever and using the handwheel. Electric operation should override manual. The housing shall be completely weather-proof.
- 2.10.3 The CV of the valve shall not be less than 1980 when 90 degree open.

#### **4.4.1.3 2.11 Balancing Valves**

- 2.11.1 Supply and install balancing valves of double regulating effect with provision for connecting a portable differential pressure meter. Each meter connection shall have pressure temperature read out ports. Valves shall be of the Y-pattern style design which can be installed in any direction without affecting flow measurements.
- 2.11.2 All valves up to 2" (50 mm) shall be of copper alloy. Valves of 2 ½" (65 mm) and above shall have cast iron body with all other metal parts of nonferrous copper alloy.
- 2.11.3 Each valve shall provide precise flow measurement, precision flow balancing and positive shut-off with no drip seat and teflon disc.
- 2.11.4 Each valve shall have multi-adjustment turns of hand wheel for maximum setting with hidden memory feature to program the valve with precision tamper proof balancing setting. Number of turns shall be 4 for valve up to 2" (50 mm), 8 between 2 ½" (65 mm) and 6" (150 mm), 12 for 8" (200 mm) and 10" (250 mm) and 16 for 12" (300 mm).
- 2.11.5 All valves up to 2" (50 mm) shall be supplied with polyurethane container.
- 2.11.6 One set of computerized balancing instrument shall be supplied with the valves. The instruments shall be a read out meter, programmed with the valve curves and with conversion formula for Cv to read the flow in gpm directly. The instrument shall also be provided with temperature measurement probe.
- 2.11.7 A chucking device shall hold the valve disconnect firmly and a built-in flat seal shall give it maximum tightness.
- 2.11.8 The valves shall be globe style design and all metal parts of non-ferrous pressure die-cast, non porous metal: copper alloy.
- 2.11.9 The valve shall be suitable for installing in any direction without affecting flow measurement and shall provide four functions:
- Precise flow measurement.
  - Precision flow balancing
  - Positive shut off with no drip seat and teflon disc.
  - Drain connection with protective cap.
- 2.11.10 The valve shall have four 360 deg. adjustment turns of the handwheel for maximum vernier type setting with hidden memory feature to program the valve with precision tamper-proof balancing setting.

#### **2.12 Water Pressure Reducing Valves**

- 2.12.1 Supply and install wherever shown on the Drawings and as specified here-in-after water pressure reducing valves of the direct operated type.
- 2.12.2 Each valve shall be constructed of cast iron body, with stainless steel spring and shaft and nylon diaphragm.
- 2.12.3 The spring shall be designed to provide the pressure reduction indicated on the Drawings.
- 2.12.4 The valve shall be designed for a work pressure of 1720 KPa and shall be threaded or flanged ended as the pipe connecting to it.
- 2.12.5 The valve shall be of the self contained type without any control lines with all internal parts being accessible by removing spring chamber and without dismantling the valve itself.
- 2.12.6 The valve shall be designed to operate smoothly and quietly without chattering or any water hammer problems.

**2.13 Temperature and Pressure Relief Valve**

2.13.1 This valve shall be used on domestic hot water lines wherever applicable.

2.13.2 Temperature and pressure relief valve shall be self-closing type with test lever and screwed connections.

2.13.3 Valve shall be suitable for a pressure of 75 to 150 psi (520 to 1030 Kpa ) service and shall be supplied with temperature relief set at 210 deg.F (100 Deg.C).

2.13.4 Valve shall be AGA and ASME rated.

**2.14 Strainers**

2.14.1 Water strainer shall be supplied and installed at the suction connection of all pumps, and ahead of all automatic flow control valves.

2.14.2 Strainers 2 1/2" (65mm) and smaller shall be Y-pattern type with bronze body, screwed cover, brass basket and screwed ends.

2.14.3 Strainers 3" (75 mm) and larger shall be of cast iron body, brass basket and flanged ends.

2.14.4 Basket shall have 1/32" (0.8 mm.) perforations for water service.

**2.15 Flexible Connectors**

2.15.1 Flexible Connectors shall be easy flexing, long cyclic life connectors, to protect mechanical equipment by relieving piping stresses, caused by piping misalignment, sagging pipe hangers, and thermal expansion.

**4.4.1.4 2.16 Double Regulating Valves**

2.16.1 Supply and install wherever shown on the drawing and wherever specified double regulating valves.

2.16.2 Valves 2 1/2" (65 mm) and below shall be of the screwed in bonnet type of bronze construction. Stem should be rising type of brass construction. Seat shall be brass with regulating disk. Valve shall be complete with double regulating device and BS 21 taper threads (ISO R7).

2.16.3 Valves 3" (75 mm) and larger shall be of cast steel of the outside screw type. Stem shall be rising type of stainless steel. Disk up to 4" (100 mm) diameter shall be stainless and above shall be of 13% Cr. Steel. Gland shall be of stainless steel. Bonnet gasket shall be of CAF according to BS 2815 Gr A. Valve shall be complete with regulating disk, double regulating device and indicator. The valve shall be flanged to BS 4504 table 4/1.

