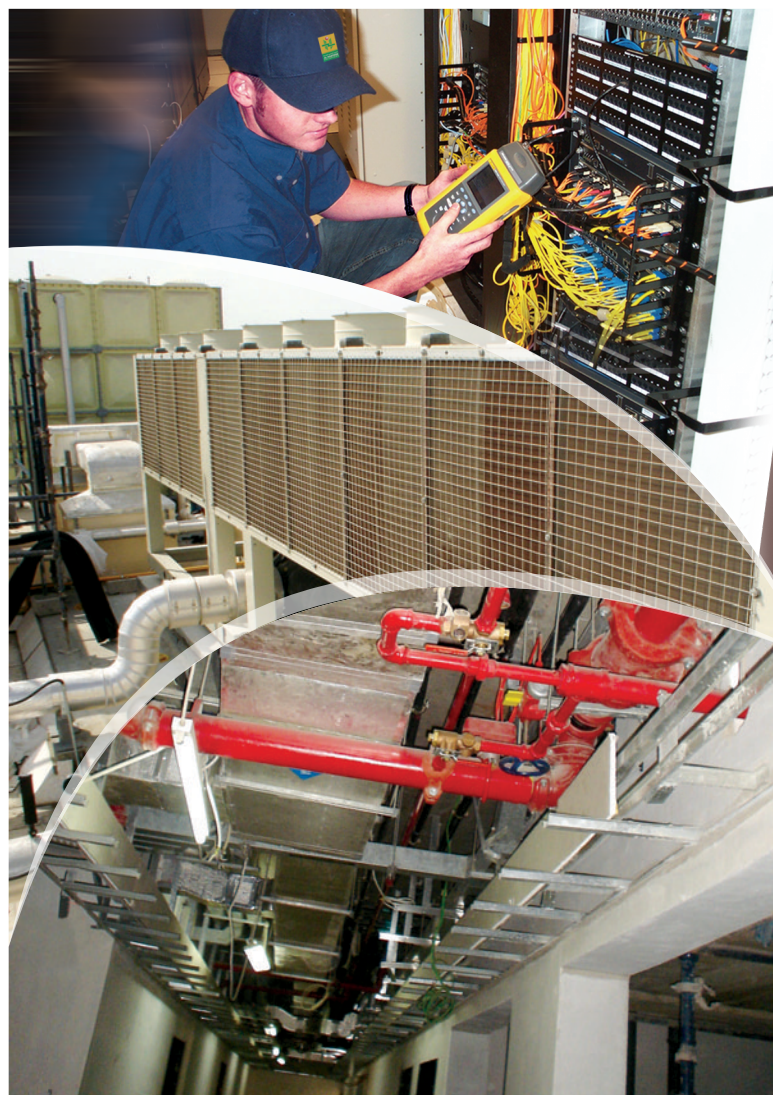


# Building Services Planning **Manual**



*A guide to Project Planning &  
Equipment Insatallation related to Building Services*

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*A guide to Project Planning &  
Equipment Installation related to Building Services*

By

Al Habtoor Engineering Planning Department

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## Message from Chairman

There has been a paradigm shift in our progress since we began operations way back in 1970. Our development began through humble infrastructure projects and concentration on ancillary ventures to support our core business. Our determination to excel combined with an innovative approach, commitment to quality and an ambition to surpass in whatever we undertake, is the key to our success.

Skills base is critical to the successful development of a company, as a result we have capitalized on the use of construction professionals from various countries. Geographical boundaries have never been an impediment in the search for experts in management, construction, trades or administration. The company is run by a multi-disciplinary team of professionals with a proven track record, the company continues to provide its clients with a single point of responsibility, accountability, coordination and communication.

However at this juncture we need to keep in mind that development is a more complex process than growth. We have gained valuable experience over 38 years of operation. It is important to measure the development and growth of the industry as a whole. As our corporate social responsibility we therefore wish to share our expertise with the construction world. In this regard we take lead and initiative in publishing the first manual related to Building Services. This manual is the result of the hard work and efforts of the Planning Department of the company. The company organized a brainstorming seminar wherein prominent members of the industry participated. Some of the notable participants included Dubai Municipality, Sama Dubai, Etisalat and the American University of Sharjah.

We hope this book serves as a valuable input to all readers and hope we get many more opportunities to serve the industry and the country at large.

### **Riad T. Sadik**

Chairman

Al Habtoor Engineering Enterprises Co. L.L.C.



## Foreword Team Leader

Al Habtoor Engineering Enterprises (HEE) is one of the leading construction and engineering companies in the Middle East. It ranks first in the field of building construction proposing construction services as a final product from engineering solutions to construction works and construction projects' management.

The construction boom in the UAE is increasing by the day. It has catapulted the demand for complementary activities like mechanical, electrical, plumbing (MEP) and building services. Each structure built requires fundamentals from each of these three areas. In the process of meeting the demands of a highly competitive market, Al Habtoor Engineering, in coordination with the UAE Authorities, Clients and Contracting Companies aims to deliver a consolidated document that will make the MEP Sector a valued entity in each and every project that is executed in the region.

In construction industry, planning is the cornerstone of any project strategy and thus is an important element of the project life cycle. The Planning Department at HEE, a highly experienced group, well conversant with Project Management Systems, monitors the projects from start to finish. Each stage is closely analyzed and researched. On behalf of Al Habtoor Engineering Enterprises, the Department presents the 'First Edition' of Building Services Planning Manual. It provides comprehensive guidance in the initial preparation, subsequent review, monitoring and controlling of programs for building services activities within a construction project. This book also provides guidance for the preparation, implementation, monitoring and controlling of the MEP-Civil integrated Programme of Works for building construction. This manual is part of the department's 'Continuous Improvement & Development Program' for the company. It is the first of the series to be published later on as an extended research work is in progress.

### **Jafar M. Khair**

Head of Planning Department

Al Habtoor Engineering Enterprises Co. L.L.C.



## Message from MEP Team Leader

Dear Readers

In my observation, from what I have seen in all these years of experience, Building Services are not given the required importance in the initial stages of planning. At times, we come across Construction programmes which have only three or four activities for Building Services, viz. First Fix, Second Fix, Final Fix. This leads to difficulty in monitoring and controlling the various Building Service activities. As a result, most of the projects are delayed because of the delay in material delivery, installation, testing & commissioning of major Building Service Activities. So, the proper planning of Building services is critical to the success of the project.

I have referred to many Project Planning and Management books, but I couldn't find a single document which covers all the aspects of Building Services from planning point of view. There are many books which talk about planning of Civil works and other works of the project, but none covers detailed planning of building services. Thus there was a pressing need for some standard manual which provides guidelines for planning of building services. This is how the concept of Building Service Manual was developed. In this manual, I have tried to integrate my knowledge of building services planning to develop a Guide for Planning/Program managers.

The development of this manual was a part of the "Planning Department - Continuous Improvement and Development Programme introduced in February 2006. I would like to extend my special thanks to my colleagues for their support in the development of this manual. I would like to thanks to MEP contractors Emirates Trading Agency & Al Habtoor Specon for their valuable support. Also, I would like to extend my thanks to all the esteemed Professionals and organizations for their feedback to the draft copy of the manual released during the MEP planning workshop on 22 May 2007. It was because of your review and feedback, that the manual has taken its current shape. I hope this manual fulfills its purpose and proves to be of significance to the Building Services and Construction Industry.

### **Gulshan Kumar**

Planning Engineer (Building Services)  
Al Habtoor Engineering Enterprises Co. LLC  
Dubai, United Arab Emirates



# Preface

## First Edition

Planning is a fundamental and a challenging activity in the management of construction project. A good construction plan forms the basis for developing the budget and schedule of work required. Planning involves the choice of technology, definition of work tasks, the estimation of required resources & durations for individual tasks and the identification of interactions among the different work tasks.

In the modern day construction projects, Building services forms an important part of the overall project. It is very important to properly integrate the planning of Building services together with other works and blend them together with other activities. This is even more important, considering the fact that, Building services and MEP related works account to almost 30 % of the overall project. Therefore, for the success of the project, it is imperative that the Building Services be planned well and properly integrated with the other works.

In the modern day fast track jobs, it's very important to prepare the detailed and realistic programme to achieve the project completion date. We have experienced in our practical life that most of the projects are delayed because of delay in material delivery, installation, testing & commissioning of major MEP activities. So, the proper planning of Building services is critical to the successful Project Planning and Project Management as a whole.

This was one of the main reasons, behind the development of this manual. The manual is intended to act as a guide for the Planning & Controlling of building Services in a typical building project. It has been prepared to highlight activities related to building services for a typical building project. In this edition, the main focus is to identify the various important building service disciplines and sequence of activities required to be undertaken in order to render the various services to successful operation.

This manual shall be reviewed periodically for further enhancement.

Any suggestion for the improvement of the manual will be thankfully acknowledged and incorporate in the next edition.



# Introduction

The Building Services Planning Manual provides guidance in initial preparation, subsequent review, monitoring and controlling of programme for Building Services activities within a construction project. The manual describes the detailed processes involved in various Building Service disciplines. It gives the information of detailed Activity Breakdown for various Building Service disciplines, also their interrelation and interactions with other works. It is designed to act as a guideline to Planning and Program managers intending to develop an integrated programme incorporating the various Building Service disciplines with other works.

The target audience for this manual includes planning engineers/ managers, program managers, project managers, team members, building service engineers, MEP Engineers/ Managers/ coordinators, consultants, other contract personnel and others who participate or have an interest in any aspect of the management of building services within a project.

The Building Services Planning Manual is organized as follows:

**Section 1** provides the Activity Breakdown structure for various Building Service processes. An activity is a discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the building construction project. This section also provides a Activity coding system for easy identification and organization to be used for activities in various Building Service disciplines. This will act as a basic guideline for planning and program managers intending to develop an integrated programme of building services together with other building works.

**Section 2** provides the Activity Flow Diagram for various building services which include among others Engineering Activities, Mechanical (HVAC) system, Electrical System, Plumbing System, Fire Fighting System, etc. The flow diagram highlights the sequence of building service activities in a typical building project. This section also includes complete Work Breakdown Structure for Building Services for a typical Building project.

**Section 3** provides the Graphical Interface of Building Service activities with other activities for various Building Service disciplines. This gives an idea of Building Service activities linked with other civil activities, their relationship and their sequence in detail. It will assist planning and program managers to develop integrated construction programme in the initial stage for easy monitoring and control of the project.

**Section 4** describes the interface of Building Service activities together with other activities in a tabular form. This section provides the detailed information of the relationship of Building Service activities with other activities by giving the predecessor, successor, lag to be used with other activities in a typical building project. Hence, it will prove very useful in preparing the integrated construction programme with Civil and Building Service activities.



**Section 5** gives information about the Activity production rate for various Building service activities. It gives information about the manpower requirement for each activity and the time required to complete that activity.

**Section 6** indicates a detailed list of important materials for various Building Service disciplines together with approximate time for technical submission/ approval, procurement, Fabrication/ delivery. The delivery period indicated, takes into consideration the Lead time for procurement of the Long Lead Items. It is very important that procurement of all the required materials/ equipments be completed in time for the construction activities to be completed as planned. This shall act as a useful guide for planning and program managers to plan the procurement and delivery of materials/ equipments for various Building Service disciplines needed for timely completion.

**Section 7** gives basic information about the various Building Service equipments commonly used. It provides essential information of the equipment, its functions, and the suitability of use at various places together with an illustrative photograph (wherever applicable). This will help people in the field of Building Services Planning and management to know the various equipments used in various disciplines of building Services.

**Section 8** describes in detail the Installation procedure for Mechanical (HVAC) systems in a typical building project. It provides detailed step-wise installation guide for the various complex processes involved in the complete Mechanical (HVAC) system right through to the completion and testing of the system. It shall act as a reference guide for various processes involved in the Mechanical (HVAC) system and the complete system as a whole.

**Section 9** provides the Installation guide for Electrical systems in a typical building project. It provides detailed step-wise installation procedure for the various complex processes/ equipments involved in the Electrical system right through to the completion and testing of the system.

**Section 10** describes in detail the procedure for installation of plumbing system for a typical building project. It provides detailed step-wise installation procedure for the various processes/ equipments involved in the Plumbing System right through to the completion and testing of the system.

**Section 11** provides the detailed Installation guide for Fire Fighting system for a typical building project. It provides the detailed installation procedure for various Fire fighting components/ equipments and the Fire fighting system as a whole.

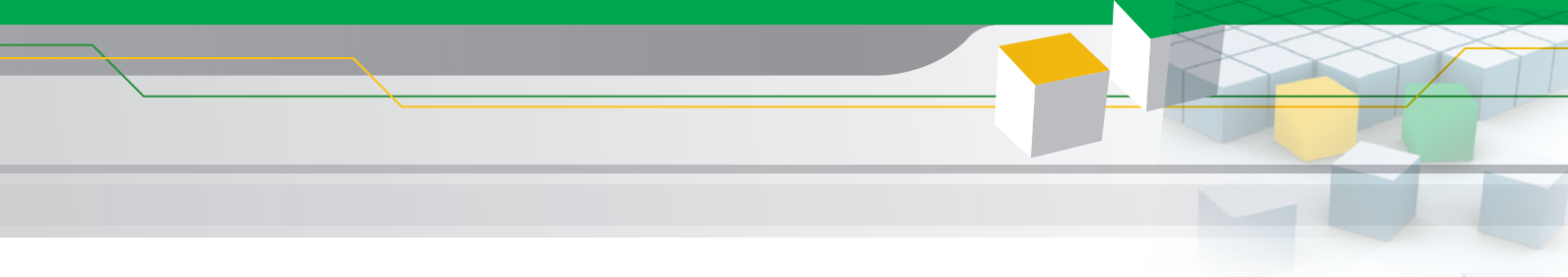
**Section 12** provides the detailed guide of electrical system and electrical equipments.



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# 1

## Activity List

Any construction project is a unique, one-of-a-kind undertaking aimed at achieving specific time, cost and quality goals and objective. Each project is made up of a number of individual activities that must be accomplished in order to achieve these goals and objectives. The first step in the construction planning and scheduling process is to identify the activities that must be completed in order to complete the entire project.

An activity is a discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the building construction project.

Activities are the fundamental work elements of a project. They are the lowest level of a work breakdown structure (WBS) and, as such, are the smallest subdivision of a project that directly concerns the module.

The description assigned to activities in a schedule is very important if the schedule is to be used as an effective communication tool. Activity description must be concise and unambiguous, and must communicate in shorthand the scope and location of the portion of the project work that the activity encompassed. An activity description must mean the same thing to everyone using the schedule to plan and manage the project. Activity description must be consistent in format. A lot of information must be communicated in a short activity description. An example of Activity description is:-

### **FL2: high level chilled water pipe installation**

FL2 indicate the location of chilled water pipe installation  
High level indicate the place where chilled water pipe to be installed  
Chilled water pipe indicate the system of work

The above example of activity description shows the scope, location and system of the work.

This section contains information regarding list of all building utilities activities involves in any type of building, towers or villas.

Activities for planning and scheduling of a building construction (building utility) project can be categorized as follows:-

- 1 Engineering
- 2 Construction
- 3 Testing & Commissioning

All construction activities are basically distributed into three types of installation groups:

- 1 First Fix Activities
- 2 Second Fix Activities
- 3 Third Fix Activities

These names are based on the installation sequences.

### First Fix Activities

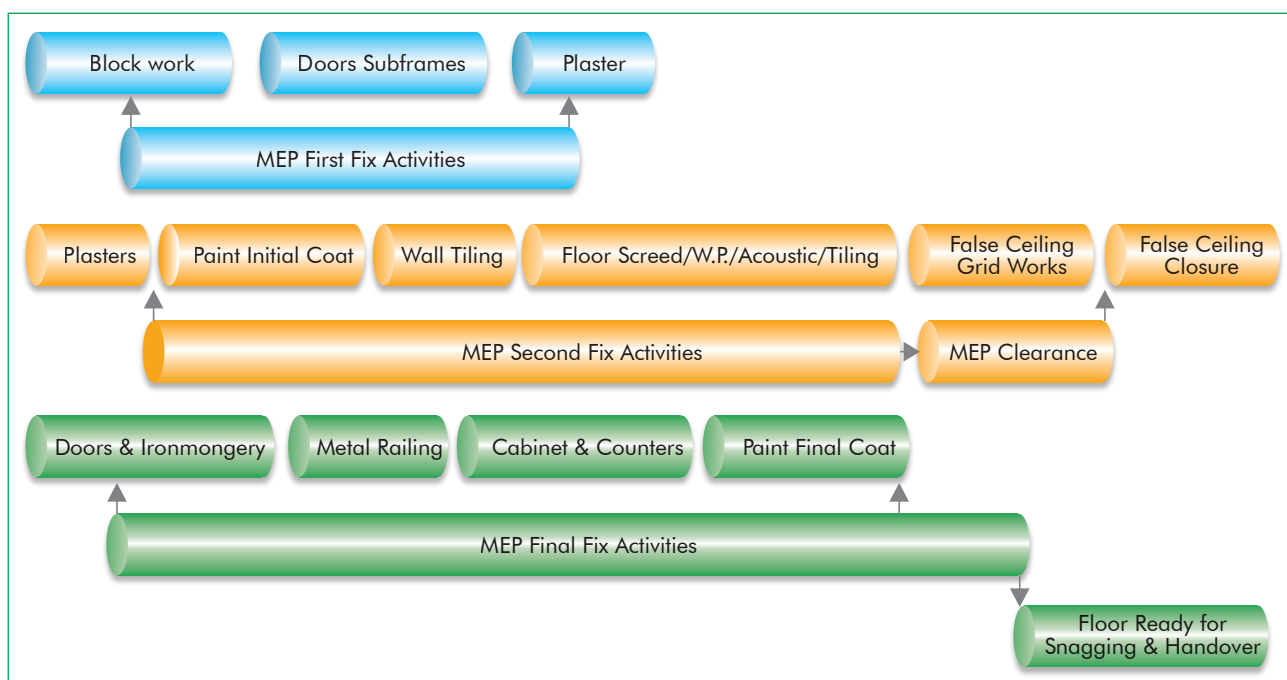
First fix activities are those activities which start along with block work and continue till completion of plaster work.

### Second Fix Activities

Second fix activities are the major part of the building utility systems. These activities start after completion of plaster. Most of the civil construction activities depend upon these activities. For example to start the false ceiling grid work, building utility high level work must finish.

### Final Fix Activities

Final fix activities generally cover all the exposed items i.e. electrical light fixtures, grilles & diffusers, sprinkler etc.

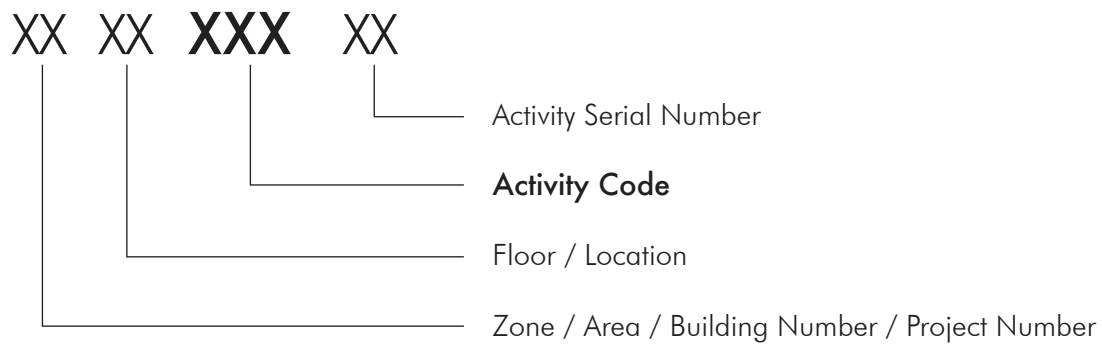


**Figure 1.1** Activity Distribution



This manual covers only building utility works. For civil activities please refer civil planning manual.

Different companies are using different activity description. By the help of this manual we are trying to make unique system for activity description to avoid any type of confusions. Each activity description contains unique three digit activity code number for planning purpose. This is a good practice to assign 10 digit activities Id.



## Activity List - Engineering

### 1.1 Engineering

Table 1.1.1 Drawing Submittal & Approval

S.No	Activity Code	Activity Description
1	DWG	Submit builder works drawings
2	DWG	Review & Approval of Builder works drawings
3	DWG	Submit Mechanical (HVAC) system shop drawings
4	DWG	Review & Approval of Mechanical (HVAC) system shop drawing
5	DWG	Submit Electrical system shop drawings
6	DWG	Review & Approval of Electrical system shop drawings
7	DWG	Submit Drainage system shop drawings
8	DWG	Review & Approval of Drainage system shop drawings
9	DWG	Submit Water system shop drawings
10	DWG	Review & Approval of Water system shop drawings
11	DWG	Submit Fire Fighting system shop drawings
12	DWG	Review & Approval of Fire Fighting system shop drawings
13	DWG	Submit Lift, Elevator & Escalator shop drawings
14	DWG	Review & Approval of Lift, Elevator & Escalator shop drawings
15	DWG	Submit Building Management system drawings
16	DWG	Review & Approval of Building Management system drawings
17	DWG	Submit Central Gas system shop drawing
18	DWG	Review & Approval of Central gas system shop drawings
19	DWG	Submit Swimming pool shop drawings
20	DWG	Review & Approval of Swimming pool shop drawings
21	DWG	Submit Shaft (Risers) shop drawings
22	DWG	Review & Approval of Shaft shop drawings
23	DWG	Submit GSM signal system shop drawings
24	DWG	Review & Approval of GSM signal system shop drawings
25	DWG	Submit MEP co ordination drawings
26	DWG	Review & Approval of MEP co ordination drawings
27	DWG	Submit Electrical Sub-station shop drawings
28	DWG	Review & Approval of Electrical sub-station drawings
29	DWG	Submit Mechanical floor equipment installation drawings
30	DWG	Review & Approval of Mechanical floor equipment installation drawings

Contd...