2.16.4 Temperature and pressure ratings shall be in accordance with BS 5160.

**2.17 Accessories (Free Fall Device)**

2.17.1 The valve shall be weight-operated with mercury switch devices opens on fusible link failure and shuts off the fuel oil supply pumps and the equipment is feeded by fuel oil such as boilers, incinerators, generators, etc., and so arranged that the weight falls freely, doing no work during the first part of its travel. By the time the weight is called upon to move the valve, it has accumulated sufficient momentum to overcome the inertia of the valve plug. Where pipe run is at low level special linkage should be supplied to raise lower position of dead weight to pipe centre line.

2.17.2 Required length of easy to fit non-corrosive, carefully selected stranded stainless steel cable to hold the valve open or closed as required.

2.17.3 Three brass screw hooks with brass pulleys which automatically align themselves to suit the run of the cable. Two of these shall be woodscrew thread, and one 6mm (—) B.S.P. thread for fitting to metal surfaces.

2.17.4 Copper tube cable connectors. Where the cable has to be cut and a loop formed, these connectors shall be quick and effective.

2.17.5 One fusible link specially made to break when the temperature reaches a pre-determined point. Normally the link should made to operate at 71oC (160oF) as B.S.S. 799 Part 5 1975, but other temperature should be catered for when required.

2.17.6 One heavy brass wood-screw threaded eye to secure the far end of the cable to the wall or ceiling.

2.17.7 One engraved warning notice to hang on the cable to prevent people walking into it.

**2.18 Thermostatic Mixing Valve**

2.18.1 Valve shall be nickel or chrome plated bronze /brass construction, Teflon coated valve body wear surface, Teflon coated brass shuttle, EPDM O-Rings, with multiple connection alternatives either sweat union, NPT (Female) union on NPT (Female) connection compression fitting.

2.18.2 Valves shall be for domestic hot water, proportional design (simultaneous control of hot and cold water ports), straight through design (hot and cold ports at same level).

2.18.3 The design shall permit easy access for maintenance with replaceable thermostatic element.

- 2.18.4 Valves shall be capable to supply constant mixed water temperature under different working conditions, it shall have a temperature indicator for accurate control and quick set-up.
- 2.18.5 Valves shall be ASSE 1070 and ASSE 1017 certified and CSA approved.
- 2.18.6 Valves shall have the following ratings:

Temperature range	21° C - 49° C
Maximum hot water inlet temperature	100° C
Maximum pressure rating	125 PSI
Maximum Flow	10 GPM
Minimum Flow	0.5 GPM
Maximum allowable and water temperature to avoid scalding	49° C

### **PART 3 EXECUTION**

#### **3.1 Installation of Valves**

- 3.1.1 Valves shall be installed only in vertical or horizontal positions unless otherwise required by the Drawings.
- 3.1.2 All valves shall be installed in accessible locations to facilitate easy removal for maintenance.
- 3.1.3 Valves shall be full-line size.
- 3.1.4 Valves 2" (50 mm) dia. and smaller shall have threaded ends, valves 2 ½" (65 mm) dia. and larger shall have flanged ends.
- 3.1.5 All threaded end valves shall be installed with unions to facilitate the removal of the valve from the pipeline.
- 3.1.6 Gate valves shall be installed on both sides of every piece of equipment for all pipe-system connections, and where shown on the Drawings.

#### **3.2 Approved List of Manufacturers**

- 3.2.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

**End of Section.**

## **SECTION 22 11 16**

### **DOMESTIC WATER PIPING AND FITTINGS**

#### **PART 1 GENERAL**

- 1.1 Introduction
- 1.2 Related Works Specified Elsewhere
- 1.3 Storage of UPVC Pipes
- 1.4 Pipe Identification
- 1.5 Arrangement and Alignment
- 1.6 Storage
- 1.7 Codes and Standards

#### **PART 2 PRODUCTS**

- 2.1 UPVC Pipes - Type 2
- 2.2 Cross Linked Polyethylene Pipes (XLPE)
- 2.3 Copper Pipes-Type 1
- 2.4 Copper Pipes-Type 2
- 2.5 Black Steel Pipes (BSP)
- 2.6 Galvanized Steel Pipes (GSP)
- 2.7 Polythene (Polyethylene) Pipes (PEP)
- 2.8 Pre-Insulated Piping System for Water Supply Application (GSP Pre-insulated)
- 2.9 Polypropylene Pipes (PP-R)
- 2.10 High Density Polyethylene Pipes (HDPE)
- 2.11 Multi-Layer Pipes (ML)
- 2.12 Flanged Pipe Joints
- 2.13 Joints between Dissimilar Materials
- 2.14 Joints Between Dissimilar Metals (Dielectric isolators)
- 2.15 Fire Stop Collar
- 2.16 Piping Schedule
- 2.17 Hose Bibs
- 2.18 Vacuum Breaker
- 2.19 Shock Arrestor (Water Hammer)
- 2.20 Water Meter
- 2.21 Water Pressure Reducing Valves
- 2.22 Pipe Expansion Joints

#### **PART 3 EXECUTION**

- 3.1 Arrangement and Alignment of Pipes
- 3.2 Special Requirement for PVC Pipe Installation
- 3.3 General Requirements for Piping Installation
- 3.4 Connection to Equipment and Control Valves

### **4.4.1.5 3.5 Hangers, Supports, Anchors And Guides - General**

- 3.6 Pipe Sleeves
- 3.7 Cleaning of Piping Systems
- 3.8 Pipework Clearances and Segregation
- 3.9 Material Tests and Identification
- 3.10 Testing
- 3.11 Installation of Unions and Flanges
- 3.12 Approved List of Manufacturers

#### **PART 1 GENERAL**

##### **1.1 Introduction**

1.1.1 Works of this Section shall be governed by Conditions of Contract and Section 22 05 00.

1.1.2 This section describes basic materials and requirements for Pipework services installations for building.

##### **1.3 Storage of UPVC Pipes**

1.3.1 PVC pipe and fittings shall be stored under cover at all times. Sun light shall not be permitted to come into contact with the PVC materials at any time, except during installation in trench. The pipes shall be stored on flat level ground free from large or sharp edged stones or objects, and shall be stacked to a maximum height of 1.5 m. (or as recommended by the manufacturer) with sockets at alternate ends, and in such a manner as to prevent sagging or bending.

##### **1.4 Pipe Identification**

- 1.4.1 All pipes shall be indelibly marked at intervals of not greater than 3m. The marking shall show the manufacturer's identification, the standard name and number, and the nominal size and class. Adhesive labels alone shall not suffice. All pipes complying with British Standards shall be kitemarked.
- 1.5 Arrangement and Alignment**
- 1.5.1 Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls wherever possible.
- 1.5.2 Install pipe groups for plumbing parallel with pipes of other trades.
- 1.5.3 Space pipe supports, arrange reducers and Pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points. However, where obstructions exist, automatic air vents shall be installed at all air pocket points and 1/2" (15 mm) drain gate valves shall be supplied and installed at all low points and riser legs.
- 1.6 Storage**
- 1.6.1 PVC pipe and fittings shall be stored under cover at all times. Sun light shall not be permitted to come into contact with the PVC materials at any time, except during installation in trench. The pipes shall be stored on flat level ground free from large or sharp edged stones or objects, and shall be stacked to a maximum height of 1.5 m. (or as recommended by the manufacturer) with sockets at alternate ends, and in such a manner as to prevent sagging or bending.
- 1.7 Codes and Standards**
- 1.7.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations

<u>Reference Code</u>	<u>Abbreviation</u>	<u>Applicable Standard</u>	<u>Title of Standard</u>
American Water Works Association	AWWA	C601-68 C501-67 M45	FIBERGLASS PIPE DESIGN MANUAL
American Society for Testing and Materials	ASTM	ASTM C425	Specification for compression joint for vitrified clay pipe and fittings.
		ASTM A53-88a	Specification for pipe, steel, black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
		ASTM B88	Specification for seamless copper water pipe.
		ASTM B280-88	Specification for seamless copper tube for A/C and refrigeration field service.
		ASTM A307	Specification for Carbon Steel Bolts and Studs. 60,000psi tensile strength
		ASTM D1785	Specification for poly (vinyl chloride) (PVC) plastic pipe, schedules 40, 80, and 120.
		ASTM D3517M	Specification for "Fiberglass" (Glass – Fiber-Reinforced Thermosetting – Resin) Pressure Pipe.



American Standard Association	ASA	ASA 40.1	
		ASA B16.22	
		ASA B1618	
		ASA B9.1	
		ASA B35.5	
British Standards	BS	BS 4514	Specification for unplasticized PVC soil and venting pipes, fittings and accessories.
		BS 5255	Specification for thermoplastics waste pipe and fittings.
		BS 5254	Specification for polypropylene waste pipe and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm.)
		BS 3505	Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water.
		BS 4346 Part 1	Joints and fittings for use with unplasticized PVC pressure pipes. Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.
		BS 4346 Part 2	Mechanic joints and fittings, principally of unplasticized PVC.
		BS 4660	Specification for unplasticized polyvinyl chloride (PVC-U) pipes and plastics fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage.
		BS 5480	Specification for Glass Reinforced Plastic (GRP) Pipes, Joints and Fittings for use of Water Supply or Sewerage.
		BS 5481	Specification for unplasticized PVC pipe and fittings for gravity sewers.
		BS 1387	Specification for screwed and socketed steel tubes and tubulars and for plain and steel tube suitable for welding or for screwing to BS21 pipe threads.
		BS 2871	Specification for copper and copper alloys, tubes.
		BS 864 Part 2	Specification for capillary and compression fittings for copper tubes.
		BS 3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure pipes.

		BS 21	Specification for pipe threads for tubes and fittings where pressure tight joints are made on the threads.
American Society for Heating, Refrigeration and Air Conditioning Engineers	ASHRAE	-	-
Deutsches Institute for Normung	DIN	DIN 19534	-
American National Standards Institute	ANSI	ANSI B18.2.2 ANSI B31.1 ANSI A21,10,11	-

## **PART 2 PRODUCTS**

### **2.1 UPVC Pipes - Type 2**

2.1.1 UPVC pipes-Type 2 (Un-plasticized Polyvinyl Chloride) pipes shall be to BS 3505 latest edition Class E 15 Bar (1500 Kpa) working pressure at 68° F (20° C) fluid temperature and 103° F (40° C) ambient temperature or ASTM specification D 1785 Schedule 40 for inside the buildings, and as per ASTM specification D1785 schedule 80 for the risers.