S.No	Activity Code	Activity Description
31	DWG	Submit CCTV system design
32	DWG	Review & Approval of CCTV system design
33	DWG	Submit Light Management system design
34	DWG	Review & Approval of Light Management system design

### 1.1.2 Material Submittal, Approval, Procurement & Delivery

**Table 1.1.2.1** Mechanical (HVAC) System

S.No	Activity Code	Activity Description
1	MAT	Submit HVAC Duct/Insulate G.I. Sheet Materials
2	MAT	Review & Approve HVAC Duct/Insulate G.I. Sheet Materials
3	MAT	Place Order & Delivery HVAC Duct/Insulate G.I. Sheet
4	MAT	Submit Dumper Materials
5	MAT	Review & Approve Dumper Materials
6	MAT	Place Order & Delivery Dumper Materials
7	MAT	Submit HVAC Pipes/Fittings/Valves
8	MAT	Review & Approve HVAC Pipes/Fittings/Valves
9	MAT	Place Order & Delivery HVAC Pipes/Fittings/Valves
10	MAT	Submit HVAC Flexible Duct Materials
11	MAT	Review & Approve HVAC Flexible Duct Materials
12	MAT	Place Order & Delivery HVAC Flexible Duct Materials
13	MAT	Submit HVAC Duct Liner Materials
14	MAT	Review & Approve HVAC Duct Liner Materials
15	MAT	Place Order & Delivery HVAC Duct Liner Materials
16	MAT	Submit HVAC Duct Accessories Materials
17	MAT	Review & Approve HVAC Duct Accessories Materials
18	MAT	Place Order & Delivery HVAC Duct Accessories Materials
19	MAT	Submit Hanger & Support Units
20	MAT	Review & Approve Hanger & Support Units
21	MAT	Place Order & Delivery Hanger & Support Units
22	MAT	Submit Extract Fans
23	MAT	Review & Approve Extract Fans
24	MAT	Place Order & Delivery Extract Fans
25	MAT	Submit Vapors Barrier & Adhesive Canvas

Contd...



S.No	Activity Code	Activity Description
26	MAT	Review & Approve Vapors Barrier & Adhesive Canvas
27	MAT	Place Order & Delivery Vapors Barrier & Adhesive Canvas
28	MAT	Submit AC Pressurization Units
29	MAT	Review & Approve AC Pressurization Units
30	MAT	Place Order & Delivery AC Pressurization Units
31	MAT	Submit Fan Coil Unit's
32	MAT	Review & Approve Fan Coil Unit's
33	MAT	Place Order & Delivery Fan Coil Unit's
34	MAT	Submit Chiller
35	MAT	Review & Approve Chiller
36	MAT	Place Order & Delivery Chiller
37	MAT	Submit AHU's
38	MAT	Review & Approve AHU's
39	MAT	Place Order & Delivery AHU's
40	MAT	Submit FAHU's
41	MAT	Review & Approve FAHU's
42	MAT	Place Order & Delivery FAHU's
43	MAT	Submit Grills & Diffusers
44	MAT	Review & Approve Grills & Diffusers
45	MAT	Place Order & Delivery Grills & Diffusers
46	MAT	Submit A/C Condensate Drain Pipes/Fittings
47	MAT	Review & Approve A/C Condensate Drain Pipes/Fittings
48	MAT	Place Order & Delivery A/C Condensate Drain Pipes/Fittings
49	MAT	Submit Kitchen Exhaust AHU
50	MAT	Review & Approve Kitchen Exhaust AHU
51	MAT	Place Order & Delivery Kitchen Exhaust AHU
52	MAT	Submit DX Units
53	MAT	Review & Approve DX Units
54	MAT	Place Order & Delivery DX Units
55	MAT	Submit Chemical Dosing
56	MAT	Review & Approve Chemical Dosing
57	MAT	Place Order & Delivery Chemical Dosing
58	MAT	Submit VAV/CAV Units
59	MAT	Review & Approve VAV/CAV Units
60	MAT	Place Order & Delivery VAV/CAV Units

Contd...

S.No	Activity Code	Activity Description
61	MAT	Submit Cladding Materials
62	MAT	Review & Approve Cladding Materials
63	MAT	Place Order & Delivery Cladding Materials
64	MAT	Submit Fire Rated Duct
65	MAT	Review & Approve Fire Rated Duct
66	MAT	Place Order & Delivery Fire Rated Duct
67	MAT	Submit Duct Heater
68	MAT	Review & Approve Duct Heater
69	MAT	Place Order & Delivery Duct Heater
70	MAT	Submit Dirt Separator
71	MAT	Review & Approve Dirt Separator
72	MAT	Place Order & Delivery of Dirt Separator
73	MAT	Submit Side Stream Filter
74	MAT	Review & Approve Side Stream Filter
75	MAT	Place Order & Delivery of Side Stream Filter
76	MAT	Submit Chilled Water Pumps & Fittings
77	MAT	Review & Approve Chilled Water Pumps & Fittings
78	MAT	Place Order & Delivery Chilled Water Pumps & Fittings
79	MAT	Submit Pressure/Temp. Gauges & Flow Sensors
80	MAT	Review & App. Pressure/Temp. Gauges & Flow Sensors
81	MAT	Place Order & Delivery Pres/Temp. Gauges & Flow Sensor
82	MAT	Submit Fire & Volume Control Dampers
83	MAT	Review & Approve Fire & Volume Control Dampers
84	MAT	Place Order & Delivery Fire & Volume Control Damper
85	MAT	Submit Isolators Materials
86	MAT	Review & Approve Isolators Materials
87	MAT	Place Order & Delivery Isolators Materials
88	MAT	Submit Heat Exchanger
89	MAT	Review & Approve Heat Exchanger
90	MAT	Place Order & Delivery Heat Exchanger
91	MAT	Submit Cooling Tower Material
92	MAT	Review & Approve Cooling Tower Material
93	MAT	Place Order & Delivery Cooling Tower Material
94	MAT	Submit Sound Attenuators
95	MAT	Review & Approve Sound Attenuators
96	MAT	Place Order & Delivery Sound Attenuators



**Table 1.1.2.2** Electrical System

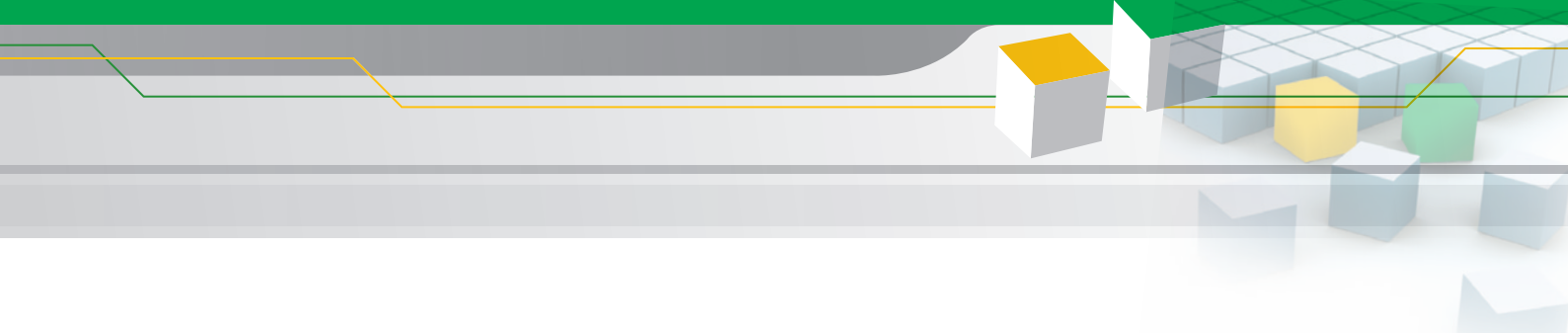
S.No	Activity Code	Activity Description
1	MAT	Submit Cable Tray Material
2	MAT	Review & Approve Cable Tray Material
3	MAT	Place Order & Delivery Cable Tray Material
4	MAT	Submit Cable Trunking Material
5	MAT	Review & Approve Cable Trunking Material
6	MAT	Place Order & Delivery Cable Trunking Material
7	MAT	Submit Anchors & Supports Materials
8	MAT	Review & Approve Anchors & Supports Materials
9	MAT	Place Order & Delivery Anchors & Supports Materials
10	MAT	Submit Electrical Wires Materials
11	MAT	Review & Approve Electrical Wires Materials
12	MAT	Place Order & Delivery Electrical Wires Materials
13	MAT	Submit CCTV System Material
14	MAT	Review & Approve CCTV System Material
15	MAT	Place Order & Delivery CCTV System Material
16	MAT	Submit LV Cables
17	MAT	Review & Approve LV Cables
18	MAT	Place Order & Delivery LV Cables
19	MAT	Submit G.I. Boxes Materials
20	MAT	Review & Approve G.I. Boxes Materials
21	MAT	Place Order & Delivery G.I. Boxes Materials
22	MAT	Submit Main Distribution Boards Materials
23	MAT	Review & Approve Main Distribution Boards Materials
24	MAT	Place Order & Delivery Main Distribution Boards Materials
25	MAT	Submit Sub-Main Distribution Boards
26	MAT	Review & Approve Sub-Main Distribution Boards
27	MAT	Place Order & Delivery Sub-Main Distrib. Boards
28	MAT	Submit Distribution Boards
29	MAT	Review & Approve Distribution Boards
30	MAT	Place Order & Delivery Distribution Boards
31	MAT	Submit MCC's
32	MAT	Review & Approve MCC's
33	MAT	Place Order & Delivery MCC's

Contd...



S.No	Activity Code	Activity Description
34	MAT	Submit Bus Bar Trunking System
35	MAT	Review & Approve Bus Bar Trunking System
36	MAT	Place Order & Delivery Bus Bar Trunking System
37	MAT	Submit Wiring Accessories
38	MAT	Review & Approve Wiring Accessories
39	MAT	Place Order & Delivery Wiring Accessories
40	MAT	Submit PVC Conduits & Accessories
41	MAT	Review & Approve PVC Conduits & Accessories
42	MAT	Place Order & Delivery PVC Conduits & Accessories
43	MAT	Submit Transformer
44	MAT	Review & Approve Transformer
45	MAT	Place Order & Delivery Transformer
46	MAT	Submit Air Craft Warning Light
47	MAT	Review & Approve Air Craft Warning Light
48	MAT	Place Order & Delivery Air Craft Warning Light
49	MAT	Submit UPS
50	MAT	Review & Approve UPS
51	MAT	Place Order & Delivery UPS
52	MAT	Submit Expansion Joints for Supports & Anchor
53	MAT	Review & Approve Expansion Joint for Supp & Anchor
54	MAT	Place Order & Delivery Expansion Joints for Supp & Anchor
55	MAT	Submit Earthing & Lightning Protection
56	MAT	Review & Approve Earthing & Lightning Protection
57	MAT	Place Order & Delivery Earthing & Lightning Protection
58	MAT	Submit Lighting Fixtures
59	MAT	Review & Approve Lighting Fixtures
60	MAT	Place Order & Delivery Lighting Fixtures
61	MAT	Submit Lighting Control System
62	MAT	Review & Approve Lighting Control System
63	MAT	Place Order & Delivery Lighting Control System
64	MAT	Submit Structured Cabling System
65	MAT	Review & Approve Structured Cabling System
66	MAT	Place Order & Delivery Structured Cabling System
67	MAT	Submit Emergency Lighting System
68	MAT	Review & Approve Emergency Lighting System

Contd...



S.No	Activity Code	Activity Description
69	MAT	Place Order & Delivery Emergency Lighting System
70	MAT	Submit HT Cables Materials
71	MAT	Review & Approve HT Cables Materials
72	MAT	Place Order & Delivery HT Cables Materials
73	MAT	Submit ATS Units
74	MAT	Review & Approve ATS Units
75	MAT	Place Order & Delivery ATS Units
76	MAT	Submit Video Intercom System
77	MAT	Review & Approve Video Intercom System
78	MAT	Place Order & Delivery Video Intercom System
79	MAT	Submit Generator
80	MAT	Review & Approve Generator
81	MAT	Place Order & Delivery Generator
82	MAT	Submit Fire Protection Cables
83	MAT	Review & Approve Fire Protection Cables
84	MAT	Place Order & Delivery Fire Protection Cables
85	MAT	Submit Fire Alarm Equipment
86	MAT	Review & Approve Fire Alarm Equipment
87	MAT	Place Order & Delivery Fire Alarm Equipment
88	MAT	Submit HV Transmission Kit
89	MAT	Review & Approve HV Transmission Kit
90	MAT	Place Order & Delivery HV Transmission Kit
91	MAT	Submit Security & BMS System Materials
92	MAT	Review & Approve Security & BMS System Materials
93	MAT	Place Order & Delivery Security & BMS System Materials
94	MAT	Submit BMS Control Equipments
95	MAT	Review & Approve BMS Control Equipments
96	MAT	Place Order & Deliver of BMS Control Equipments

**Table 1.1.2.3** Plumbing System

S.No	Activity Code	Activity Description
1	MAT	Submit Drainage Pipes & Fittings Materials
2	MAT	Review & Approve Drainage Pipes & Fittings
3	MAT	Place Order & Delivery Drainage Pipes & Fittings
4	MAT	Submit Manhole Covers & Frames
5	MAT	Review & Approve Manhole Covers & Frames
6	MAT	Place Order & Delivery Manhole Covers & Frames
7	MAT	Submit UPVC Sleeves Materials
8	MAT	Review & Approve UPVC Sleeves Materials
9	MAT	Place Order & Delivery UPVC Sleeves Materials
10	MAT	Submit Floor Drain/Cleanouts/Gully Trap
11	MAT	Review & Approve Floor Drain/Cleanouts/Gully Trap
12	MAT	Place Order & Delivery Floor Drain/Cleanouts/Gully Trap
13	MAT	Submit Hot & Cold Water Pipes & Fittings
14	MAT	Review & Approve Hot & Cold Water Pipes & Fittings
15	MAT	Place Order & Delivery Hot & Cold Water Pipes & Fitting
16	MAT	Submit Sump Pump
17	MAT	Review & Approve Sump Pump
18	MAT	Place Order & Delivery Sump Pump
19	MAT	Submit Expansion Tank
20	MAT	Review & Approve Expansion Tank
21	MAT	Place Order & Delivery Expansion Tank
22	MAT	Submit GRP Tank & Fittings
23	MAT	Review & Approve GRP Tank & Fittings
24	MAT	Place Order & Delivery GRP Tank & Fittings
25	MAT	Submit Water Transfer & Booster Pumps
26	MAT	Review & Approve Water Transfer & Booster Pumps
27	MAT	Place Order & Delivery Water Transfer & Booster Pumps
28	MAT	Submit Valves Materials
29	MAT	Review & Approve Valves Materials
30	MAT	Place Order & Delivery Valves Materials
31	MAT	Submit Circulation Pump-Run Around Coil
32	MAT	Review & Approve Circulation Pump-Run Around Coil
33	MAT	Place Order & Delivery Circulation Pump-Run Around Coil

**Table 1.1.2.4** Fire Fighting System

S.No	Activity Code	Activity Description
1	MAT	Submit Fire Fighting Pipes & Pipe Clamps
2	MAT	Review & Approve Fire Fighting Pipes & Pipe Clamps
3	MAT	Place Order & Delivery Fire Fight. Pipes & Pipe Clamps
4	MAT	Submit Sprinkler Heads
5	MAT	Review & Approve Sprinkler Heads
6	MAT	Place Order & Delivery Sprinkler Heads
7	MAT	Submit Fire Extinguishers
8	MAT	Review & Approve Fire Extinguishers
9	MAT	Place Order & Delivery Fire Extinguishers
10	MAT	Submit FHC's Material
11	MAT	Review & Approve FHC's Material
12	MAT	Place Order & Delivery FHC's Materials
13	MAT	Submit Fire Fighting Pumps
14	MAT	Review & Approve Fire Fighting Pumps
15	MAT	Place Order & Delivery Fire Fighting Pumps
16	MAT	Submit Fire Suppression System
17	MAT	Review & Approve Fire Suppression System
18	MAT	Place Order & Delivery Fire Suppression System
19	MAT	Submit Fire Fighting Valves
20	MAT	Review & Approve Fire Fighting Valves
21	MAT	Place Order & Delivery Fire Fighting Valves

### 1.1.3 Method Statement (MS) Submittal & Approval

**Table 1.1.3.1** Mechanical System (HVAC)

S.No	Activity Code	Activity Description
1	MST	Submit Chiller & Cooling Tower Installation MS
2	MST	Review & Approval Chiller & Cooling Tower Installation MS
3	MST	Submit HVAC Equipment Installation MS
4	MST	Review & Approval of HVAC Equipment Installation MS
5	MST	Submit CHW Piping Installation MS
6	MST	Review & Approval of CHW Piping Installation MS
7	MST	Submit Duct works Installation MS
8	MST	Review & Approval of Duct works Installation MS
9	MST	Submit HVAC Testing, Adjusting & Balancing MS
10	MST	Review & Approval of HVAC Testing, Adjusting & Balancing MS
11	MST	Submit Flushing & Chemical Treatment of Chilled Water System MS
12	MST	Review & Approval of Flushing & Chemical Treatment of Chilled Water System MS



**Table 1.1.3.2** Electrical System

S.No	Activity Code	Activity Description
1	MST	Submit of Earthing & Lighting Installation MS
2	MST	Review & Approval Earthing & Lighting Installation MS
3	MST	Submit of GI Conducting Installation MS
4	MST	Review & Approval GI Conducting Installation MS
5	MST	Submit of PVC Conduit Installation MS
6	MST	Review & Approval PVC Conduit Installation MS
7	MST	Submit of Under Floor Trucking Installation MS
8	MST	Review & Approval Under Floor Trucking Installation MS
9	MST	Submit of Cable Tray Trucking Installation MS
10	MST	Review & Approval Cable Tray Trucking Installation MS
11	MST	Submit of Transformers Installation MS
12	MST	Review & Approval Transformers Installation MS
13	MST	Submit of LV-HV Cable Installation MS
14	MST	Review & Approval LV-HV Cable Installation MS
15	MST	Submit of LV Switch Gear Installation MS
16	MST	Review & Approval LV Switch Gear Installation MS
17	MST	Submit of DG Set Installation MS
18	MST	Review & Approval DG Set Installation MS
19	MST	Submit of Busbar Installation MS
20	MST	Review & Approval Busbar Installation MS
21	MST	Submit of BMS System Installation MS
22	MST	Review & Approval BMS System Installation MS
23	MST	Submit of Low Current System Installation MS
24	MST	Review & Approval Low Current System Installation MS
25	MST	Submit of UPS Panel Installation MS
26	MST	Review & Approval UPS Panel Installation MS
27	MST	Submit of Wiring ACCS, Fixtures Installation MS
28	MST	Review & Approval Wiring ACCS, Fixtures Installation MS



**Table 1.1.3.3** Plumbing System

S.No	Activity Code	Activity Description
1	MST	Submit Concealed Drainage Piping MS
2	MST	Review & Approval of Concealed Drainage Piping MS
3	MST	Submit Above Ground Drainage Piping MS
4	MST	Review & Approval of Above Ground Drainage Piping MS
5	MST	Submit Domestic Hot & Cold Water Supply Piping MS
6	MST	Review & Approval of Domestic Hot & Cold Water Supply Piping MS
7	MST	Submit Installation of Domestic Water Supply Pumps MS
8	MST	Review & Approval of Installation of Domestic Water Supply Pumps MS
9	MST	Submit Installation of Water Heaters MS
10	MST	Review & Approval of Installation of Water Heaters MS
11	MST	Submit Installation of Sanitary Fixtures MS
12	MST	Review & Approval of Installation of Sanitary Fixtures MS

**Table 1.1.3.4** Fire Fighting System

S.No	Activity Code	Activity Description
1	MST	Submit Installation of Fire Fighting Pipes & Fittings MS
2	MST	Review & Approval of Installation of Fire Fighting Pipes & Fittings MS
3	MST	Submit Installation of Sprinklers MS
4	MST	Review & Approval of Installation of Sprinklers MS
5	MST	Submit Installation of Fire Hose Cabinets MS
6	MST	Review & Approval of Installation of Fire Hose Cabinets MS
7	MST	Submit Hydro-Static Testing of Sprinkler MS
8	MST	Review & Approval of Hydro-Static Testing of Sprinkler MS
9	MST	Submit Fire Alarm System MS
10	MST	Review & Approval of Fire Alarm System MS
11	MST	Submit Installation of Zone Control Valve MS
12	MST	Review & Approval of Installation of Zone Control Valve MS
13	MST	Submit Installation of Pressure Reducing Valve Station MS
14	MST	Review & Approval of Installation of Pressure Reducing Valve Station MS



## Activity List - Construction

### 1.2 Construction

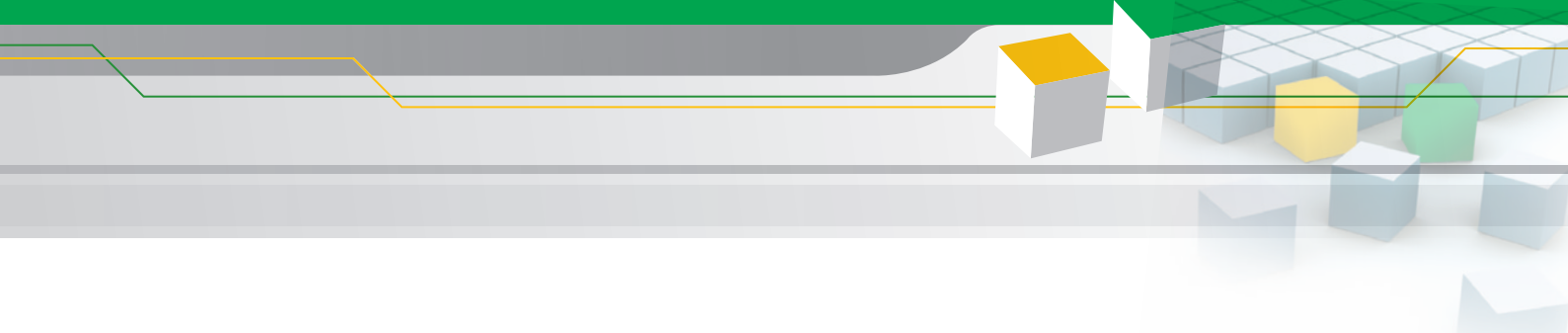
Table 1.2.1 Project Milestone Requirements

Type	Area	Code	Description
Milestone	Tower	KEY	Temporary Power Availability
		KEY	Drainage Connection
		KEY	Water Availability
		KEY	Civil Defense Inspection
		KEY	Authority Inspection (Electrical)
		KEY	Permanent Power Availability
		KEY	Chilled Water Availability (from District Cooling Plant)

**Table 1.2.2** Mechanical System

Type	Area	Code	Description
1st Fix	Typical Floor	MEC	Duct hangers & Supports
		MEC	Chilled Water Pipe Hangers & Supports
2nd Fix	Typical Floor	MEC	Ducting Supply, Return, Fresh & Exhaust Air
		MEC	Volume, Fire & Smoke Damper Fixing
		MEC	Duct Risers
		MEC	Duct Insulation
		MEC	Chilled Water Piping - High Level Horizontal
		MEC	Chilled Water Pipe Riser
		MEC	Chilled Water Pipe Leakage Testing
		MEC	Chilled Water Pipe Insulation
		MEC	Fan Coil Unit (FCU) Installation
		MEC	Duct Connection to FCU
		MEC	Chilled Water Pipe Connection to FCU
		MEC	Bends, Droppers & Mouth Piece
	Basement / Mechanical Floor	MEC	Chillers Installation
		MEC	Heat Exchanger Installation
		MEC	Staircase Pressure Fan Installation
		MEC	Garbage Exhaust Fan Installation
		MEC	Chilled Water Pump Installation
		MEC	Expansion Tank & Pressure Unit Installation
		MEC	Air Scrubbers installation
		MEC	Chemical Dosing Plant Installation
		MEC	AHU Installation
		MEC	Duct Connection to AHU
		MEC	Pipe Connection to AHU
Final Fix	Typical Floor	MEC	Kitchen Exhaust Fan Fixing
		MEC	Ceiling Diffuser Fixing
		MEC	Grille & Linear Fixing
		MEC	Thermostat Fixing

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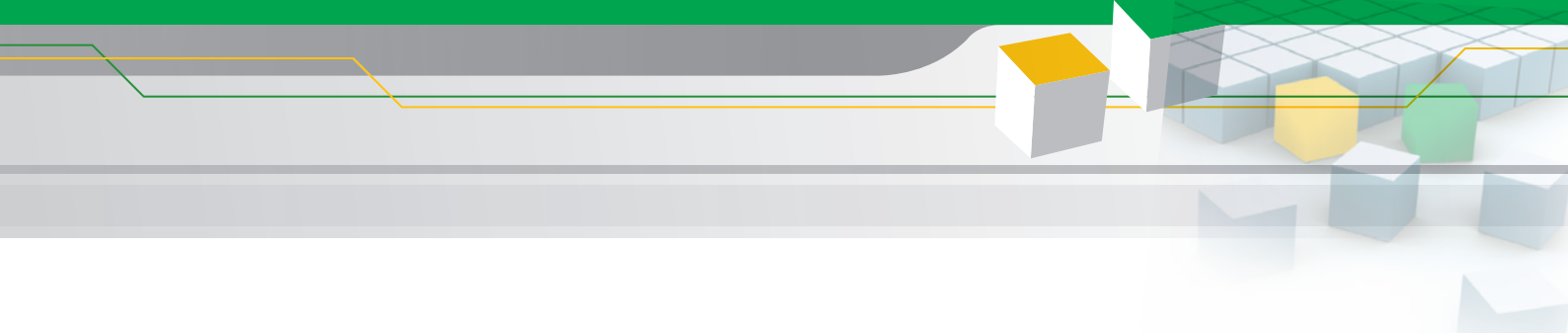


Type	Area	Code	Description
Testing & Pre-Commissioning	Tower	MEC	Pre commissioning chilled water pumps
		MEC	Water circulation in system and drain (Static)
		MEC	Circulation of water with cleaning chemical
		MEC	Pre commissioning FAHU's
		MEC	Cleaning of all filters and strainers
		MEC	Pre commissioning pressurization fans
		MEC	Water circulation in system and drain (dynamic)
		MEC	Refilling of water and witness by Engineer
		MEC	Prelim. Adjusting and balancing of valves
Commissioning & Handover	Tower	MEC	Test and commission chilled water pumps
		MEC	Test and commission heat exchangers
		MEC	Test and commission FAHU's
		MEC	Test and commission floor FCU's
		MEC	FAHU air balancing
		MEC	Air balancing supply & return grilles
		MEC	FCU water balancing
		MEC	Balancing air from pressurization fans
		MEC	Water balancing of FAHU's
		MEC	Main System Valves adjustment

**Table 1.2.3** Electrical System

Type	Area	Code	Description
Embed.in Conc.	Typical Floor	ELE	Embedded Conduits in Concrete
1st Fix	Typical Floor	ELE	Marking on Block walls
		ELE	Cutting & Chasing in block walls
		ELE	Fix Conduits, GI Boxes in Block Walls
2nd Fix	Typical Floor	ELE	G.I. & PVC Surface Conduiting
		ELE	Installation of Distribution Boards
		ELE	Installation of Sub-Main Boards
		ELE	Installation of Main LV Panel
		ELE	Erect Cable Trays
		ELE	Cable Trucking
		ELE	Earthing System
		ELE	LV Cabling
		ELE	ELV Cabling
		ELE	Main LV Cable Termination
		ELE	Sub main Cable Termination
		ELE	Wiring for Lighting & Small Power
		ELE	Wiring for ELV System
		ELE	Wiring for Fire Fighting System
		ELE	Circuit Continuity Test
		ELE	Ceiling Rose & Flexible Drops
		ELE	Distribution Boards Dressing
		ELE	Bus bar Installation
		ELE	Lightning Protection System
	Basement	ELE	Transformer Installation
		ELE	Generator Installation
		ELE	ATS Panel Installation
		ELE	LV Cabling from Transformer to LV Panel

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Type	Area	Code	Description
Final Fix	Typical Floor	ELE	Fixing Fire Alarm & Light Fittings
		ELE	Fixing Switches, Sockets & Accessories
Testing & Pre-Commissioning	Tower	ELE	Circuit continuity test by bus riser
		ELE	Continuity test LV wiring
		ELE	Pre commissioning ELV fixtures
		ELE	Final test and commissioning bus risers
Commissioning & Handover	Tower	ELE	Test and commission variable frequency drive
		ELE	Lighting protection earth resistance test
		ELE	Floor MDB, SMDB, MCC panel commissioning
		ELE	Test and commission light fixtures
		ELE	Test and commission ELV final fixtures



**Table 1.2.4** Plumbing System

Type	Area	Code	Description
Underground	Typical Floor	PLB	Underground Piping
Embedded in Concrete	Typical Floor	PLB	Putting sleeves in concrete slab
		PLB	Embedded pipe in concrete slab
1st Fix	Typical Floor	PLB	Cutting & Chasing in block walls
		PLB	Putting Pipes (water supply / drainage) in block walls
2nd Fix	Typical Floor	PLB	Horizontal Drainage Piping
		PLB	Horizontal Water Supply Piping
		PLB	Drainage Pipe Water Leakage Testing
		PLB	Water Supply Water Leakage Testing
		PLB	Vertical (Riser) Drainage Piping
		PLB	Vertical (Riser) Water Supply Piping
		PLB	Floor Drain (Trap) Fixing
		PLB	Water Heater Installation
		PLB	Bath Tub / Shower Tray Installation
	Basement / Mechanical / Roof	PLB	Sewage Lift Pump Installation & Piping
		PLB	Water Transfer Pump Installation & Piping
		PLB	Water Booster Pump Installation & Piping
		PLB	Erection of Water Tank & Connections
Final Fix	Typical Floor	PLB	Sanitary Ware Installation
		PLB	Sanitary Fixture Fixing
		PLB	Water Meter Fixing
Testing & Pre-Commissioning	Tower	PLB	Pre commission water transfer & Booster pumps
		PLB	Pre commission floor water heaters
		PLB	Overhead Roof Water Tank fillup
		PLB	Flushing & checking leaks in water supply pipes
		PLB	Flushing & checking leaks in drainage pipes
		PLB	Simultaneous flow test on drainage risers
Commissioning & Handover	Tower	PLB	Test and commission water transfer & booster pumps
		PLB	Commissioning water supply PRV's
		PLB	Commissioning floor water heaters
		PLB	Commissioning of bath tubs & sanitary ware

**Table 1.2.5** Fire Fighting System

Type	Area	Code	Description
1st Fix	Typical Floor	FFS	Fire Fighting Hangers & Supports
2nd Fix	Typical Floor	FFS	Fire Fighting Piping
		FFS	Fire Fighting Pipe Riser
		FFS	Fire Fighting Pipe Testing
		FFS	Fire Fighting Accessories Fixing
	Basement/Me- chanical Floor	FFS	Fire Pump Set Installation
		FFS	Fire Pump Set Pipe Connections
Final Fix	Typical Floor	FFS	Sprinkler Fixing
		FFS	Fire Hose Cabinet Fixing
		FFS	Fire Hose Reel Fixing
		FFS	Fire Extinguisher Fixing
		FFS	Fire Blanket Fixing
Testing & Pre- Commissioning	Tower	FFS	Pressurize Fire Fighting pipes
		FFS	Flushing & Refilling of Fire Fighting Pipes
Commissioning & Handover	Tower	FFS	Commissioning Fire Fighting PRV's
		FFS	Commissioning of FHC's
		FFS	Commissioning of Sprinklers

### 1.2.6 Mechanical Floor / Roof Activities

**Table 1.2.6.1** Mechanical - HVAC System

S.No	Activity Code	Activity Description
1	MMF	Chiller Installation
2	MMF	Heat Exchanger Installation
3	MMF	Staircase Pressure Fan Installation
4	MMF	Garbage Exhaust Fan Installation
5	MMF	Chilled Water Pump Installation
7	MMF	Pressure Unit Installation
8	MMF	Air Scrubber Installation
9	MMF	Chemical Dosing Plant Installation
10	MMF	Air Handling Unit Installation

**Table 1.2.6.2** Electrical System

S.No	Activity Code	Activity Description
1	EMF	Transformer Installation
2	EMF	Generator Installation
3	EMF	ATS Panel Installation
4	EMF	LV Cabling from Transformer to LV Panel
5	EMF	MCC Installation

**Table 1.2.6.3** Plumbing System

S.No	Activity Code	Activity Description
1	PMF	Sewage Lift Pump Installation
2	PMF	Water Transfer Pump Installation
3	PMF	Water Booster Pump Installation
4	PMF	Water Tank Installation

**Table 1.2.6.4** Fire Fighting System

S.No	Activity Code	Activity Description
1	FMF	Fire Pump Set Installation



### 1.2.7 Shaft (Riser) Activities

**Table 1.2.7.1** Mechanical - HVAC / Electrical / Plumbing / Fire Fighting System

S.No	Activity Code	Activity Description
1	RIS	Drainage Pipe Riser
2	RIS	Water Supply Pipe Riser
3	RIS	Fire Fighting Pipe Riser
4	RIS	Duct Riser
5	RIS	Chilled Water Pipe Supply/Return Riser
6	RIS	Bus Bar Riser
7	RIS	LV Riser
8	RIS	HV Riser

**Table 1.2.8** Swimming Pool Activities

S.No	Activity Code	Activity Description
1	SWP	Water Supply Piping
2	SWP	Drainage Piping
3	SWP	Pump Installation
4	SWP	Filter Installation
5	SWP	Pool Equipments Installation
6	SWP	Electrical Installation
7	SWP	Testing & Commissioning

### 1.2.9 Lift, Elevator & Escalator Activities

**Table 1.2.9.1** Lift & Elevator

S.No	Activity Code	Activity Description
1	LFT	Gondola / Scaffolding Installation
2	LFT	Guide Rail Installation
3	LFT	Entrance & Doors Installation
4	LFT	Pit Equipment Installation
5	LFT	Conduits and Troughs Fixing
6	LFT	Fascia Plates Fixing
7	LFT	Machine Room Equipment Installation
8	LFT	Cabinet Assembly and Wiring
9	LFT	Testing & Adjustment
10	LFT	Cabin Finishes
11	LFT	Commissioning & Handover

**Table 1.2.9.2** Escalator

S.No	Activity Code	Activity Description
1	ESC	Escalator Truss Assembly
2	ESC	Alignment and Installation of Steps
3	ESC	Glass Panel & Hard Rail Assembly
4	ESC	Testing & Adjustment of Escalator
5	ESC	Outer sheathing Panel Installation
6	ESC	Glass Exterior Panels Installation
7	ESC	Commissioning & Handover

**Table 1.2.10** Central Gas System (LPG)

S.No	Activity Code	Activity Description
1	GAS	Sleeve for Filling Fine in Slab
2	GAS	Riser in Shaft
3	GAS	Gas Meter & Accessories Installation
4	GAS	Gas Detector Installation
5	GAS	Gas Tank Installation (Roof)
6	GAS	Gas Filling Line Installation
7	GAS	PR.DP Installation & Roof Network
8	GAS	Commissioning

### 1.2.11 Local Authorities Activities

**Table 1.2.11.1** DEWA / SEWA / ADEWA (Electrical Authority)

S.No	Activity Code	Activity Description
1	AUT	Submission of Electrical Drawing to Authority (after consultant Approval)
2	AUT	Approval of Electrical Drawings by Authority
3	AUT	Submission of Application to Authority (Fee Estimation)
4	AUT	Fee Payment to Authority
5	AUT	Transformer Installation & HV Connection by Authority
6	AUT	Inspection & Snagging of Electrical Installation by Authority
7	AUT	Power on by Authority

**Table 1.2.11.2** Civil Defence

S.No	Activity Code	Activity Description
1	AUT	Submission of Fire Fighting Drawing to Civil Defence (after consultant approval)
2	AUT	Approval of Fire Fighting Drawings by Civil Defence
3	AUT	Inspection of Civil Defence
4	AUT	Civil Defence Approval
5	AUT	Building Completion Certificate

**Table 1.2.11.3** Dubai Municipality

S.No	Activity Code	Activity Description
1	AUT	Dubai Municipal Inspection & Approval
2	AUT	Water Connection

## Activity List – Testing & Commissioning

### 1.3 Testing And Commissioning

**Table 1.3.1** Mechanical System (HVAC)

S.No	Activity Code	Activity Description
1	TCM	Water Circulation in System & Drain (Static)
2	TCM	Circulation of Water With Cleaning Chemical
3	TCM	Cleaning of all Filters and Strainers
4	TCM	Water Circulation in System and Drain (Dynamic)
5	TCM	Refilling of Water
6	TCM	Preliminary Adjustment and Balancing of Valves
7	TCM	Commissioning of FCU's
8	TCM	Commissioning of FAHU's
9	TCM	Commissioning of Chilled Water Pumps
10	TCM	Commissioning of Heat Exchangers
11	TCM	Commissioning of Pressurization Fans
12	TCM	Commissioning of Chillers
13	TCM	FAHU Air Balancing
14	TCM	Toilet Exhaust / Kitchen Exhaust Air Balancing
15	TCM	Air Balancing Supply and Return Grilles
16	TCM	FCU Water Balancing
17	TCM	Balancing Air from Pressurization Fans
18	TCM	FAHU Water Balancing
19	TCM	Main System Valve Adjustment



**Table 1.3.2** Electrical System

S.No	Activity Code	Activity Description
1	TCE	Circuit Continuity Test by Bus Riser
2	TCE	Continuity Test LV Wiring
3	TCE	Insulation Resistance Test (Cabling)
4	TCE	Commissioning Bus Riser
5	TCE	Commissioning LV Riser
6	TCE	Commissioning HV Riser
7	TCE	Test & Commission Variable Frequency Drive
8	TCE	Lightning Protection Earth Resistance Test
9	TCE	MDB, SMDB & MCC Panel Commissioning
10	TCE	Test & Commission Light Fixtures
11	TCE	Test & Commission ELV Final Fixtures

**Table 1.3.3** Plumbing System

S.No	Activity Code	Activity Description
1	TCP	Flushing & Checking Leaks in Drainage Pipes
2	TCP	Flushing & Checking Leaks in Water Supply Pipes
3	TCP	Overhead Roof water Tank Fill-up
4	TCP	Chlorination of the System
5	TCP	Simultaneous Flow test on Drainage Risers
6	TCP	Test & Commission of Water Transfer Pump
7	TCP	Test & Commission of Booster Pumps
8	TCP	Commissioning Water Supply PRV's
9	TCP	Commissioning Water Heaters
10	TCP	Commissioning of Bath Tubs & Sanitary Wares



**Table 1.3.4** Fire Fighting System

S.No	Activity Code	Activity Description
1	TCF	Commissioning of Fire Fighting Pumps
2	TCF	Pressurize Fire Fighting Pipes
3	TCF	Flushing & Refilling of Fire Fighting Pipes
4	TCF	Commissioning Fire Fighting PRV's
5	TCF	Commissioning of FHC's
6	TCF	Commissioning of Sprinklers



# 2

## Activity Flow

### Introduction

Once the activities have been identified, the next step is to determine the sequence that activities will be performed during construction. The flow of activities must be known before to start the relationships between activities. Activity sequence is a function of activity relationship. Activity relationship is defined in Section 3.

The main concept of develop the activity flow diagram to highlight the sequence of MEP activities installation in multistory buildings & towers. This flow diagram is very useful while preparing construction schedule.

The activity flow diagram deals only to get the idea of MEP activity overall system. For more detail i.e. MEP interface with civil activity and production rate refer the relevant section. The flow diagram includes all drawing & material submittal and approval as well as material procurement and delivery sequence. Third party involvement i.e. authority requirement, inspection and approval also include in the flow diagram.

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| Figure 2.2 | Engineering Activity Flow Diagram                |
| Figure 2.3 | Mechanical (HVAC) Activity Flow Diagram          |
| Figure 2.4 | Electrical Activity Flow Diagram                 |
| Figure 2.5 | Plumbing Activity Flow Diagram                   |
| Figure 2.6 | Fire Fighting Activity Flow Diagram              |
| Figure 2.7 | Shaft (Risers) Activity Flow Diagram             |
| Figure 2.8 | Lift, Elevator & Escalator Activity Flow Diagram |

## 2.1 Work Breakdown Structure

### Introduction

Successful project management used planning techniques to define the project objectives in sufficient detail to support effective management of the project. The Work Breakdown Structure (WBS) provides the foundation for defining work as it related to project objectives and establishes the structure for managing the work to its completion.