2.1.2 The pipe shall be homogenous throughout and free from visible cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

2.1.3 All fittings and accessories shall be of same material and quality as the pipe and jointing up to 2 ½" diameter shall be of the spigot and socket cemented type where solvent cement is applied to both parts all in compliance with B.S. 4346: Part I: 1969 joints and fittings for use with un-plasticized PVC pressure pipes, Part I : Injection moulded PVC PVC fittings for solvent welding for use with pressure pipes. After pushing the pipe into the socket, the joint shall be allowed to set for at least 10 hr.

2.1.4 Jointing for all pipes buried underground outside buildings and for all pipes above 3" diameter shall be of the rubber ring integral socket type to BS 4346 Part 2.

2.1.5 Expansion joints with guides as recommended by manufacturer shall be installed on long run solvent cemented pipes every 30 meters of length, and wherever shown in the specification.

2.1.6 Bending PVC pipes is only allowed in non-critical application at room temperature and after the approval of the Engineer.

2.1.7 Before bending, the pipe should be heated at the section to be bent to a temperature of about 275-300° F (135-150° C).

2.1.8 The bore should be supported by packing with sand or by insertion of thick rubber pipe, the heating being carried out in a hot air oven or by immersion in hot oil or glycerine. Overheating should be avoided, and the pipe should not be held at the bending temperature too long.

### **2.2 Cross Linked Polyethylene Pipes (XLPE)**

2.2.1 XLPE piping system shall be basically consist of the following components:

2.2.1.1 Cross linked polyethylene pipe pulled in coloured (red for hot water blue for cold water application) corrugated conduits of polyethylene material.

2.2.1.2 Ring main line fittings and valves of bronze or DZR brass construction.

#### **2.2.2 Pipes**

2.2.2.1 The inner pipe shall be made of cross linked polyethylene which can withstand upto 95 degree C fluid temperature inside it at a maximum pressure of 10 bars. Pipes shall be able to withstand short time temperature loading upto 110 degree C at a maximum pressure of 10 bars.

2.2.2.2 All pipes shall be stamped at equal intervals with clear marks showing clearly the name of the manufacturer along with the pressure and temperature ratings, pipe diameter and wall thickness, pipe standard DIN 16892/93 and the country of origin of manufacturer.

2.2.2.3 All pipes shall be laid so that they can be easily replaced, whenever necessary by fast and easy pulling from the conduits.

- 2.2.2.4 Pipes shall satisfy the requirement for drinking water installation and approved by a recognized health organization DVGW or equivalent whenever specifically intended for potable application.
- 2.2.3 Conduits
- 2.2.3.1 The conduits shall be made of temperature stabilized high density polyethylene and shall be capable of retaining its form up to 105 degree C. Conduits shall have different colour for different application.
- 2.2.4 Fittings and Accessories
- 2.2.4.1 One single line XLPE pipe in one single conduit will supply water to one fixture only from a main ring above false ceiling.
- 2.2.4.2 Ring feed line shall have an isolating valve of bronze construction. Each pipe at its termination above false ceiling shall be labeled with a tag indicating the fixture it is supplying.
- 2.2.4.3 Pipes to be connected to the different fittings via a special wall box of reinforced plastic fitted with bronze or DZR brass elbow suitable for ½" or ¾" threaded connection as required. The box should be suitably designed in order to enable the replacement of existing pipes in the event of their damage (puncturing).
- 2.2.4.4 All valves, wall box, elbows, tees, bends should be of bronze or DZR brass connections to be of a cone grip unions type allowing full flow capacity, minimum pressure loss, easily detachable with torque clearly defined for a fool proof installation.
- 2.2.4.5 Contractor to use proper tools for assembly as recommended by manufacturer, i.e. assembly pliers, Ratchet torque wrench, cutters, etc.
- 2.2.4.6 Distribution ring shall be located above the false ceiling as indicated on the drawings.

#### **4.4.1.6 2.3 Copper Pipes-Type 1**

- 2.3.1 Copper pipes shall be of the seamless hard drawn tubing type.
- 2.3.2 All copper tubes shall be marked with the manufacturer's name or trade mark and tube type, at intervals not to exceed 500mm. All brass, bronze, copper, or copper alloy fittings shall be marked in accordance with the applicable ANSI Standard and must be indelibly marked with the manufacturer's name or trade mark.
- 2.3.3 Joints in copper tubing used in water distribution systems, installed under a concrete slab resting on the ground shall be avoided.
- 2.3.4 Type L shall be used within the building and type K for underground installation.
- 2.3.5 Copper pipes and fittings shall be to ASTM B 88, Seamless Copper Water Tube, and shall be of the solder joint type.
- 2.3.6 Soldered joint fittings shall be cast brass or bronze and shall be made in accordance to ASA B 16.22 and ASA B 16.18.
- 2.3.7 Soldered joint fittings for water supply applications subjected to maximum water temperature of 150° F (65° C) shall be made with 50-50 tin-lead solder and those applications up to 250° F (121° C) water temperature shall be made with 95-5 tin-antimony solder. For continuous operation at temperatures exceeding 250° F (121° C) brazing filler metals shall be used. The working pressure in the piping network in addition to the maximum water temperature shall be checked and complied within each of the above jointing methods Surfaces to be soldered shall be cleaned bright. The joints shall be given a thin coating of approved soldering flux and the tubing end inserted into the fitting as far as possible.
- 2.3.8 Heating and finishing of the joint shall be done in accordance with the recommendations of the manufacturer of the fittings.