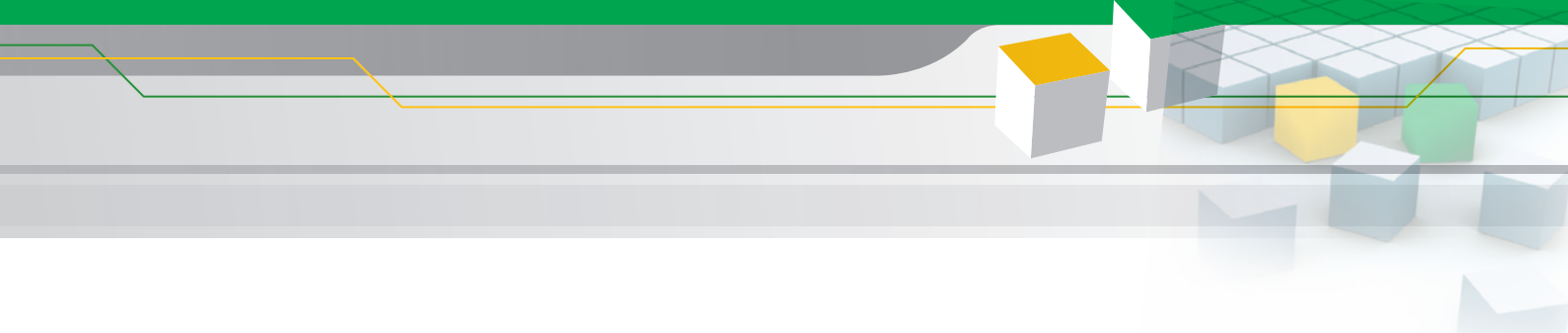
The WBS elements assist the project stakeholders in developing a clear vision of an end product of the project and of the overall process by which it will be created. The WBS divides the project scope into hierarchal, manageable, definable packages of work that balance the control needs of management with an appropriate and effective level of project data.

### WBS Dictionary

A WBS dictionary is a set of specific definitions that thoroughly described the scope of each work element identified in the WBS. The WBS dictionary defines each WBS element down to the control account or work package level in term of the content of work to be performed. A guide of building services WBS dictionary in tabular form & graphical form is mentioned below for easy reference includes:

**Table 2.1.1 Building Services - Work Breakdown Structure Dictionary (Tabular)**

01	Building Services
01.01	Local Authorities Activities
01.01.01	Electrical Authority Inspections & Approvals
01.01.02	Municipality Inspections & Approvals
01.01.03	Civil Defence Inspections & Approvals
01.01.04	Other Agencies Inspections & Approvals
01.02	Engineering
01.02.01	Drawing Submittal & Approvals
01.02.01.01	Mechanical (HVAC)
01.02.01.02	Electrical
01.02.01.03	Plumbing
01.02.01.04	Fire Fighting
01.02.01.05	Lift, Elevator & Escalator
01.02.01.06	Swimming Pool
01.02.02	Material Submittal, Approvals, Procurement & Delivery
01.02.02.01	Mechanical (HVAC)
01.02.02.02	Electrical
01.02.02.03	Plumbing
01.02.02.04	Fire Fighting
01.02.02.05	Lift, Elevator & Escalator
01.02.02.06	Swimming Pool

- 
- 01.02.03 Method Statement
    - 01.02.03.01 Mechanical (HVAC)
    - 01.02.03.02 Electrical
    - 01.02.03.03 Plumbing
    - 01.02.03.04 Fire Fighting
    - 01.02.03.05 Lift, Elevator & Escalator
    - 01.02.03.06 Swimming Pool
  - 01.03 Construction
    - 01.03.01 Mechanical (HVAC) System
      - 01.03.01.01 First Fix Activities
      - 01.03.01.02 Second Fix Activities
      - 01.03.01.03 Final Fix Activities
    - 01.03.02 Electrical System
      - 01.03.02.01 First Fix Activities
      - 01.03.02.02 Second Fix Activities
      - 01.03.02.03 Final Fix Activities
    - 01.03.03 Plumbing System
      - 01.03.03.01 First Fix Activities
      - 01.03.03.02 Second Fix Activities
      - 01.03.03.03 Final Fix Activities
    - 01.03.04 Fire Fighting System
      - 01.03.04.01 First Fix Activities
      - 01.03.04.02 Second Fix Activities
      - 01.03.04.03 Final Fix Activities
    - 01.03.05 Shaft (Risers) Activities
    - 01.03.06 Swimming Pool
    - 01.03.07 Lift, Elevator & Escalator
  - 01.04 Testing & Commissioning
    - 01.04.01 Mechanical (HVAC) System
    - 01.04.02 Electrical
    - 01.04.03 Plumbing
    - 01.04.04 Fire Fighting
    - 01.04.05 Lift, Elevator & Escalator
  - 01.05 Project Closing

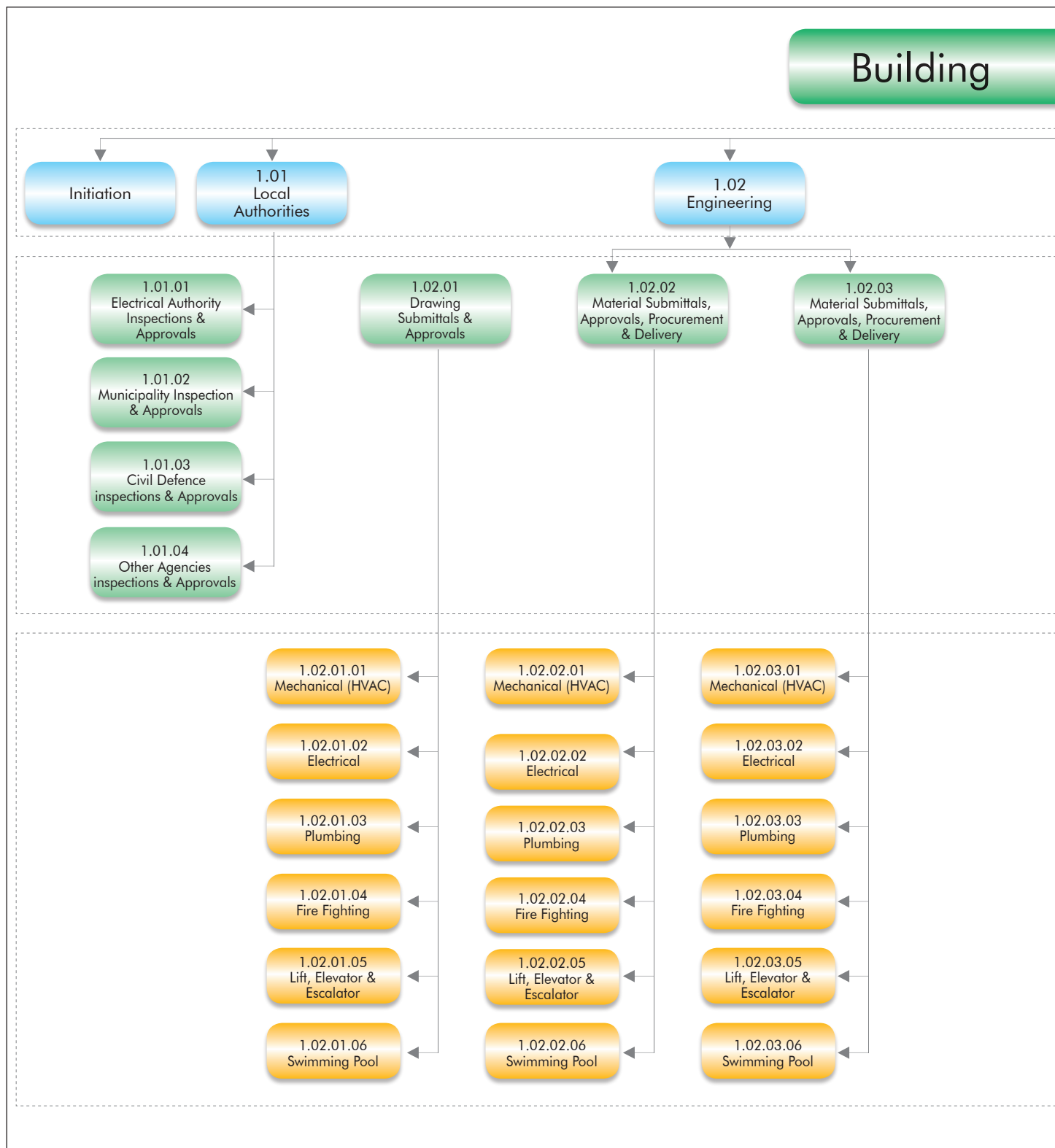
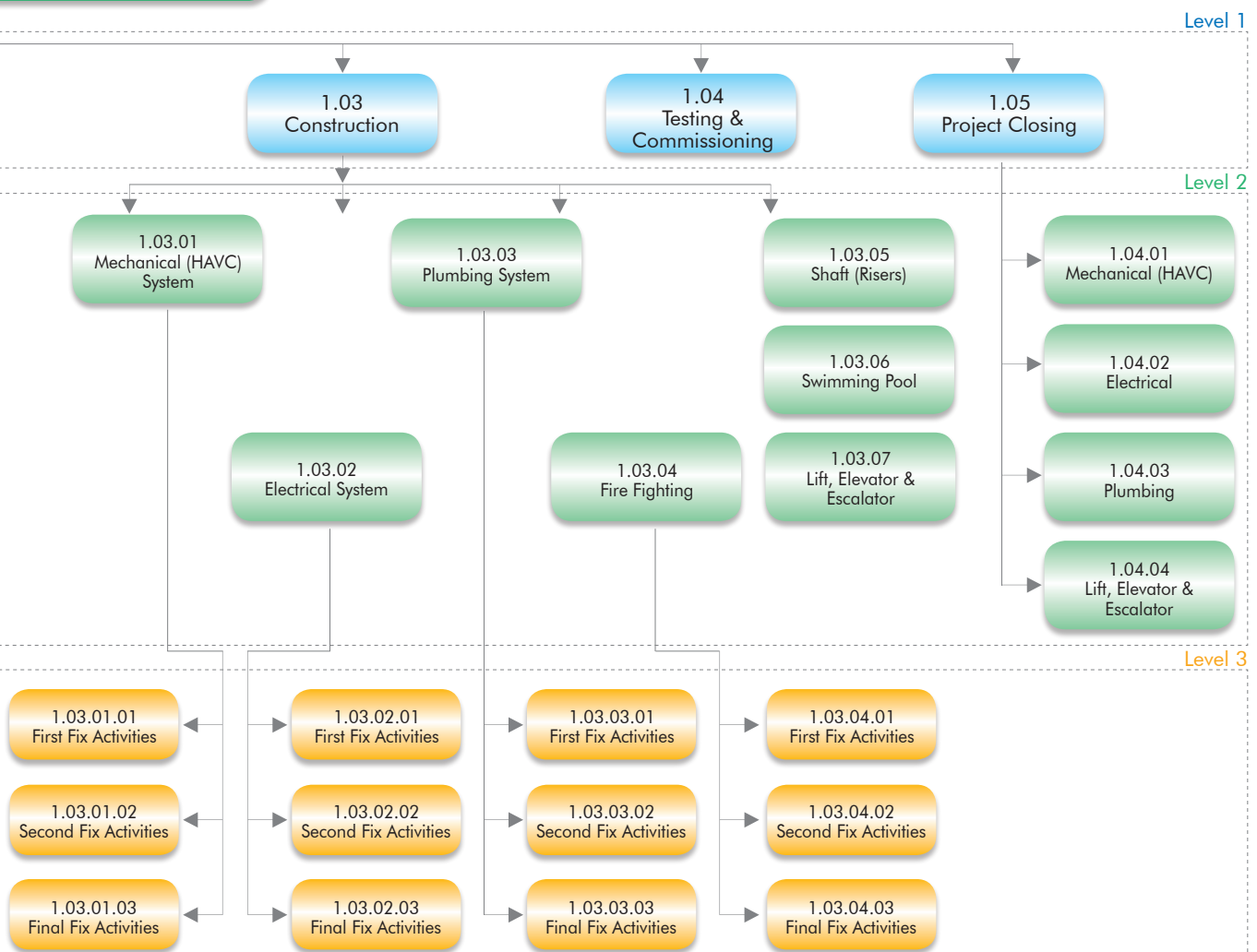


Figure 2.1.1 Building Services - Work Breakdown Structure Dictionary (Graphical)