#### **2.4 Copper Pipes-Type 2**

- 2.4.1 Copper pipes shall be to BS 2871 Part 1 table X or table Y Copper Water Tube or to EN 1057-R250.
- 2.4.2 Table X tubes shall be used within the building and Table Y tubes for underground installation.
- 2.4.3 Copper pipes shall be suitable for compression fitting application.
- 2.4.4 Fittings shall be to BS 864 Part 2 - type A brass.
- 2.4.5 All copper tubes shall be marked with the manufacturer's name or trade mark and tube type, at intervals not to exceed 500mm.
- 2.4.6 All fittings shall be marked in accordance with the applicable standard and must be marked with the manufacturer's name or trade mark.

#### **2.5 Black Steel Pipes (BSP)**

- 2.5.1 BSP shall be black mild steel, seamless type to BS 1387 medium weight for sizes up to 6"(150mm) diameter and to BS 3601 for sizes above 6"(150mm) diameter or to ASTM A-53 GR.B Sch. 40, and all pipe fittings shall be black forged steel of the same quality and weight as the pipes.

- 2.5.2 All joints shall be welded by an approved welding process, each joint being of sufficient strength to withstand the stresses imposed by internal pressure, thermal expansion and weight of tube, fittings and thermal insulation.
- 2.5.3 All welded tees, branches, vent pipes, reducers, etc. shall have leveled joints, and finished off with a circumferential butt joint weld.
- 2.5.1 Welding of pipe work may be by either oxy-acetylene or electric process.
- 2.5.4 Pipes fittings shall be suitable for welded connections. Butt weld fittings shall be to ANSI B 16-9 and BS 1640 made of seamless carbon steel to ASTM A324 B grade WPB.
- 2.5.5 Threaded fittings shall be to BS 21 (ISO 7) made of Malleable Iron to BS and ISO 49.
- 2.6 Galvanized Steel Pipes (GSP)**
- 2.6.1 Galvanized steel pipes shall be of the welded galvanized steel pipes to B.S. 1387 "medium weight" or ASTM A 53-88a Sch. 40. All pipe fittings elbows, tees, crosses, unions, reducers, etc. shall be of the same quality and weight as the pipes.
- 2.6.2 Pipe fittings 2" (50 mm) and smaller shall be suitable for threaded connections, 2 ½" (65 mm) and larger shall be flanged/grooved fittings.

#### **4.4.1.7 2.7 Polythene (Polyethylene) Pipes (PEP)**

- 2.7.1 Polythene pipes shall be to B.S. 6730 for above-ground use and BS 6572 for under-ground use class C [130 psi (90 N/cm<sup>2</sup>) (896 Kpa) maximum sustained working pressure].
- 2.7.2 PEP 1" (25 mm) to 3" (80 mm) nominal size may be threaded using taper pipe threads conforming to BS21.
- 2.7.3 PEP shall be flexible and manufactured for use with compression fittings.
- 2.7.4 PEP shall be clearly marked showing manufacturer's trade mark, nominal size, type, material and pressure rating.
- 2.7.5 Compression fittings shall comply with B.S. 864 Part 3 type (A) specially made for jointing of PEP.
- 2.7.6 Compression fitting shall consist of gunmetal body for receiving the pipe, copper compression ring, brass compression nut and copper liner or insert.
- 2.7.7 The fittings shall be free from internal fins or other irregularities. Union nuts shall be either hexagonal or octagonal.

#### **4.4.1.8 2.8 Pre-Insulated Piping System for Water Supply Application (GSP Pre-insulated)**

- 2.8.1 Materials: All pipe shall be factory pre-insulated.
- 2.8.2 Carrying pipe: galvanized steel pipe as specified elsewhere in this section.
- 2.8.3 Insulation: Factory pressure injected Polyurethane foam insulation with density of 35-40 Kg/m<sup>3</sup> and a minimum thickness of 30 mm having a thermal conductivity of 0.023 W/m deg C at 10 deg. C mean temperature.
- 2.8.4 Outer casing : uPVC pressure pipe to BS 3503: 1968.
- 2.8.5 Fittings/Joining : The pre-insulated pipe manufacturer is to supply the contractor with all elbows, tees and other fittings as required in uPVC matching the outer casings for site jointing and also an appropriate quantity of liquid Polyurethane chemical system suitable for pouring after site jointing of the outer casing.
- 2.8.6 Expansion : Contractor shall submit necessary calculations for pipe expansion which shall be designed to be absorbed by bends.
- 2.8.7 Backfilling : Underground pipes not located in concrete trenches shall be carefully backfilled and hand tamped in 150 mm layers until a cover of at least 600 mm from the top of the pipe has been achieved. Backfill shall be sand or fine gravel less than 12 mm diameter and shall be free of rocks or foreign material. Pipes located in roads shall be protected by precast concrete slab over the bedding.

#### **4.4.1.9 2.9 Polypropylene Pipes (PP-R)**

- 2.9.1 Polypropylene Copolymer Random (PP-R) pipes shall be manufactured according to DIN 8077/8078, fittings shall be manufactured according to DIN 16962.
- 2.9.2 Pipes and fittings shall be jointed using electro-fusion welding process. Welding shall be made as recommended by the manufacturer. Threaded fittings shall be used to connect to other piping systems, fixtures, etc., fitting with metal insert shall be sealed with Teflon tape.

- 2.9.3 PP-R piping system shall be installed with special pre-caution for thermal expansion especially for exposed installation
- 2.9.4 Thermal expansion shall be compensated by use of proper elbows, fittings, as recommended by the manufacturer.
- 2.9.5 PP-R pipes shall not be installed or stored under direct UV light. Pipes in shafts and roof shall be of multi-layer PP-R aluminium consisting of main pipe PP-R coated with aluminium foil and covered with PP-R film treated to resist long time exposure to UV light. Pipes on roof shall be insulated and cladded.
- 2.9.6 Pipe bending shall be generally avoided, in extreme cases pipes may be bent by heating with hot air without direct flames. The minimum bending radius shall be 8 times the pipe diameter.
- 2.9.7 PP-R pipes and fittings shall be certified for potable water use by a recognized European Standard, DVGW or approved equivalent.
- 2.9.8 Pressure rating of pipes and fittings shall be PN 25. Pipes shall be suitable for working pressure of 10 bars at a working temperature of 60 degree C.

#### **4.4.1.10      2.10 High Density Polythylene Pipes (HDPE)**

- 2.10.1 HDPE pipes shall be made from polyethylene (PE) as per ISO 4427:1996 (E) Standard.
- 2.10.2 HDPE pipes shall be manufactured from polyethylene type PE 100 resin, it shall contain only those antioxidants, UV stabilisers and pigments necessary for the manufacture of pipes confirming to ISO 4427 specifications.
- 2.10.3 The pipes for drinking water shall be either black, blue or black with blue stripes.
- 2.10.4 Pressure rating for HDPE pipes shall be SDR 11 (pn 16), nominal outside diameter and the wall thickness shall conform to ISO 161-1:1996.
- 2.10.5 Fittings shall be electrofusion type for pipe upto 4" (100 mm) dia. and butt fusion for pipes above 4" (100 mm) dia.

#### **4.4.1.11      2.11 Multi-Layer Pipes (ML)**

- 2.11.1 **Pipes**
- 2.11.1 Multi-layer pipes shall compose of 3 layers:
  - 2.11.1.1 Outer pipe in heavy duty or cross-linked polyethylene.
  - 2.11.1.2 Intermediate pipe in Aluminium, homogenous longitudinally welded.
  - 2.11.1.3 Inner pipe in cross-linked polyethylene suitable for potable water use.
  - 2.11.1.2 The Aluminium pipe shall be permanently connected to inner and outer Polyethylene pipes by using special adhesive layers to ensure dimensional and compression stability. Pipe shall be UV-protected, corrosion resistant, chemical resistant, sound absorbent with low thermal expansion.
  - 2.11.1.3 Pipes shall satisfy the requirements for drinking water installation and shall be approved by a recognized health organization, DVGW or approved equivalent. Pipes shall be stamped at equal intervals with clear marks showing manufacturer's name, pressure / temperature rating, pipe internal diameter, wall thickness, country of origin, date of manufacture and applicable standard.
    - Technical Specifications:
    - Surface Roughness (internal Pipe) Max: 0.4 µm
    - Thermal Expansion Max: 0.026 m/(m.°K)
    - Thermal Conductivity Max: 0.043 w/(m.°K)
    - Operating Temperature Range: 0 °C to 95 °C
    - Operating Pressure: 10 Bars
- 2.11.2 **Fittings**
- 2.11.2.1 Fittings shall be press-type and screw type compression fittings made of heat-treated nickel plated brass or gunmetal. The fitting shall have a compression sleeve which is fitted onto the pipe and then compressed onto it, O-rings shall be provided to ensure hydraulic seal.
- 2.11.3 **Installation**
- 2.11.3.1 Installation shall be done as per manufacturer's recommendation using proper tools provided by the manufacturer, pipe shall be stored and handled as recommended.
- 2.11.3.2 Expansion shall be avoided by using expansion loops where necessary. Pipe maybe installed in walls, floors, above false ceiling, inside shafts. However direct exposure to sun shall not be allowed unless pipes are adequately protected and UV-stabilized.

## **2.12 Flanged Pipe Joints**

- 2.12.1 All flanged joints shall be made up with compressed ring type asbestos gaskets. Gaskets shall be 1.5 mm. thick.
- 2.12.2 Bolts for flanges shall be of low carbon steel with hexagonal heads and hard pressed steel hexagon nuts. Bolts shall be to ASTM specifications A 307 or SAE grade 2, with tensile strength of 64000 psi (441.3 Mpa) minimum.
- 2.12.3 All bolt holes shall be spot faced.