# Services



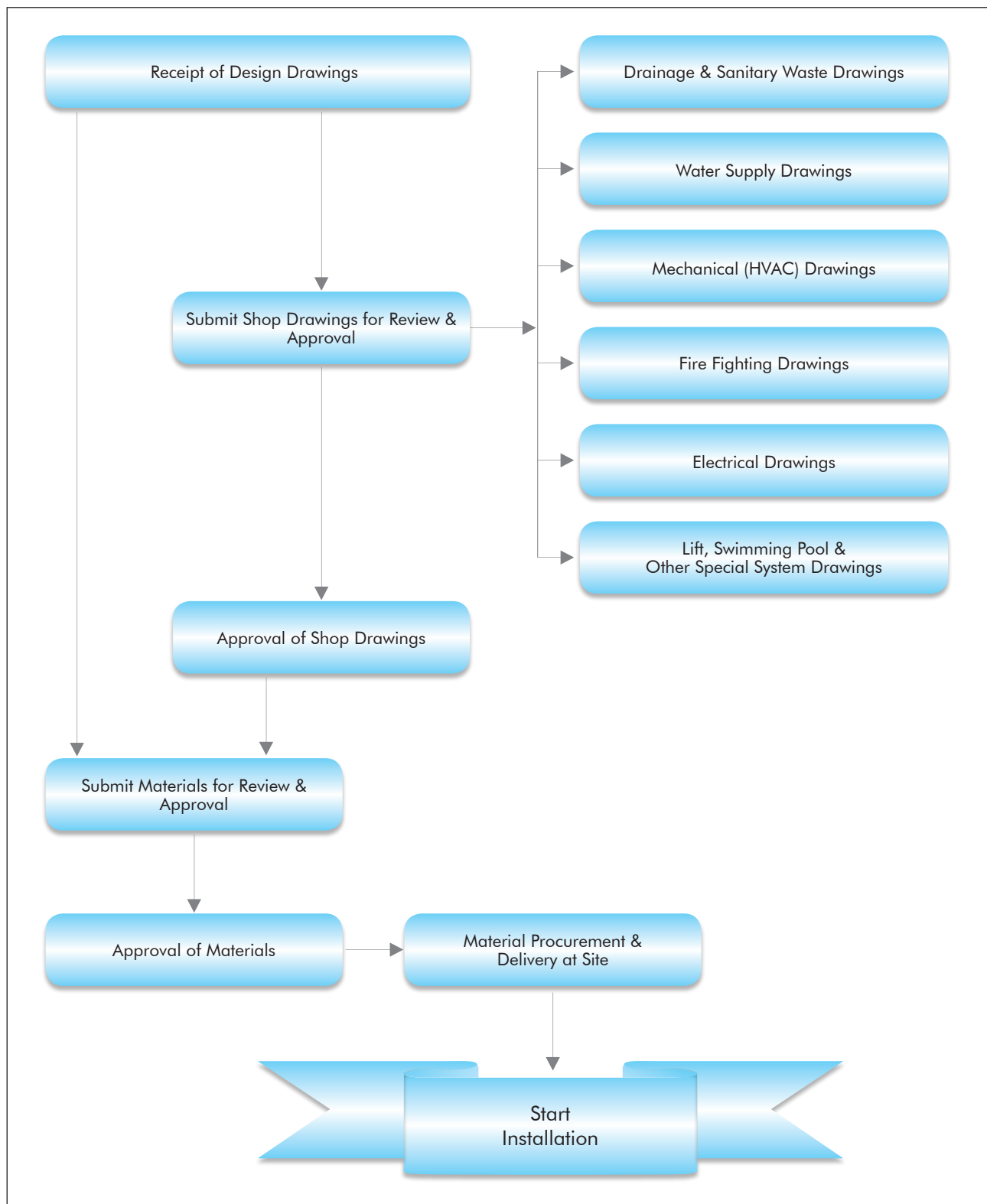


Figure 2.2 Engineering Activities Flow Diagram

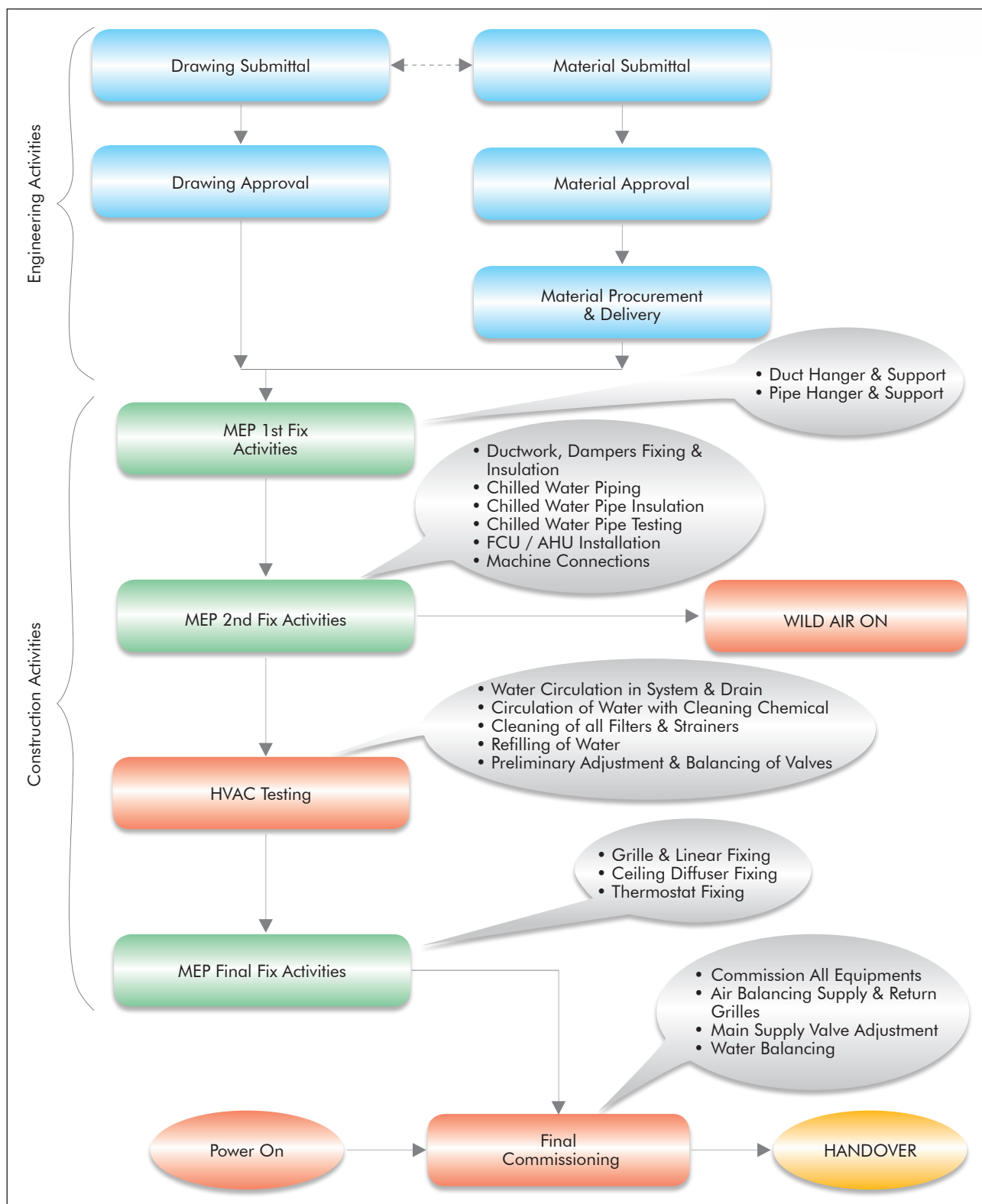


Figure 2.3 Mechanical (HVAC) Activities Flow Diagram



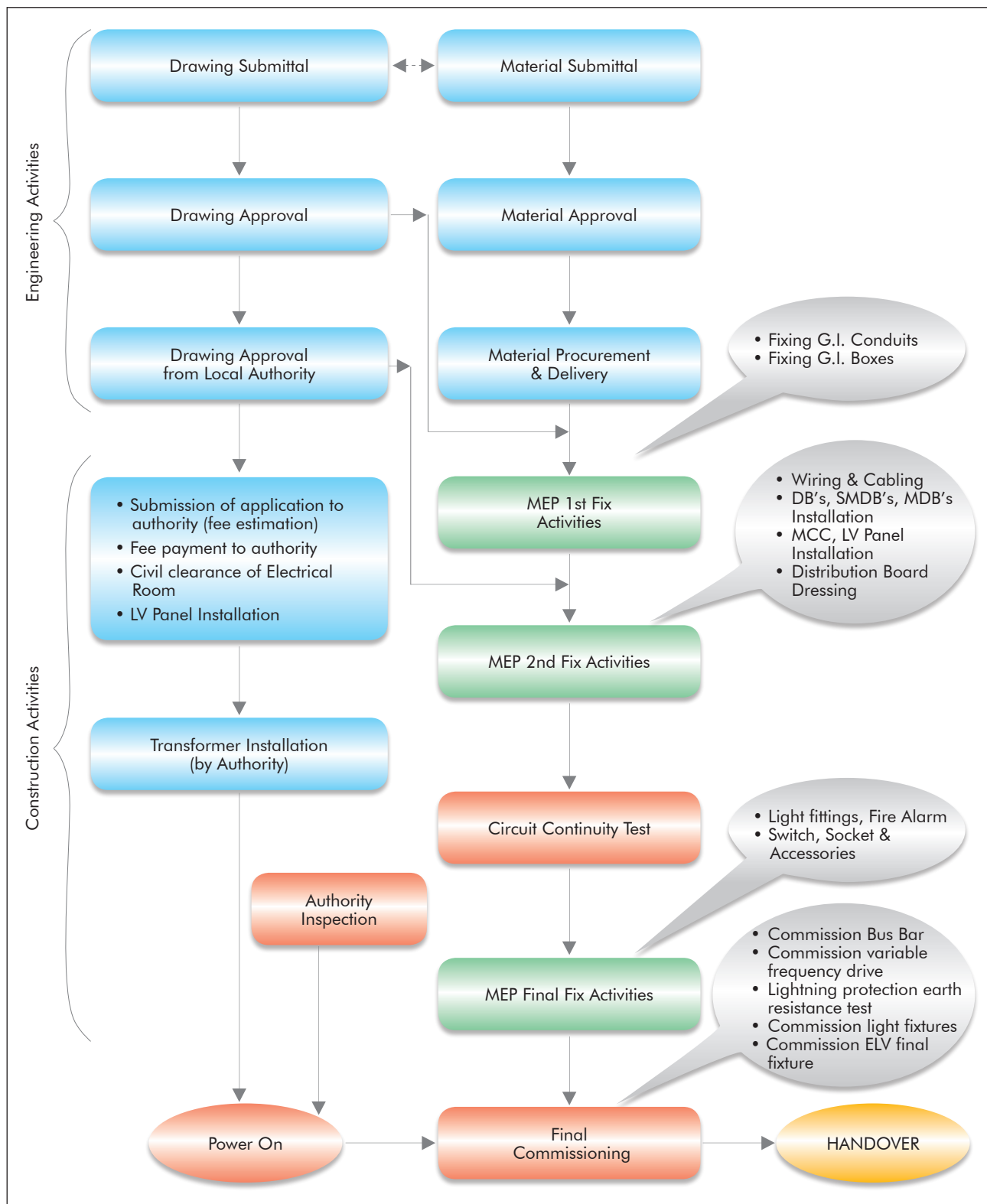


Figure 2.4 Electrical Activities Flow Diagram

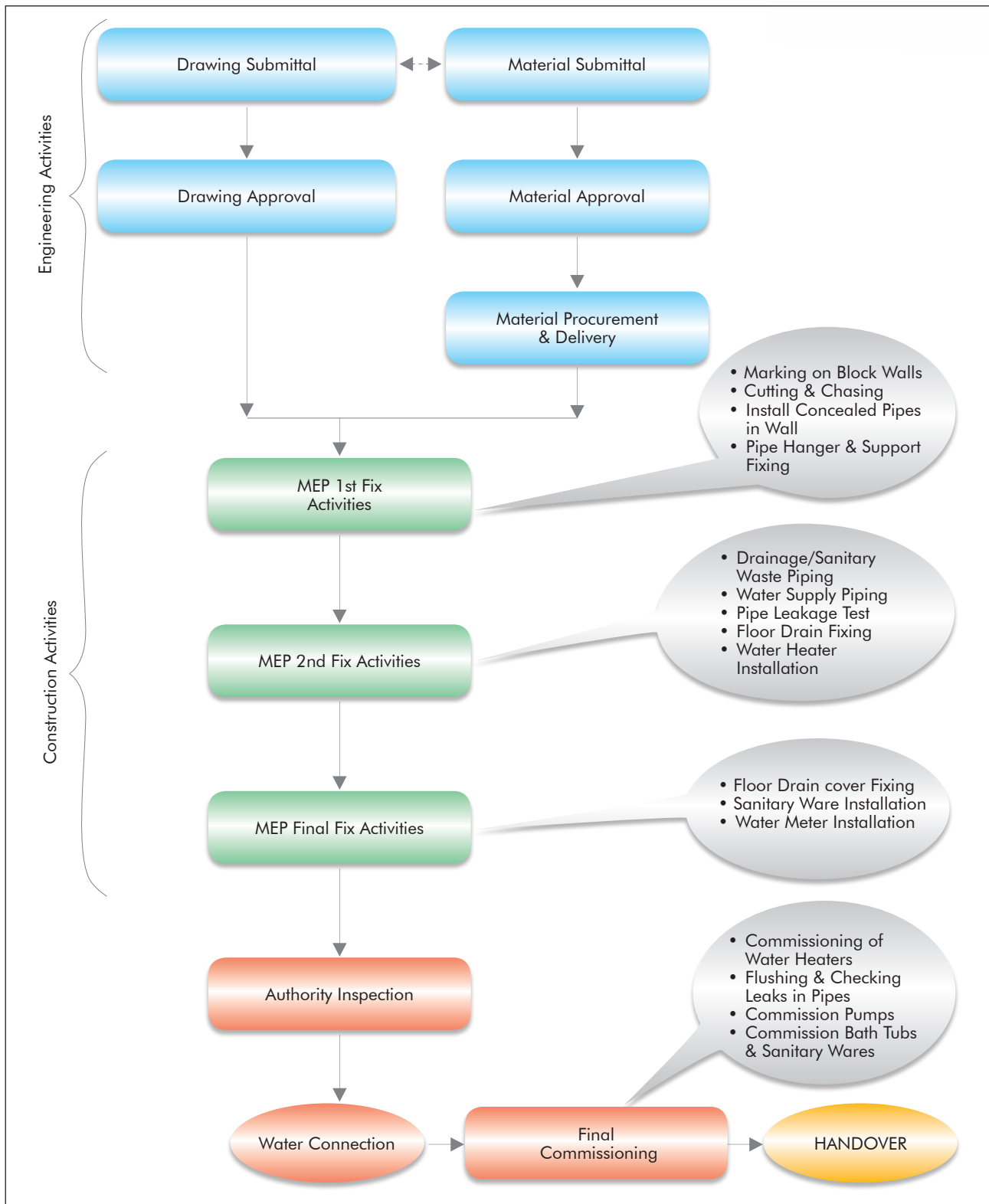


Figure 2.5 Plumbing Activities Flow Diagram

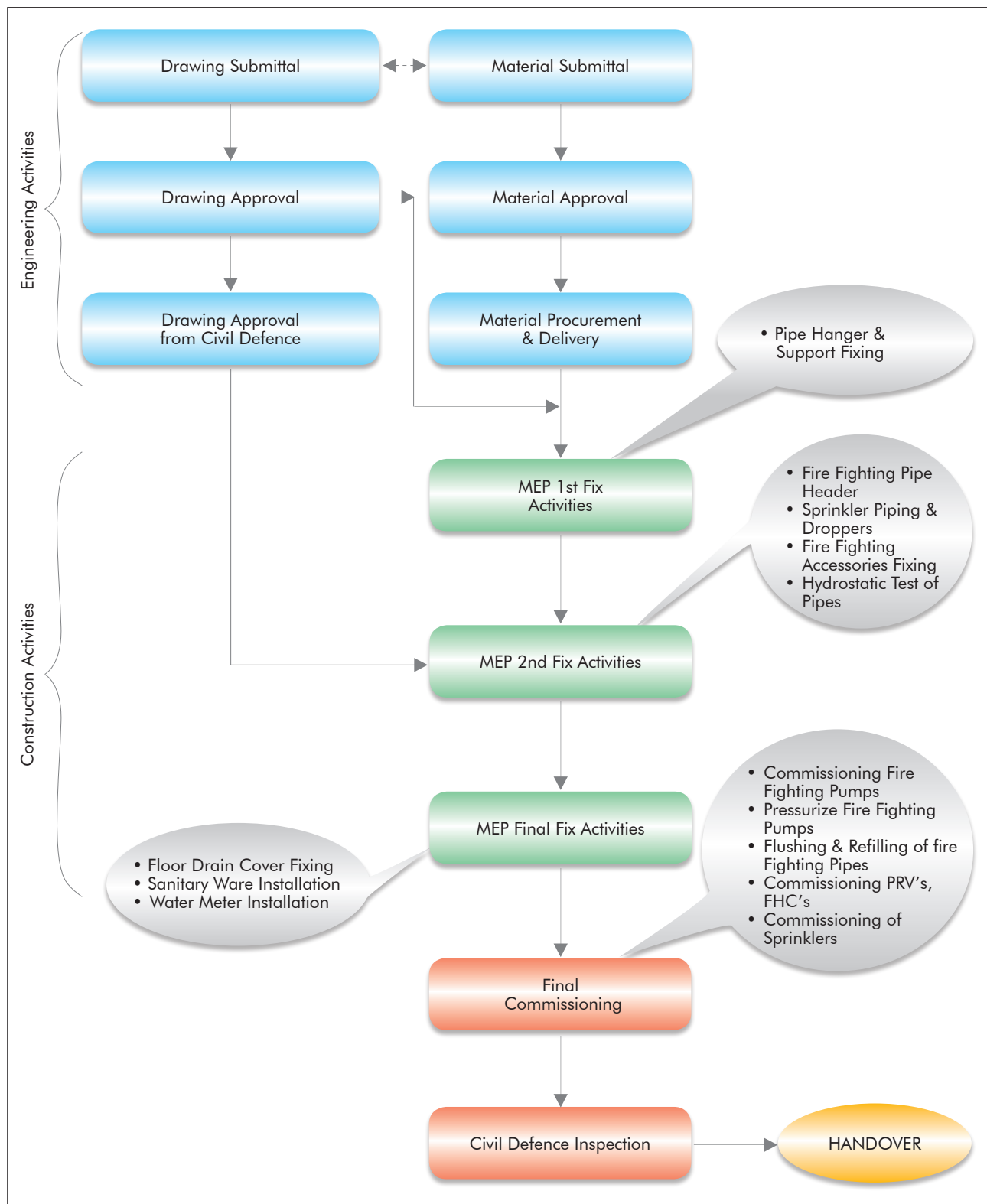


Figure 2.6 Fire Fighting Activities Flow Diagram

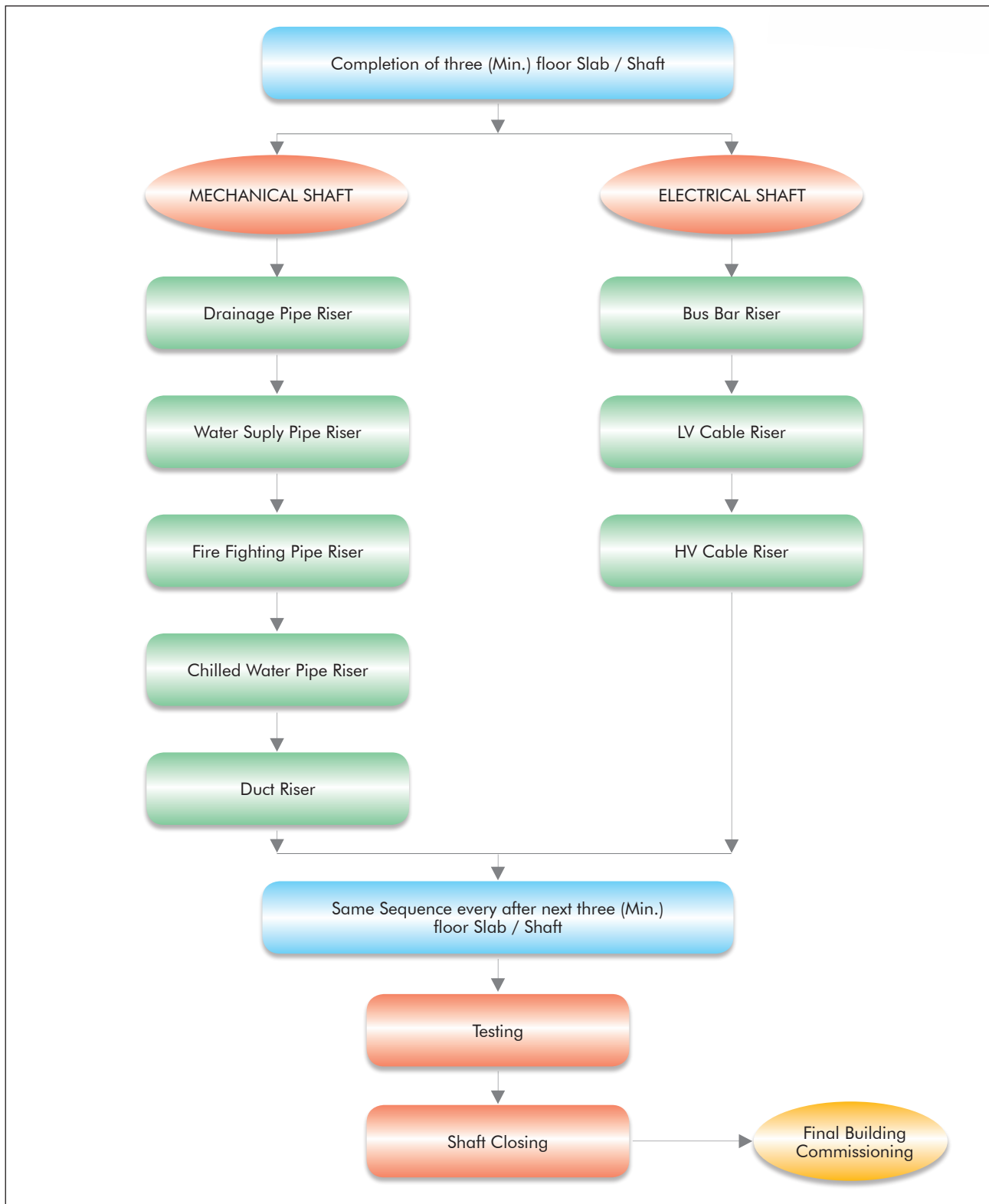


Figure 2.7 Shaft (Risers) Activities Flow Diagram

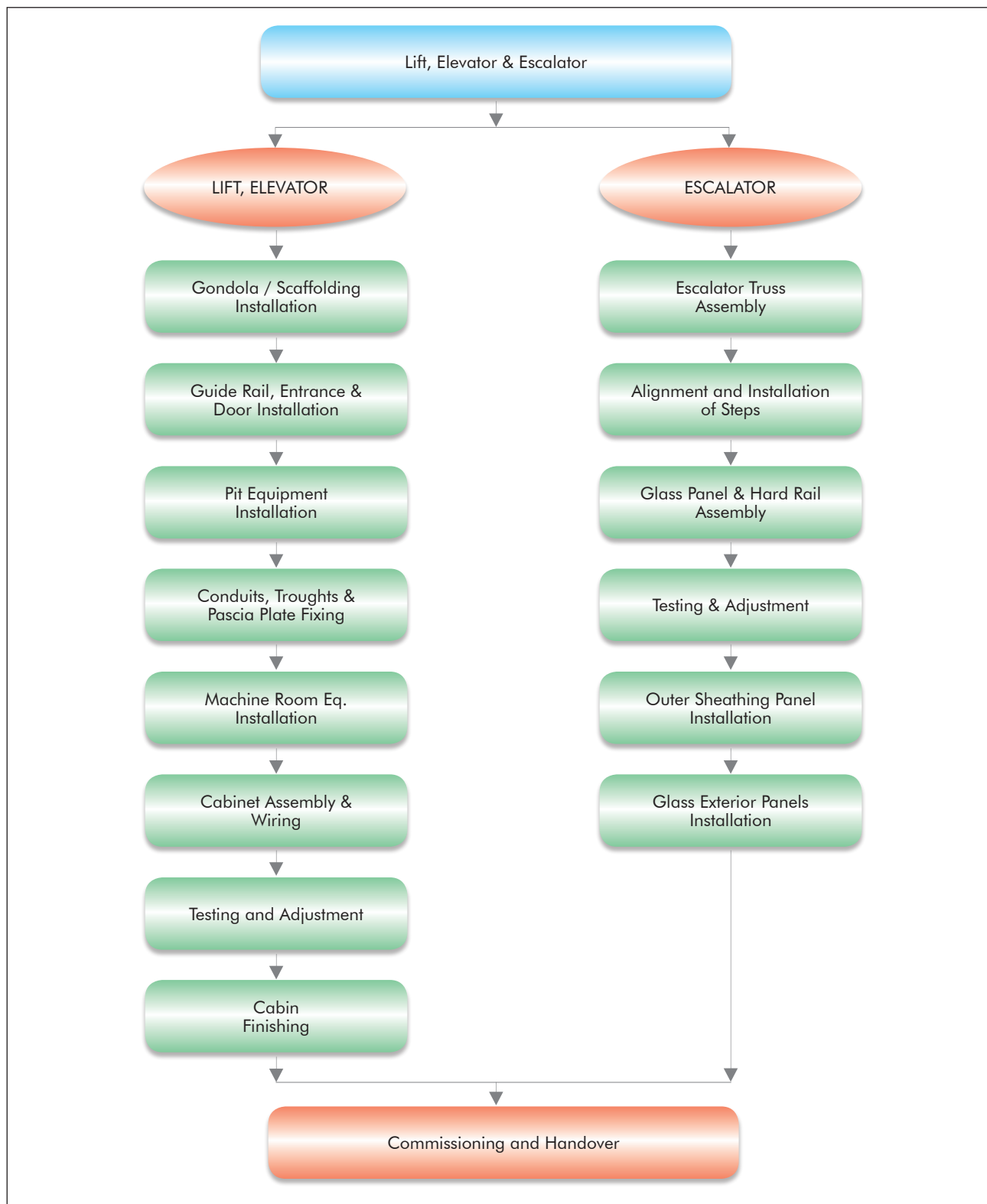


Figure 2.8 Lift, Elevator & Escalator Activities Flow Diagram

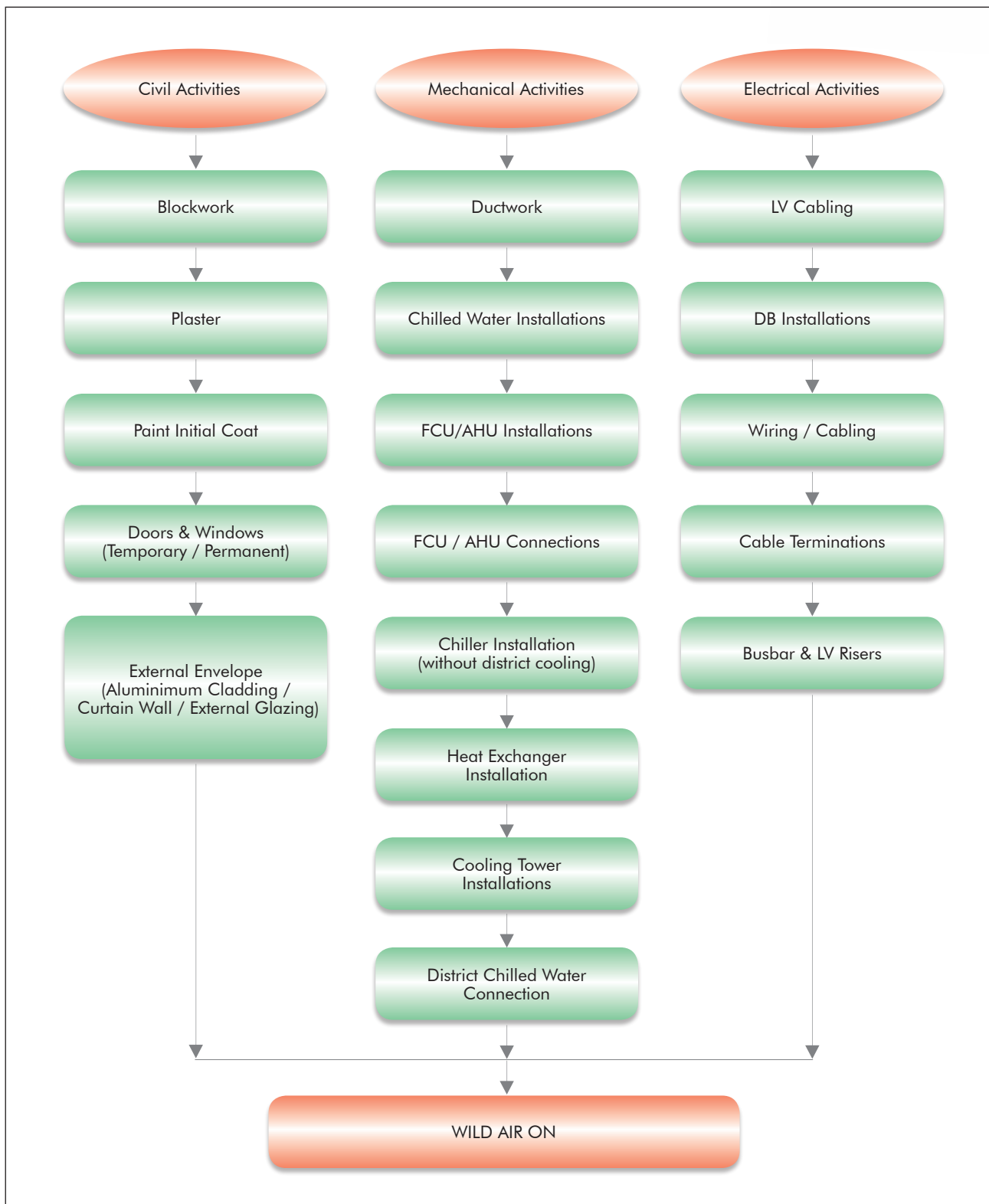


Figure 2.9 Requirement for Wild Air On: (Uncontrolled cold air, prior to balancing)

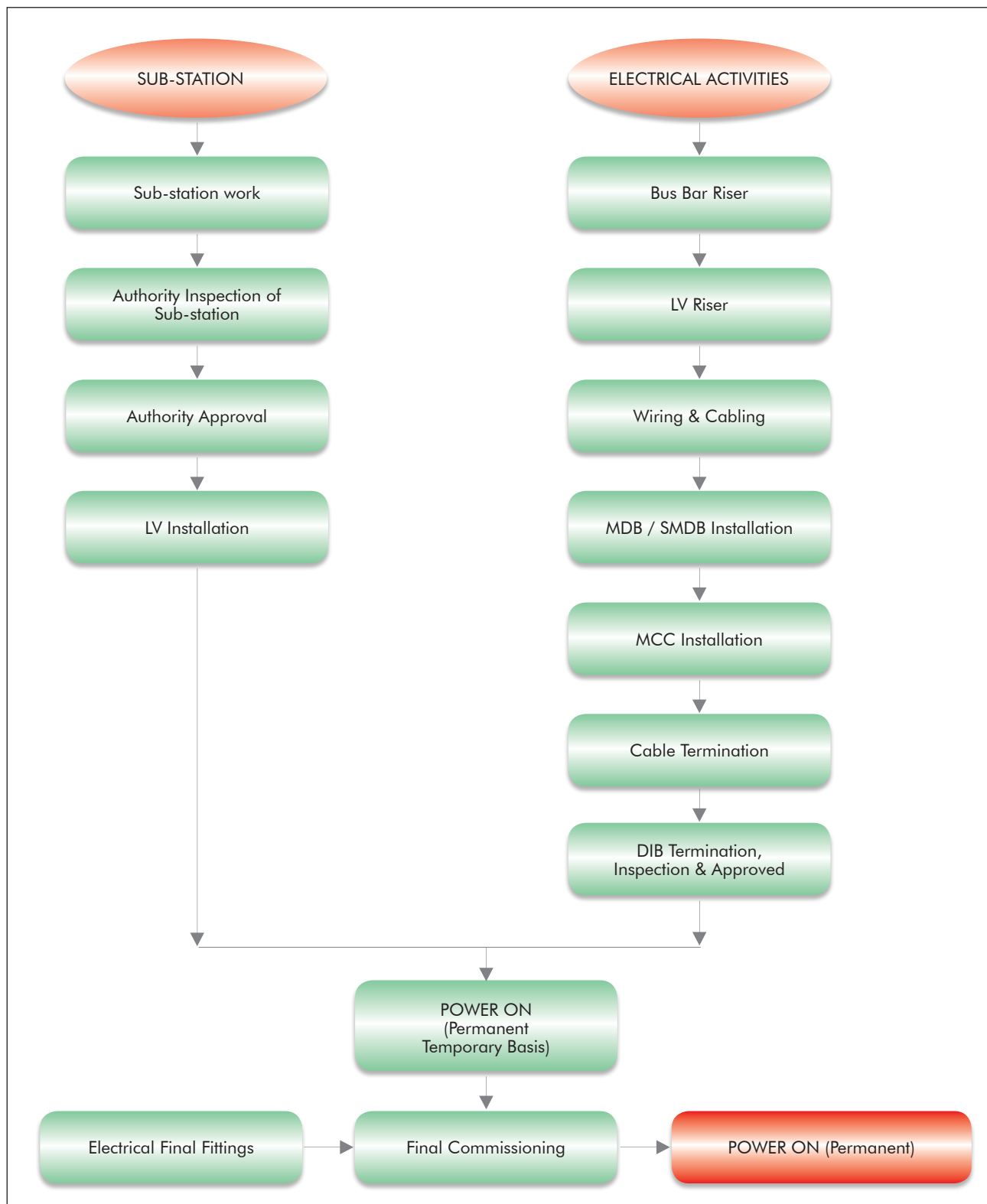


Figure 2.10 Requirement for Power On



# 3

## Building Service And Civil Activity Relationship

### Introduction

For better project monitoring and control it's very necessary to prepare the detailed program. To prepare the construction program without detailed MEP activity is not a good practice because lots of or we can say all civil finishing activities are directly related to MEP activities. For example without completing the high level piping & equipment installation civil contractor can't start their false ceiling work.

By the help of MEP and civil interface chart planning engineer can prepare the detailed integrated construction program in the initial stage for easy monitoring and controlling the project. Each service has separate chart and in the graphical mode for easy understanding.

For activity relationship with civil activity with detailed lag, relation please refer Section 4 (Building Services and Civil activity relationship)

This covers all MEP activity linked with the other civil activities, their relationship and their sequences in an engineering detailed manner.

The MEP and civil interface chart has been made after several discussions with Professional Engineers and the MEP sub-contractors.

List of Figures:-

- |            |   |
|------------|---|
| Figure 3.1 | Mechanical (HVAC) system interface with civil |
| Figure 3.2 | Electrical system interface with civil        |
| Figure 3.3 | Plumbing system interface with civil          |
| Figure 3.4 | Fire Fighting system interface with civil     |



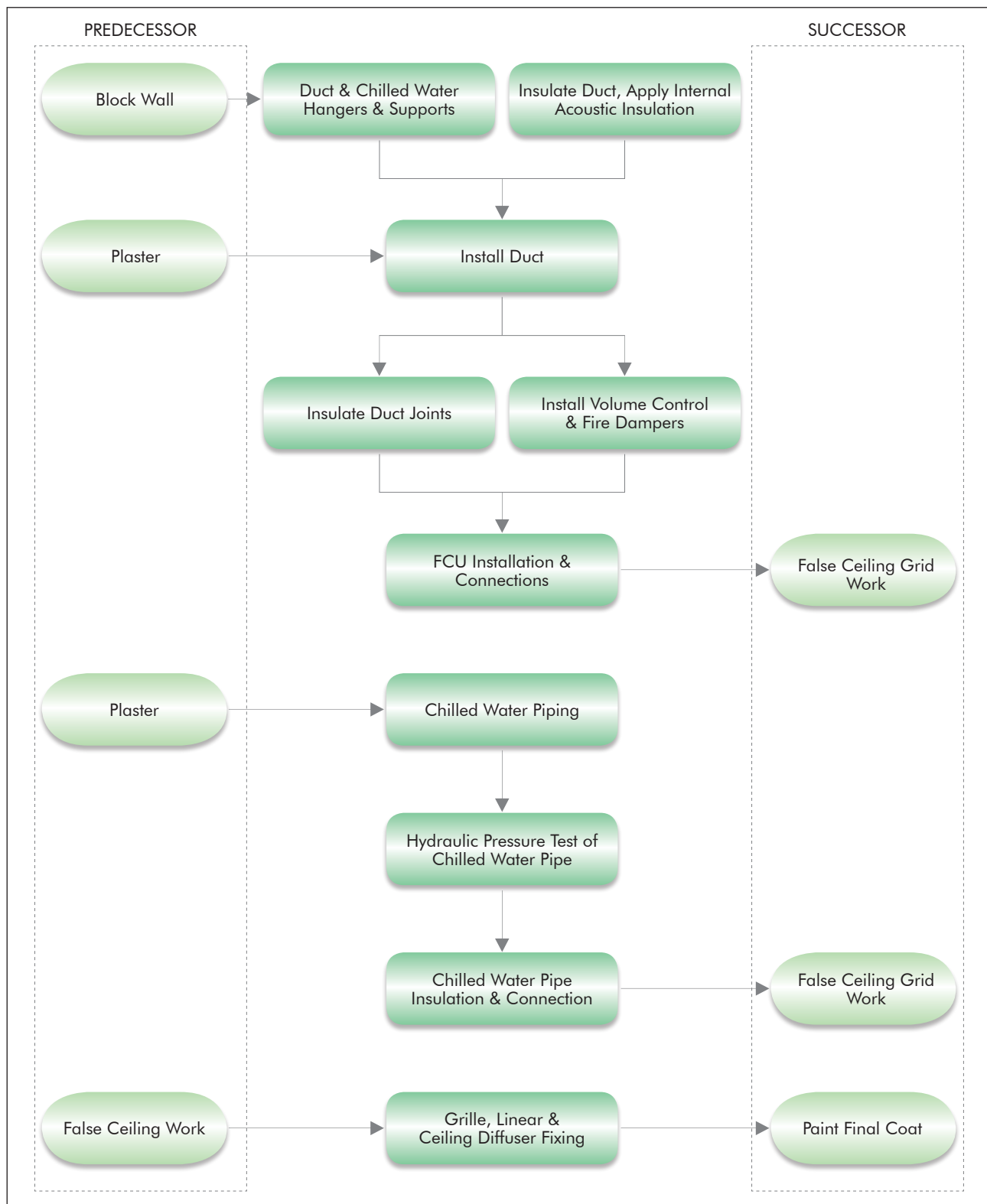


Figure 3.1 Mechanical (HVAC) System – Interface with Civil

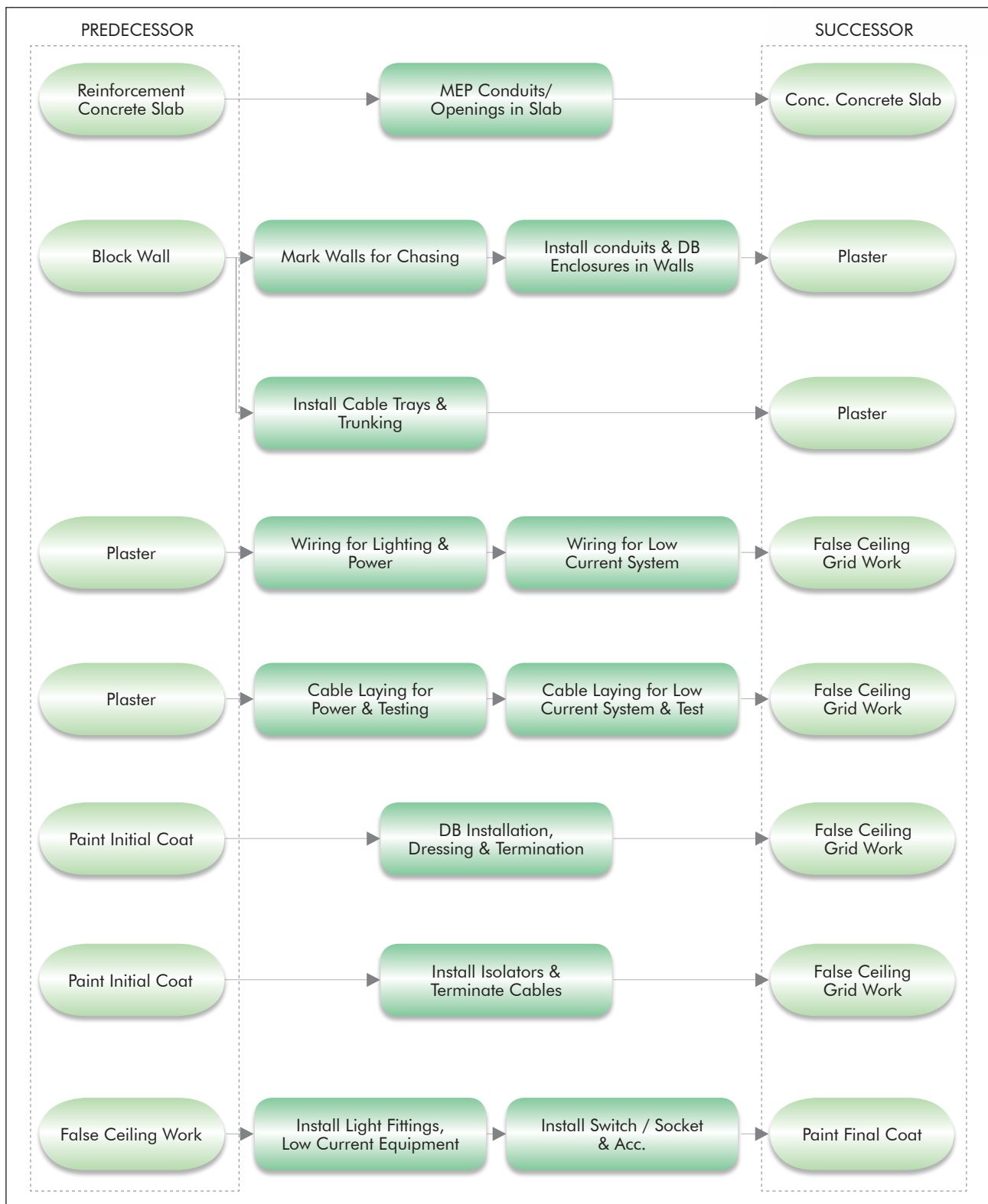


Figure 3.2 Electrical System – Interface with Civil

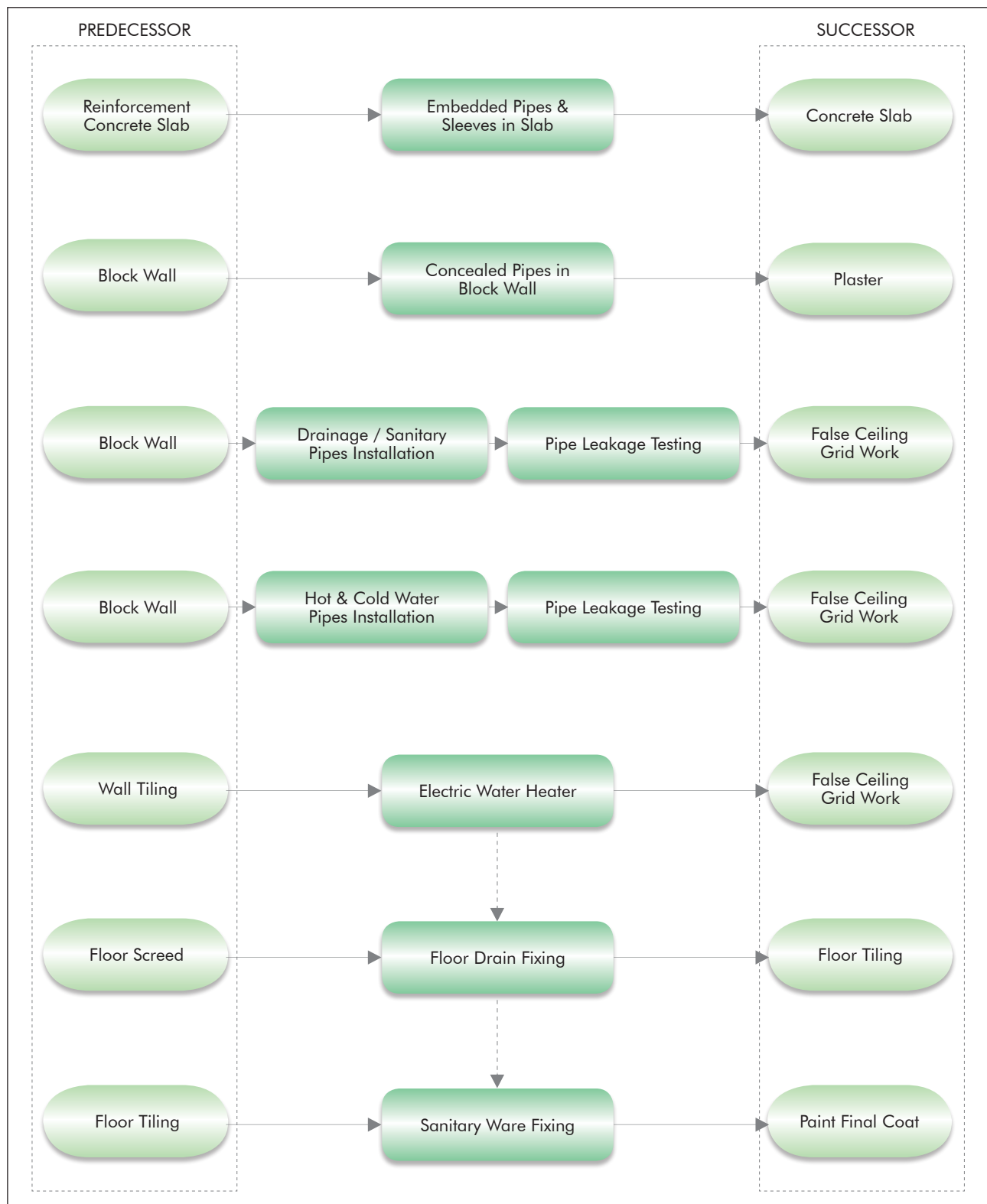


Figure 3.3 Plumbing System – Interface with Civil

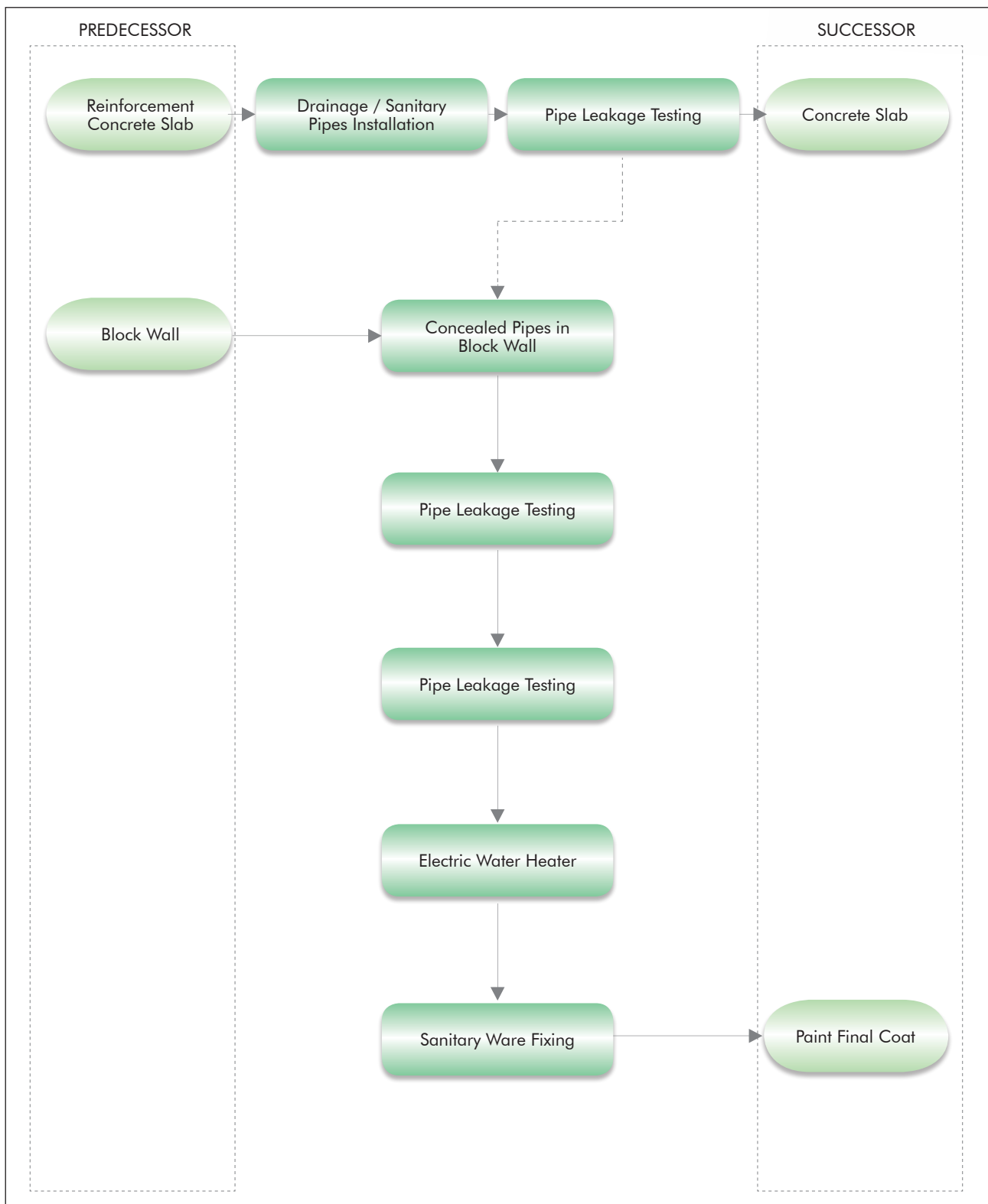


Figure 3.4 Fire Fighting System - Interface with Civil

# 4

## Building Service And Civil Activity Interface - Tabular

### Introduction

During the project planning process, the activities necessary to complete the construction project were identified, along with estimated activities. The next step is to development of an activity network, which establishes the logical relationship between activities.

This section will built on the construction planning and scheduling process of building services presented in section 1, 2 and 3, and will define the elements of an activity network and the concept of precedence as it applies to network scheduling.