## **4.4.1.12 2.13 Joints between Dissimilar Materials**

### **2.13.1 Screwed Pipe to Cast Iron Pipe**

- 2.13.2 Joints between wrought-iron, steel, brass or copper pipe and cast iron pipe shall be made with cast iron spigots screwed to the steel pipe and caulked to the cast iron pipe.

### **2.13.3 Copper Tubing to Screwed Pipe Joints**

- 2.13.4 Joints shall be made by the use of brass converter fittings. The joint between the copper pipe and the fitting shall be properly soldered, and the connection between the threaded pipe and the fitting shall be made with a standard pipe size screw joint.

## **2.14 Joints Between Dissimilar Metals (Dielectric isolators)**

- 2.14.1 Make joints between ferrous and non-ferrous screwed piping and equipment by using Teflon or nylon isolating materials in the form of screwed unions.
- 2.14.2 Make joints between ferrous and non-ferrous flanged piping and equipment with insulating gaskets and "Teflon sleeves and washers between flanges, bolts and nuts.
- 2.14.3 The entire insulating joint including the dielectric material shall be suitable to withstand the temperature, pressure and other operating characteristics for the service for which they are used.

## **2.15 Fire Stop Collar**

- 2.15.1 Supply and install factory manufactured fire stop collar for all the plastic pipes penetrating fire rated walls and floors. The Collar should be of heavy gauge galvanized metal to house the intumescent insert. The intumescent shall provide a minimum of 15 times the free expansion and shall contain no water soluble expansion ingredients and approved to be used in combination with the smoke sealant from the same manufacturer. The collar should be UL classified and FM systems approved to the requirements of ASTM E814 (UL 1479).
- 2.15.2 The fire sealant should be of non hardening compound, non water soluble ingredients, capable of expanding a minimum of 5 times when subjected to 230 degree F to 100° F. The sealant should be UL classified and FM system approved to the requirements of ASTM E814 (UL 1479).

## **2.16 Piping Schedule**

### **2.16.1 General**

- 2.16.1.1 Piping classes are specified for each service in the following schedule. The designations indicated refer to detailed specifications for piping in this section of the specifications:

### 2.16.2 Piping Classes

[illegible]

- 2.17 Hose Bibs**  
2.17.1 Hose bibs shall be finished ¾" (20 mm) chrome plated brass, compression type with chrome plated handle and standard ¾" (20 mm) male hose connection or otherwise indicated on the Drawings.
- 2.18 Vacuum Breaker**  
2.18.1 Where indicated or otherwise required, vacuum breakers shall be installed and set at least 100 mm above the floor level of equipment or fixture rims to prevent contamination of water supply.
- 2.19 Shock Arrestor (Water Hammer)**  
2.19.1 Shock arrestor shall be mechanical pneumatic type, stainless steel construction with hermetically sealed bellows and threaded connection.  
2.19.2 Arrestors shall be located adjacent to all quick closing valves, solenoid valves, where required and as indicated on Drawings.  
2.19.3 Proper sizes shall be determined by the individual application.
- 2.20 Water Meter**  
2.21.1 Water meters, all bronze construction type, shall be supplied and installed by the Contractor. The water meter shall be a disk positive displacement type and shall be furnished with a straight reading dial and shall have a rated maximum delivery of not less than twice the flowing GPM (l/s).
- 2.21 Water Pressure Reducing Valves**  
2.21.1 Each valve shall be constructed of bronze body, with stainless steel spring and shaft and nylon diaphragm.  
2.21.2 The spring shall be designed to provide the pressure reduction indicated on the Drawings.  
2.21.3 The valve shall be designed for a work pressure of 250 psi and shall be threaded or flanged ended as the pipe connecting to it.  
2.21.4 The valve shall be of the self contained type without any control lines with all internal parts being accessible by removing spring chamber and without dismantling the valve itself.  
2.21.5 The valve shall be designed to operate smoothly and quietly without chattering or any water hammer problems.
- 2.22 Pipe Expansion Joints**  
2.22.1 Supply and install expansion joints wherever pipes cross structural expansion joints, wherever required to prevent undue stresses caused by thermal expansion of the pipes and wherever expansion cannot be accommodated by natural offsets and changes of direction.  
2.22.2 Expansion joints shall be of the packless-bellow type with flanged or welded ends as suitable for the pipe application.  
2.22.3 Bellows shall be of stainless steel and suitable for a pressure of 125 psi (860 Kpa) or the design working pressure, whichever is greater. Expansion joints shall be provided with guides to prevent any unnecessary misalignment of the pipe. Guides and anchor arrangements shall be per the recommendations of the expansion joints manufacturers and as shown on the drawings.



## **5 Proposed Timeline and Safety Plan**

### **5.1 Construction Timeline and Phases**

The below proposed timeline is indicative and considered for guidance only and The Tenderer shall carefully review it and submit his recommendation according to his vision and capabilities of the execution of the works. The timeline shall also include the following milestones:

- Concept Design;
- Detailed Design;
- Bill of Quantities;
- Workshop Drawings;
- As-Built Drawings.