The concept of precedence is established in all network schedules. The concept of precedence is necessary for the effective monitoring and controlling of complex projects. Precedence assumes that succeeding activities cannot start until all preceding activities are started. The concept of precedence is the characteristic that makes network schedules so effective in planning, scheduling, monitoring and controlling construction projects.

While it is true those bar charts implicity include activity sequencing, the logical relationships between activities are not explicity built into bar chart schedules. Therefore, a change in sequence or duration of an activity in a bar chart will only affect those activities for which the sequence or duration was changed.

This section deals in building services and civil activities interface in very detailed manner. While integrating building services activities in the master civil program this section is very helpful. All building services activities having at least one predecessor and one successor with three types of relationships with suitable lags. All relationships are logically correct and cab be used as per project time requirements.

Example:

Main Activity : Install Cable Tray & Trunking



Predecessor:-

- 1 Block work (SS+5): activity install cable tray and trunking will start after 5 days of the block work start. This duration (lag+5) is the minimum period for blockwork to complete some area to start the given activity.
- 2 Block work (SS+7): activity install cable tray and trunking will start after 7 days of the block work start. This duration (lag+7) can be used when we have little flexible time.
- 3 Block work (FS+0): activity install cable tray and trunking will start after completion of the block work. This relationship can be used when we have enough float in block work.

Note: - Same principle will follow for successors.

List of Figures:-

- Table 4.1 Mechanical (HVAC) system interface with civil
- Table 4.2 Electrical system interface with civil
- Table 4.3 Plumbing system interface with civil
- Table 4.4 Fire Fighting system interface with civil

Table 4.1 Mechanical (HVAC) system – interface with civil

Predecessor				Main Activity	Successors					
Activity	Relationship				Relationship			Activity		
	Lag (days)				Lag (days)					
	Min.	Avg.	Max.		Min.	Avg.	Max.			
Block Work	SS	SS	FS	Duct Hangers & Supports	SS	FS	FS	Ducting - Supply, Return, Fresh & Exhaust		
	2	5	0		2	0	0			
Block Work	SS	SS	FS	Chilled Water Pipe Hanger & Supports	SS	FS	FS	Chilled Water Piping		
	2	5	0		2	0	0			
Duct Hangers & Supports	SS	FS	FS	Ducting - Supply, Return, Fresh & Exhaust	SS	SS	FS	Damper Fixing - Volume, Fire & Smoke		
	2	0	0		5	8	0			
Damper Fixing - Volume, Fire & Smoke	SS	SS	FS	Damper Fixing - Volume, Fire & Smoke	SS	SS	FS	Duct Insulation		
	5	8	0		0	5	0			
Damper Fixing - Volume, Fire & Smoke	SS	SS	FS	Duct Insulation	FS	FS	FS	Duct Connection to FCU		
	0	5	0		0	0	0			
Chilled Water Pipe Hanger & Supports	SS	FS	FS	Chilled Water Piping	FS	FS	FS	Chilled Water Pipe Leakage Testing		
	2	0	0		0	0	0			
Chilled Water Piping	SS	SS	FS	Chilled Water Pipe Insulation	FS	FS	FS	Pipe Connection to FCU		
	5	10	0		0	0	0			
Chilled Water Piping	FS	FS	FS	Chilled Water Pipe Leakage Testing	FF	FF	FF	Chilled Water Pipe Insulation		
	0	0	0		2	4	7			
Chilled Water Piping	SS	SS	FS	Condensate Drain Piping	SS	FF	FS	Condensate Drain Pipe Insulation		
	5	7	0		2	0	0			
Condensate Drain Piping	SS	FF	FS	Condensate Drain Piping Insulation	FS	FS	FS	False Ceiling Suspension		
	2	0	0		0	0	0			
Block Work	FS	FS	FS	Fan Coil Unit Installation	SS	SS	FS	Duct Connection to FCU Pipe Connection to FCU		
	0	0	0		3	5	0			
Fan Coil Unit Installation	SS	SS	FS	Duct Connection to FCU	FS	FS	FS	False Ceiling Suspension		
	3	5	0		0	0	0			
Fan Coil Unit Installation	SS	SS	FS	Pipe Connection to FCU	FS	FS	FS	False Ceiling Suspension		
	3	5	0		0	0	0			
False Ceiling Suspension	SS	SS	FS	Bends, Droppers & Mouth Piece	SS	SS	FS	False Ceiling Closure		
	2	5	0		2	5	0			
Doors & Ironmongery	SS	FS	FS	Kitchen Exhaust Fan Fixing	FS	FS	FS	Preliminary Testing & Snagging		
	4	0	0		0	0	0			
False Ceiling Suspension	SS	SS	FS	Ceiling Diffuser Fixing	FS	FS	FS	Preliminary Testing & Snagging		
	2	5	0		0	0	0			
Final Paint	SS	FF	FS	Grille & Linear Fixing	FS	FS	FS	Preliminary Testing & Snagging		
	2	0	0		0	0	0			
Final Paint	FS	FS	FS	Thermostat Fixing	FS	FS	FS	Preliminary Testing & Snagging		
	0	0	0		0	0	0			



**Table 4.2 Electrical System – Interface with Civil**

Predecessor				Successors	Relationship			Activity
Activity	Relationship				Lag (days)			
	Lag (days)				Lag (days)			
	Min.	Avg.	Max.		Min.	Avg.	Max.	
Block Work	SS	SS	FS	Marking on Block work for Concealed Conduits	SS	SS	FS	Cutting & Chasing in Block work
	3	7	0		2	5	0	
Marking on Block Work Concealed Conduits	SS	SS	FS	Cutting & Chasing in Block work	SS	SS	FS	Concealed Conduits, G.I. for Boxes in Block work
	2	5	0		2	5	0	
Cutting & Chasing in Blockwork	SS	SS	FS	Concealed Conduits, G.I. Boxes in Block work	FF	FF	FS	Plaster
	2	5	0		2	5	0	
Block Work	SS	SS	FS	Install Cable Tray & Trunking	SS	SS	FS	Cable laying for Power / Low Current System
	5	10	0		4	7	0	
Block Work	SS	SS	FS	G.I. & PVC Surface Conduits	SS	SS	FS	Wiring for Lighting & Power & Low Current Sys.
	3	7	0		3	7	0	
Plaster	SS	FS	FS	Wiring for Lighting & Power	SS	FS	FS	False Ceiling Suspension
	7	0	0		5	0	0	
Plaster	SS	FS	FS	Wiring for Low Current System	SS	FS	FS	False Ceiling Suspension
	7	0	0		5	0	0	
Plaster	SS	FS	FS	Cable laying for Power	SS	FS	FS	False Ceiling Suspension
	7	0	0		5	0	0	
Plaster	SS	FS	FS	Cable laying for Low Current System	SS	FS	FS	False Ceiling Suspension
	7	0	0		5	0	0	
Paint Initial Coat	SS	SS	FS	Distribution Board Installation, Dressing & Termination	SS	SS	FS	Switch, Sockets & Accessories Fixing
	4	8	0		2	6	0	
Paint Initial Coat	SS	SS	FS	Sub Main Distribution Board Installation	SS	SS	FS	Install Isolator & Terminate Cables
	4	8	0		2	6	0	
Paint Initial Coat	SS	SS	FS	Main Distribution Board Installation	SS	SS	FS	Install Isolator & Terminate Cables
	4	8	0		2	6	0	
Doors & Ironmongery	SS	SS	FS	Install Isolator & Terminate Cables	FS	FS	FS	Circuit Continuity Test
	2	5	0		0	0	0	
Install Isolator & Terminate Cables	FS	FS	FS	Circuit Continuity Test	FS	FS	FS	Switch, Sockets & Accessories Fixing
	0	0	0		0	0	0	
Paint Final Coat	SS	FF	FS	Fire Alarm Fixing	FS	FS	FS	Preliminary Testing & Snagging
	4	0	0		0	0	0	
Paint Final Coat	SS	FF	FS	Light Fixtures Fixing	FS	FS	FS	Preliminary Testing & Snagging
	4	0	0		0	0	0	
Paint Final Coat	SS	FF	FS	Switch, Sockets & Accessories Fixing	FS	FS	FS	Preliminary Testing & Snagging
	4	0	0		0	0	0	



Table 4.3 Plumbing System – Interface with Civil

Predecessor				Main Activity	Successors			
Activity	Relationship				Relationship			Activity
	Lag (days)				Lag (days)			
	Min.	Avg.	Max.		Min.	Avg.	Max.	
Block Work	SS	SS	FS	Marking on Block work	SS	SS	FS	Cutting & Chasing
	3	7	0		2	5	0	
Marking on Block work	SS	SS	FS	Cutting & Chasing	SS	SS	FS	Concealed Water & Drainage Piping
	2	5	0		2	5	0	
Cutting & Chasing	SS	SS	FS	Concealed Water & Drainage Piping	FF	FF	FS	Plaster
	2	5	0		2	5	0	
Block Work	SS	SS	FS	Drainage Piping – Horizontal	FS	FS	FS	Drainage Pipe Leakage Test
	3	7	0		0	0	0	
Block Work	SS	SS	FS	Water Supply Piping – Horizontal	FS	FS	FS	Water Supply Leakage Test
	3	7	0		0	0	0	
Drainage Piping – Horizontal	FS	FS	FS	Drainage Pipe Leakage Test	FS	FS	FS	False Ceiling Suspension
	0	0	0		0	0	0	
Water Supply Piping – Horizontal	FS	FS	FS	Water Supply Leakage Test	FS	FS	FS	False Ceiling Suspension
	0	0	0		0	0	0	
Drainage Piping – Horizontal	SS	SS	FS	Floor Trap Fixing	FS	FS	FS	False Ceiling Suspension
	2	5	0		0	0	0	
Plaster	SS	SS	FS	Electric Water Heater Installation & Conn.	FS	FS	FS	False Ceiling Suspension
	2	5	0		0	0	0	
Wall Tiling	SS	SS	FF	Bath Tub / Shower Tray Installation	SS	FF	FS	Floor Tiling/Screed/ Wet W.P.
	2	5	0		2	2	0	
Floor Tiling / Screed / Wet W.P.	SS	SS	FS	Sanitary Ware Installation	SS	SS	FS	Sanitary Fixture Fixing
	2	5	0		2	5	0	
Sanitary Ware Installation	SS	SS	FS	Sanitary Fixture Fixing	FS	FS	FS	Preliminary Testing & Snagging
	2	5	0		0	0	0	
Floor Tiling / Screed / Wet W.P.	SS	SS	FS	Floor Trap Cover Fixing	FS	FS	FS	Preliminary Testing & Snagging
	2	5	0		0	0	0	
Doors & Ironmongery	FS	FS	FS	Water Meter Fixing	FS	FS	FS	Preliminary Testing & Snagging
	0	0	0		0	0	0	

Table 4.4 Fire Fighting System – Interface with Civil

Predecessor				Main Activity	Successors			
Activity	Relationship				Relationship			Activity
	Lag (days)				Lag (days)			
	Min.	Avg.	Max.		Min.	Avg.	Max.	
Block Work	SS	SS	FS	Support & hangers Fixing for Pipes	SS	SS	FS	Fire Fighting Piping – Horizontal
	3	7	0		2	4	0	
Support & hangers Fixing for Pipes	SS	SS	FS	Fire Fighting Piping – Horizontal	FS	FS	FS	Fire Fighting Pipe Testing
	2	4	0		0	0	0	
Fire Fighting Piping – Horizontal	FS	FS	FS	Fire Fighting Pipe Testing	FS	FS	FS	Fire Fighting Accessories Fixing
	0	0	0		0	0	0	
Fire Fighting Pipe Testing	FS	FS	FS	Fire Fighting Accessories Fixing	FS	FS	FS	False Ceiling Suspension
	0	0	0		0	0	0	
False Ceiling Closure	SS	FF	FS	Sprinkler Fixing	FS	FS	FS	Preliminary Testing & Snagging
	2	0	0		0	0	0	
Paint Final Coat	SS	FF	FS	Fire Hose Reel Fixing	FS	FS	FS	Preliminary Testing & Snagging
	2	0	0		0	0	0	
Paint Final Coat	SS	FF	FS	Fire Extinguisher Fixing	FS	FS	FS	Preliminary Testing & Snagging
	2	0	0		0	0	0	
Paint Final Coat	SS	FF	FS	Fire Blanket Fixing	FS	FS	FS	Preliminary Testing & Snagging
	2	0	0		0	0	0	

# 5

## Activity Production Rate

### Introduction

The production rate should be the planned average daily production rate based on available resource and the environment within which the work will be performed. The production rate include not only the productive time associated with a particular activity but also idle and non-productive time associated with the movement and setup of equipment, break times, expected equipment downtime for maintenance and repair, and other expected downtime. When estimating a production rate, resource availability and other factors affecting productive need to be considered.

Resource planning and scheduling are critical to the successful completion of any project. Labor, material and equipment must be considered when establishing planned activity durations and developing network logic. Project work cannot be accomplished on schedule without the following three resources being available in sufficient quantities at the time they are needed:

- Manpower (Labor)
- Equipment
- Materials

### Estimation of activity durations

The accuracy of activity duration estimates is very important. The duration of an activity is a function of the amount of work that must be accomplished and the rate at which work can be accomplished. Simply stated, the duration of an activity is the quantity of work divided by the production rate. The basic formula for estimating activity durations is as follows:

$$\text{Activity Duration} = \frac{\text{Work Quantity}}{\text{Production Rate} \times \text{Resource Usage}}$$



The work quantity is the amount of work that must be accomplished as defined by the construction documents. The quantity of work is expressed in some measurable quantity such as the amount of material or the equipment that need to be installing.

This section covers the manpower requirement to complete each activity and the time required to complete. The production rate given in this section, on the other hand, is not a constant and can be affected by a number of factors both within and beyond the contractor's control.

**Table 5.1 Production Rate For MEP Activities**

Description	Unit	Qty./ day (Avg)	Qty/hr (Avg.)	Manpower Requirement Per GroupTotal								Manpower Per Group
				PL	PF	PW	DM	IN	EL	HL		
FIRE FIGHTING PIPES												
25mm diameter black seamless steel pipe with threaded fittings	m	30	3.75		1					1	2	
32mm diameter black seamless steel pipe with threaded fittings	m	30	3.75		1					1	2	
40mm diameter black seamless steel pipe with threaded fittings	m	30	3.75		1					1	2	
50mm diameter black seamless steel pipe with threaded fittings	m	30	3.75		1					1	2	
65mm diameter black seamless steel pipe with grooved-end	m	20	2.5		1					1	2	
80mm diameter black seamless steel pipe with grooved-end	m	20	2.5		1					2	3	
100mm diameter black seamless steel pipe with grooved-end	m	20	2.5		1					2	3	
125mm diameter black seamless steel pipe with grooved-end	m	20	2.5		1					2	3	
150mm diameter black seamless steel pipe with grooved-end	m	18	2.25		2					4	6	
200mm diameter black seamless steel pipe with grooved-end	m	18	2.25		2					4	6	
250mm diameter black seamless steel pipe with grooved-end	m	18	2.25		2					4	6	
300mm diameter black seamless steel pipe with grooved-end	m	18	2.25		2					4	6	

PL = Plumber, PF = Pipe Fitter, PW = Pipe Welder, IN = Insulator, DM = Ductman, EL = Electrician, HL = Helper

Contd...

Description	Unit	Qty./ day (Avg)	Qty/hr (Avg.)	Manpower Requirement Per GroupTotal								Manpower Per Group
				PL	PF	PW	DM	IN	EL	HL		
HOT AND COLD WATER DISTRIBUTION PIPES												
20mm diameter C.P.V.C. pipes include fittings	m	36	4.5	1						1	2	
25mm diameter C.P.V.C. pipes include fittings	m	36	4.5	1						1	2	
32mm diameter C.P.V.C. pipes include fittings	m	36	4.5	1						1	2	
40mm diameter C.P.V.C. pipes include fittings	m	36	4.5	1						1	2	
50mm diameter C.P.V.C. pipes include fittings	m	36	4.5	1						1	2	
63mm diameter C.P.V.C. pipes include fittings	m	24	3	1						2	3	
75mm diameter C.P.V.C. pipes include fittings	m	24	3	1						2	3	
90mm diameter C.P.V.C. pipes include fittings	m	24	3	1						2	3	

#### SANITARY AND RAINWATER PIPES

40mm diameter UPVC pipes with elastomere joint socket include fittings	m	36	4.5	1						1	2
50mm diameter UPVC pipes with elastomere joint socket include fittings	m	36	4.5	1						1	2
63mm diameter UPVC pipes with elastomere joint socket include fittings	m	30	3.75	1						1	2
75mm diameter UPVC pipes with elastomere joint socket include fittings	m	30	3.75	1						1	2
110mm diameter UPVC pipes with elastomere joint socket include fittings	m	24	3	1						2	3
125mm diameter UPVC pipes with elastomere joint socket include fittings	m	24	3	1						2	3
160mm diameter UPVC pipes with elastomere joint socket include fittings	m	18	2.25	1						2	3
200mm diameter UPVC pipes with elastomere joint socket include fittings	m	18	2.25	1						2	3
25mm diameter PVC condensate pipes with insulation	m	30	3.75	1				1		1	3
32mm diameter PVC condensate pipes with insulation	m	30	3.75	1				1		1	3
40mm diameter PVC condensate pipes with insulation	m	30	3.75	1				1		1	3
50mm diameter PVC condensate pipes with insulation	m	30	3.75	1				1		1	3

PL = Plumber, PF = Pipe Fitter, PW = Pipe Welder, IN = Insulator, DM = Ductman, EL = Electrician, HL = Helper

Contd...



Description	Unit	Qty./ day (Avg)	Qty/hr (Avg.)	Manpower Requirement Per GroupTotal							Manpower Per Group
				PL	PF	PW	DM	IN	EL	HL	
60mm diameter PVC condensate pipes with insulation	m	20	2.5	1				1		1	3
110mm diameter PVC condensate pipes with insulation	m	20	2.5	1				1		2	4

#### HYDRONIC PIPES (CHILLED WATER PIPES)

15mm diameter seamless black steel pipe include fittings	m	30	3.75		1					1	2
20mm diameter seamless black steel pipe include fittings	m	30	3.75		1					1	2
25mm diameter seamless black steel pipe include fittings	m	30	3.75		1					1	2
32mm diameter seamless black steel pipe include fittings	m	30	3.75		1					1	2
40mm diameter seamless black steel pipe include fittings	m	30	3.75		1					1	2
50mm diameter seamless black steel pipe include fittings	m	30	3.75		1					1	2
65mm diameter seamless black steel pipe include fittings	m	20	2.5		1					1	2
80mm diameter seamless black steel pipe include fittings	m	20	2.5		1					1	2
100mm diameter seamless black steel pipe include fittings	m	20	2.5		1					2	3
125mm diameter seamless black steel pipe include fittings	m	20	2.5		1					2	3
150mm diameter seamless black steel pipe include fittings	m	20	2.5		1					2	3
200mm diameter seamless black steel pipe include fittings	m	18	2.25		2					4	6
250mm diameter seamless black steel pipe include fittings	m	18	2.25		2					4	6
300mm diameter seamless black steel pipe include fittings	m	18	2.25		2					4	6

#### HYDRONIC PIPES INSULATION (CHILLED WATER PIPES)

15mm diameter pipe insulation	m	50	6.25					1		1	2
20mm diameter pipe insulation	m	50	6.25					1		1	2
25mm diameter pipe insulation	m	50	6.25					1		1	2
32mm diameter pipe insulation	m	50	6.25					1		1	2
40mm diameter pipe insulation	m	50	6.25					1		1	2
50mm diameter pipe insulation	m	50	6.25					1		1	2
65mm diameter pipe insulation	m	30	3.75					1		1	2
80mm diameter pipe insulation	m	30	3.75					1		1	2

PL = Plumber, PF = Pipe Fitter, PW = Pipe Welder, IN = Insulator, DM = Ductman, EL = Electrician, HL = Helper

Contd...