The contractor shall also take into his consideration the following milestones in his proposed/recommended timeline:

- Any Authorities/Governmental Approvals may deemed required;
- Supervisor Approval;
- Project Closeout Report.

Building Name	Activity	Duration (Months)	Timeline (By Month)											
			1	2	3	4	5	6	7	8	9	10	11	12
			Phase 01			Phase 02				Phase 03				
Site Plan	Site delivery & mobilization	1												
	Site plan works	3												
	<b>Total duration</b>	<b>4</b>												
Main Building (1)	Steel roof maintenance	2												
	Internal finishes	3												
	External finishes	3												
	<b>Total duration</b>	<b>5</b>												
Workshops Building (2)	Exists steel roof removal	3												
	install new steel roof	3												
	Internal finishes	3												
	External finishes	2												
	<b>Total duration</b>	<b>5</b>												
Classrooms Building (3)	Internal finishes	2												
	External finishes	2												
	<b>Total duration</b>	<b>3</b>												
New Building (4)	Remove exist parking shade	1												
	Design discussion & approval	1												
	License & governmental approvals	1												
	building construction & finishes	3												
	Public utility delivery	1												
	<b>Total duration</b>	<b>6</b>												

Closingout & Final delivery

## 5.2 Proposed Safety Plan of Each Phase

The red shaded areas shall be unsafe while the construction of each phase, hence, the school administration shall take all necessary actions for their students to be safe away from any construction area.

### **Phase 01**

#### **Site Plan:**

Site delivery & mobilization

#### **Building (3):**

Internal finishes

External finishes

#### **New Building (5):**

Remove exist parking shade

Design discussion & approval

License & governmental approvals

**Note: The areas shaded in red is unsafe for building users at this working phase.**



## **Phase 02**

### **Main Building (1):**

Steel roof maintenance  
Internal finishes  
External finishes

### **Workshops Building (2):**

Exists steel roof removal  
install new steel roof  
Internal finishes  
External finishes

**Note: The areas shaded in red is unsafe for building users at this working phase.**



### **Phase 03**

#### **Site Plan:**

Site plan upgrade to meet handicap requirements

#### **New Building (5):**

building construction & finishes

Public utility delivery

**Note: The areas shaded in red is unsafe for building users at this working phase.**



## 6 Sketches and figures

### 6.1 List of sketches and figures

- Fig (01) – Site Plan
- Fig (02) – Classroom Building
- Fig (03) – Workshops Building
- Fig (04) – Upper floor of Workshops Building
- Fig (05) – Laboratory Building
- Fig (06) – Classroom Building, demolition and removal of the existing floor and install matt porcelain flooring
- Fig (07) – Classroom Building, removal of the existing floor tiles and install ceramic flooring
- Fig (08) – Classroom Building, demolition and removal of the existing wall tiles and install ceramic tiles for walls
- Fig (09) – Classroom Building, demolition and removal of the existing gypsum board and tiles
- Fig (10) – Classroom Building, demolition and removal of the existing aluminum windows
- Fig (11) – Classroom Building, demolition and removal of the existing wooden doors
- Fig (12) – Classroom Building, removal of the existing aluminum partitions
- Fig (13) – Classroom Building, removal of the existing WCs toilets, sink and urinal
- Fig (14) – Classroom Building, steel handrail for the exterior upstairs
- Fig (15) – Workshops Building, demolition and removal of the existing floor tiles
- Fig (16) – Workshops Building, slab on grade
- Fig (17) – Workshops Building, removal of the existing floor tiles
- Fig (18) – Workshops Building, demolition and removal of the existing wall tiles
- Fig (19) – Workshops Building, removal of the existing WCs toilets, sink and urinals
- Fig (20) – Workshops Building, false ceiling gypsum tiles
- Fig (21) – Upper floor of Workshops Building, false ceiling gypsum tiles
- Fig (22) – Workshops Building, demolition and removal of the existing metal and aluminum windows
- Fig (23) – Workshops Building, electrostatic coated hinged metal door
- Fig (24) – Upper floor of Workshops Building, removal of the existing brick wall
- Fig (25) – Upper floor of Workshops Building, removal of the existing aluminum partitions
- Fig (26) – Workshops Building, steel handrail for the exterior upstairs
- Fig (27) – Laboratory Building, removal of the existing floor tiles
- Fig (28) – Laboratory Building, demolition and removal of the existing floor tiles
- Fig (29) – Laboratory Building, demolition and removal of the existing wall tiles
- Fig (30) – Laboratory Building, demolition and removal of the existing metal and aluminum windows
- Fig (31) – Laboratory Building, internal signage made of coloured aluminum composed panels
- Fig (32) – Laboratory Building, demolition and removal of the existing floor tiles
- Fig (33) – Laboratory Building, demolition and removal of the existing moisture/heat isolation layer
- Fig (34) – Laboratory Building, demolition and removal of the existing aluminum partitions
- Fig (35) – Laboratory Building, demolition and removal of the existing WCs toilets, sinks and urinals