Description	Unit	Qty./day (Avg)	Qty/hr (Avg.)	Manpower Requirement Per Group							Manpower Per Group
				PL	PF	PW	DM	IN	EL	HL	
100mm diameter pipe insulation	m	30	3.75					1		1	2
125mm diameter pipe insulation	m	20	2.5					1		1	2
150mm diameter pipe insulation	m	20	2.5					1		1	2
200mm diameter pipe insulation	m	20	2.5					1		1	2
250mm diameter pipe insulation	m	16	2					1		1	2
300mm diameter pipe insulation	m	16	2					1		1	2

### PLUMBING EQUIPMENT

Water distribution pumps installation (one set)	nos	1	0.125		2					2	4
Booster pumps installation	nos	1	0.125		2					2	4
Sewage lift pumps installation	nos	1	0.125		2					2	4
Electric water heater installation	nos	2	0.25	1						2	3
Bath tub installation	nos	1	0.125	1						2	3
Shower tray installation	nos	1	0.125	1						2	3
Water closet installation	nos	1	0.125	1						1	2
Bidet installation	nos	1	0.13	1						1	2
Wash basin installation	nos	1	0.13	1						1	2
Kitchen sink installation	nos	1	0.125	1						1	2

### FIRE FIGHTING EQUIPMENT

Fire water pumps installation	nos	1	0.13		2					2	4
Fire hose cabinet installation	nos	1	0.13		2					2	4
Sprinkler fixing	nos	30	3.75		1					1	2

### HVAC EQUIPMENT

Fan coil unit (FCU) installation	nos	4	0.50		2					2	4
Air handling unit (AHU) installation	nos	1	0.13		4					4	8
Fresh air handling unit (FAHU) installation	nos	1	0.13		4					4	8
Chilled water pump installation	nos	1	0.13		2					2	4

### DUCTING

Duct installation	sq.ft	60	7.50				1			1	2
Duct insulation	sq.ft	60	7.50					1		1	2
Duct connection to FCU	nos	4	0.50		1					1	2
Duct connection to AHU	nos	1	0.13		4					4	8
Duct connection to FAHU	nos	1	0.13		4					4	8
Chilled water pipe connection to FCU / AHU / FAHU	nos	1	0.13		4					4	8

PL = Plumber, PF = Pipe Fitter, PW = Pipe Welder, IN = Insulator, DM = Ductman, EL = Electrician, HL = Helper



# 6

## Material Procurement

### Introduction

Procurement activities are those activities that are necessary to ensure that needed labor, material, and equipment are available at the project site when needed. Procurement activities are a part of the construction process and must be scheduled as such. An easy and effective means of arranging procurement activities in a construction schedule is the use of procurement ladder mentioned below.

- Material Submit for Review
- Engineer Approval of Material
- Procurement (Order Material)
- Fabricate & Ship Material
- Receive Material

Procurement activities must be included directly in the construction planning and scheduling process. The ability to erect, install, or construct any part of the construction project depend on the availability of the necessary labor, materials, installed equipment, and production equipment. Procurement activities are logical predecessors to construction activities and must be accounted for in the schedule. Not including procurement activities in the construction planning and scheduling process can impact the success of the project. Long lead items can result in procurement activities being on the construction project's critical path as well as those successors construction activities that are not on the critical path if procurement is not included in the construction schedule. In the other words, including procurement in the construction schedule can shift the critical path from the longest chain of construction activities to the longest chain of activities necessary to complete the project, which includes both procurement and construction activities.

Like any construction activity, procurement must be planned and coordinated with suppliers. Suppliers of key materials and equipment need to be included in the project planning and scheduling process.



Owner-supplied materials and equipment must also be included in the construction schedule, which helps the owner plan for their procurement and know when they needed at the construction site so as not to impact project completion. If owner-supplied materials and equipment are not included in the project schedule, then there is no way of knowing when they need to be provided and the impact of not receiving them on site as planned.

On any construction project there is a myriad of materials and installed equipment that needs to be procured before they are installed. Including procurement activities for everything that goes into a construction project is not practical, would make the schedule too complicated, and would detract from the ability of the project team to effectively monitor and control the project. Only the procurement of resources that are critical to the completion of the project, have long lead items, have constraints that impact delivery schedules, or have to coordinated and/or approved by outside entities should be included in the schedule. Common materials that are readily available and can be easily obtained from local sources do not need to be included in the schedule.

It is important that the procurement activities be completed as planned as it is for construction activities to be completed as planned, Problem and delays in the procurement of key materials and equipment can have a domino effect in delays and lost productivity.

This section covers the MEP material procurement & delivery process for the material which is critical to the success of the construction project. The duration mentioned in this section is the minimum duration required for material procurement.

**Table 6.1 Material Submittal, Approval, Procurement & Delivery Schedule – Pipes, Valves, Pumps**

S.No.	Description	Unit	Duration Requirement - 1st Delivery On Site				Total
			Submittal	Approval	Procurement	Manufacturing & Delivery	
PIPES							
PIP-01	Pipe for Fire Fighting System	mtr	21	35	14	60	130
PIP-02	Pipe for Sanitary Water System	mtr	14	14	9	30	67
PIP-03	Pipe for Rain Water System	mtr	14	14	9	30	67
PIP-04	Pipe for Cold Water Supply System	mtr	18	14	12	30	74
PIP-05	Pipe for Hot Water Supply System	mtr	18	14	12	30	74
PIP-06	Pipes for Chilled Water Supply / Return	mtr	21	35	14	60	130
PIP-07	Pipes for Natural Gas	mtr	14	21	12	45	92
PIP-08	Pipes for LPG Gas	mtr	14	21	12	45	92
VALVES							
VAL-01	Double Regulation Valves	nos	21	35	14	60	130
VAL-02	Valves for Fire Fighting System	nos	21	21	12	60	114
VAL-03	Pressure Reducing Valve Station	nos	21	21	14	60	116
VAL-04	Automatic Air Vent	nos	14	14	12	30	70
VAL-05	Valves for Sanitary Water System	nos	14	14	12	30	70
VAL-06	Valves for Rain Water System	nos	14	14	12	30	70
VAL-07	Valves for Water Supply System	nos	14	14	12	30	70
VAL-08	Valves for Chilled Water Supply / Return	nos	21	30	14	60	125
VAL-09	Landing Valves	nos	14	14	14	45	87
VAL-10	Valves for Natural / LPG Gas	nos	14	14	14	45	87
PUMPS							
PUM-01	Sump Pump	nos	21	14	14	60	109
PUM-02	Water Distribution Pumps	nos	21	14	14	90	139
PUM-03	Sewage Pumps	nos	21	14	14	90	139
PUM-04	Booster Pumps	nos	21	14	14	90	139
PUM-05	Fire Water Pumping Station	nos	30	21	14	120	185
PUM-06	Chilled Water Pumps	nos	30	35	14	120	199

Table 6.2 Material Submittal, Approval, Procurement & Delivery Schedule – Mep Equipments

S.No.	Description	Unit	Duration Requirement - 1st Delivery On Site				Total
			Submittal	Approval	Procurement	Manufacturing & Delivery	
MAJOR MEP EQUIPMENTS							
EQP-01	Fan Coil Units	nos	21	35	14	90	160
EQP-02	Air Handling Units	nos	21	35	14	120	190
EQP-03	Chillers	nos	21	45	21	120	207
EQP-04	Water Heat Exchanger	nos	21	35	14	90	160
EQP-05	Air to Air Heat Exchanger	nos	21	35	14	90	160
EQP-06	Air Scrubbers	nos	14	21	12	60	107
EQP-07	Expansion Tanks	nos	14	21	12	60	107
EQP-08	Boiler / Burner	nos	14	21	12	90	137
EQP-09	Calorifier	nos	14	35	12	90	151
EQP-10	Generator	nos	21	45	14	120	200
EQP-11	Motor Control Center (MCC)	nos	21	35	14	120	190
LPG / NATURALGAS ITEMS							
GAS-01	Gas Storage tank	nos	14	35	14	75	138
GAS-01	Gas Leak Detect System	nos	14	35	14	75	138
FIRE FIGHTING & PLUMBING ITEMS							
FFP-01	Sprinkler	nos	14	21	14	60	109
FFP-02	Zone Fire Alarm Flow Switch	nos	14	21	14	60	109
FFP-03	Fire Hose Cabinet	nos	14	21	14	75	124
FFP-04	Fire Hose Reel	nos	14	21	14	75	124
FFP-05	Portable Fire Extinguisher	nos	21	35	14	60	130
FFP-06	Dry Chemical (ABC) System	nos	21	35	14	60	130
FFP-07	FM-200 Extinguishing System	nos	21	35	14	90	160
FFP-08	Water Meter	nos	14	21	14	60	109
FFP-09	Irrigation System	nos	21	45	14	90	170
FFP-10	GRP Water Tanks	nos	14	21	14	60	109
FFP-11	Floor Drain	nos	14	14	14	45	87

**Table 6.3 Material Submittal, Approval, Procurement & Delivery Schedule–Fire Fighting, HVAC Equipments**

S.No.	Description	Unit	Duration Requirement - 1st Delivery On Site				Total
			Submittal	Approval	Procurement	Manufacturing & Delivery	
FIRE FIGHTING & PLUMBING ITEMS							
FFP-12	Sanitary Fixtures	nos	14	35	14	60	123
FFP-13	Pipe Support & Clamp	nos	12	21	14	30	77
FFP-14	Grease Trap	nos	14	21	14	45	94
FFP-15	Water Hammer Arrestor	nos	14	21	14	45	94
FFP-16	Electric Water Heaters	Nos	14	35	14	60	123
HVAC ITEMS							
VAC-01	Ducts	sq.m	14	35	14	45	108
VAC-02	Flexible Duct	m	14	35	14	45	108
VAC-03	Duct Insulation	sq.m	14	14	14	45	87
VAC-04	Fire Damper	nos	14	14	14	60	102
VAC-05	Motorized Smoke Damper	nos	14	35	14	60	123
VAC-06	Volume Control Damper	nos	14	14	14	60	102
VAC-07	Dack Draft Damper	nos	14	14	14	60	102
VAC-08	Gravity Damper	nos	14	14	14	60	102
VAC-09	Fire Damper	nos	14	35	14	60	123
VAC-10	Sound Attenuator	nos	14	35	14	60	123
VAC-11	Accoustic Liner for Duct	sq.m	14	14	14	45	87
VAC-12	Access Doors	nos	14	14	14	45	87
VAC-13	Air Filters	nos	21	14	14	60	109
VAC-14	Vibration Isolators	nos	14	14	14	60	102
VAC-15	Control Valve & Thermostat	nos	14	21	14	60	109
VAC-16	Centrifugal Fans	nos	14	35	14	60	123
VAC-17	Centrifugal In Line Fans	nos	14	35	14	60	123
VAC-18	Floor Top Fans	nos	14	21	14	60	109
VAC-19	Portable Air Fans	nos	14	21	14	60	109
VAC-20	Axial Fans	nos	14	21	14	60	109

**Table 6.4 Material Submittal, Approval, Procurement & Delivery Schedule – HVAC, Electrical**

S.No.	Description	Unit	Duration Requirement - 1st Delivery On Site				Total
			Submittal	Approval	Procurement	Manufacturing & Delivery	
HVAC ITEMS							
VAC-21	Staircase Pressure Fan Installation	nos	14	35	14	60	123
VAC-22	Diffuser	nos	14	14	14	45	87
VAC-23	Grilles & Registers	nos	14	14	14	45	87
VAC-24	Building Management System	lot	30	45	21	90	186
VAC-25	Pipe Insulation of Chilled Water	mtr	14	21	14	45	94
	Supply / Return						
VAC-26	Chemical Dosing Plant	nos	21	35	21	90	167
ELECTRICAL ITEMS							
ELE-01	ATS Panel	nos	21	35	14	60	130
ELE-02	Main Panel Boards MDBs	nos	21	35	14	60	130
ELE-03	Capacitor Bank	nos	21	35	14	60	130
ELE-04	Intermediate Distribution Boards SMDBs	nos	21	35	14	60	130
ELE-05	Distribution Panel Boards DBs	nos	14	21	14	45	94
ELE-06	UPS Distribution Boards UDBs	nos	14	35	14	60	123
ELE-07	Earthing and Lighting Protection	item	14	35	14	45	108
ELE-08	Power Cables	mtr	14	21	14	45	94
ELE-09	Cable Trays	mtr	14	14	14	30	72
ELE-10	Cable Trunk	mtr	14	14	14	30	72
ELE-11	Wiring Devices	item	14	35	14	45	108
ELE-12	Conduits	mtr	14	14	14	30	72
ELE-13	Light Fixtures	nos	14	35	14	60	123
ELE-14	Emergency Lighting	nos	14	35	14	45	108
ELE-15	Self Contained Emergency Lighting	nos	14	35	14	45	108
ELE-16	Disconnect Switch and Cables	nos	14	21	14	30	79
ELE-17	Telecommunication System	nos	21	35	14	60	130
ELE-18	E-PABX System	lot	21	35	14	60	130
ELE-19	External Lighting	lot	14	21	14	60	109

Table 6.5 Material Submittal, Approval, Procurement & Delivery Schedule – Electrical

S.No.	Description	Unit	Duration Requirement - 1st Delivery On Site				Total
			Submittal	Approval	Procurement	Manufacturing & Delivery	
ELECTRICAL ITEMS							
ELE-20	Dimming Panel	nos	21	35	14	60	130
ELE-21	Fire Alarm	nos	14	21	14	45	94
ELE-22	CCTV System	lot	21	35	14	60	130
ELE-23	Access Control System	lot	21	35	14	60	130
ELE-24	Central Battery	nos	21	21	14	45	101
ELE-25	Bus Duct	ml	21	35	14	45	115
ELE-26	Cable & Wiring Identification System	lot	14	14	14	30	72

# 7

## Building Services Equipments Information

### Air Handling Units (AHU)

The air-handling system consists of one or more fan sections, heat exchange sections for heating and / or cooling, an air filtration section, a section for mixing return air with outside air, and a discharge air plenum. Depending on their size, air handling units can be delivered as a single package or assembled from modular components.



### Fan Coil Units (FCU)

Fan coil unit consists of a filter, a cooling and/ or heating coil, a fan, and controls. Units can be located above the ceiling, in wall cabinets, or in soffits. Each fan coil units can be controlled by an independent thermostat. Fan coil units can be designed with two or four pipes. Two pipe fan coil unit are served by a set of supply and return pipes that can carry either hot or chilled water; thus a particular unit is capable of heating or cooling, depending on which water service is available.

A four pipe fan coil unit system has two sets of piping – one set of supply and return for chilled water and another set for hot water. The four pipe system is more flexible than the two pipe system but also more expensive to install. Fan coil units can be used at building perimeters in combination with VAV cooling-only system serving interior spaces.



### Variable Air Volume (VAV)

VAV systems used for cooling vary the quantity of air supplied to the space in response to the space (room) thermostat. The air handling unit supply chilled air. If the cooling load is high, the chilled airflow will be high. As the load diminishes, the airflow is reduced accordingly. No energy is wasted by reheating or mixing warm and chilled air.



## Thermostat

Thermostats are devices that sense and respond to temperature, combining the function of the sensor and controller. Room (space) thermostats may be designed for heating or cooling alone or for heating and controlling in combination.



## Refrigerants

Refrigerants transfer heat (cooling) by changing phase from liquid to vapor. Absorption cooling, evaporative cooling and desiccant cooling all rely on water as the refrigerant. The vapor compression cycle uses other chemicals selected for their physical and thermodynamic properties, such as latent heat of vaporization, thermal conductivity, viscosity, and boiling pressures and temperatures. Chemical stability, flammability and toxicity are also important, along with compatibility with compressor seals and lubricants.

## Direct Expansion (DX) System

Small air conditioning units are often called direct expansion units. If refrigerant is used in the coil, the system is generally termed direct expansion (DX). Most DX systems are equipped with air-cooled condensers. DX refrigerant coils are used in most small air-conditioning equipment and can be used in large equipment. If the compressor is included with the equipment, the resulting device is termed unitary. Unitary devices include small-package terminal units such as window air conditioners and large units such as rooftop air conditioners. If the compressor is remote, and refrigerant is piped to the unit, the resulting system is termed a split system.



## Chilled Water Systems

Water is the low-cost thermal transfer medium that can be pumped from a central cooling plant to dispersed air-conditioning equipment in a large facility. Water chillers may utilize vapor compression or absorption cycle refrigerant and condensing may be accomplished by air cooling or water cooling.



## Chiller

A device that generates a cold liquid that is circulated through an air-handling unit's cooling coil to cool the air supplied to the building. Chillers are a key component of most centralized air-conditioning systems. The function of a chiller is to generate cooling. This is achieved by removing heat and rejecting it out of the building. Chiller efficiency is normally measured by the "Coefficient of Performance" or COP.

This is the ratio of cooling achieved to energy input, and is generally in the region of 3 - three units of cooling for every unit of energy input. Chillers come in a variety of shapes, forms and configurations. In all cases though there will be something being chilled - normally water - and somewhere where heat is being dumped, typically cooling towers.





The main energy efficiency opportunities for chillers are:

**Load matching:** Chillers work poorly at low load, so it is best to have a range of chillers and controls to minimize low load operation.

**Operating temperatures:** Adjusting the temperature of the chilled water and the water going to the cooling towers can improve efficiency.

**Heat recovery:** Around 10% of the heat rejected by a chiller can be used to heat hot water at 60-70°C.

## Cooling Tower

Used in most applications, cooling towers produce water at an appropriate temperature for condensing by evaporation. A portion of the circulated water is evaporated in the cooling tower to cool the remainder, thus minimizing the use of water and any associated expense for processing. Approximately 7 percent of the circulation rate is evaporated and lost to bleed-off in the tower. New water is introduced to make up for that which is lost. Evaporation is achieved by flowing the water over a fill material in the tower, which is designed to effect good contact between water and air. The typical, economical cooling tower is capable of producing water within 5°F of the ambient wet-bulb temperature. In typical temperature climates, this results in water temperature about 10°F cooler than ambient dry-bulb temperature.



## Heat Exchanger

A heat exchanger is a device for transferring heat from one medium to another, such as from steam to hot water, or from water at a higher temperature to water at a lower temperature. There are two basic types of heat exchanger: the shell-and-tube type and the plate type.



Shell-and-tube type Heat Exchanger

The shell-and-tube type of heat exchanger consists of a bundle of tubes in the shell.

This is a "plate type" heat exchanger which passes hot geothermal water past many layers of metal plates, transferring the heat to other water passing through the other side of each plate.



Plate type Heat Exchanger

## Expansion Tanks

Expansion tank is installed to provide high and low limits on the pressure. Tanks can be of the open gravity variety or closed and pressurized. Gravity tanks need to be placed at the very top of the system and are open to the atmosphere. As water in the system expands and contracts, the level in the expansion tank rises and falls. The surface exposed to the atmosphere is a source of dissolved air, which can cause corrosion and air binding. Closed tanks need not be placed at high point of the system. They can be constructed with the water surface exposed to a charge of air, or they can be separated from water by a rubber bellows. Bellows type expansion tanks are preferred, to avoid problems with dissolved air.



## Ductwork

Ductwork is a part of the air handling system and includes the supply, return, outside (fresh) air, relief air and exhaust air ducts. Whereas the supply and return air ducts must be connected to the air handling units, the other ducts may be run independently. Ducts are usually fabricated from sheet metal, such as galvanized steel, aluminum or stainless steel. In most commercial buildings, ductwork shares space above the false ceiling.



## Grilles and Registers

Grilles and registers are air devices equipped with vanes for directing airflow. They can be located in ceiling, walls, or floors. Vanes may be fixed or adjustable. Grilles simply contain vanes; registers contain a control damper behind the vanes.



## Ceiling Diffusers

Diffusers are ceiling-mounted air supply devices with louvers, slots or vanes. Their function is to mix or diffuse supply air with room air without undue draft or localized hot or cold areas.



## Duct Insulation

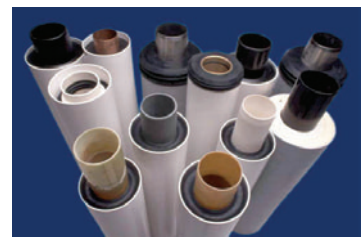
Generally, you will not need insulation for heating and air-conditioning ducts that are enclosed in already well-insulated portions of your house. But, if the ducts for either your heating or your air-conditioning system run above the ceiling or below the floors, they should be insulated.

Insulation is often applied to the interior of the duct and provides acoustical absorption as well as thermal benefits. When applied internally, insulation is called duct liner. Liner, which is applied in the fabrication shop, reduces heating or cooling loss from the duct.



## Chilled Water Pipe Insulation

Chilled water pipe insulation is desirable to prevent thermal losses, to reduce the hazard of touching hot piping surfaces and to prevent condensation on cold piping. Material commonly used for piping insulation includes calcium silicate, foam glass, fiberglass and foam rubber. Fiberglass is less durable but equally suitable and much less expensive for the range of temperature encountered in HVAC systems.



## Plumbing Fixtures

Plumbing fixtures are receptacles, devices, or appliances that are supplied with water or that receive liquid-borne wastes and then discharge wastes into the drainage system. The following are some plumbing fixtures commonly used for building services, with the common abbreviation:

- Water closets (WC)
- Sinks (SK)
- Bidets (BD)
- Urinals (UR)

- Bathtubs (BT)
- Service sinks (SS)
- Kitchen sinks (KS)
- Lavatories (LAV)
- Showers (SH)
- Wash basin (WB)

### Fire Alarm System

Fire alarm systems are an integral part of a fire protection plan. They are basically electrical systems that are specially designed to announce the presence of fire or smoke. They are not intended to suppress or extinguish a fire.

### Fire Extinguishers

Fire extinguishers are used as the first line of fire protection. They are normally pre-charged with water or chemicals and are hand-operated. In general fire extinguisher shall be installed in kitchens, electrical rooms, corridors and in the special areas in the buildings.

### Sprinklers

The major component of an automatic sprinkler system is the sprinkler, which discharges water in a specific pattern for extinguishing or controlling a fire. A sprinkler head consists of three major components: a nozzle, a heat detector and water spray pattern deflector.





# 8

## Mechanical (HVAC) Installation Guide

### Introduction

This section describes in detail the Installation procedure for Mechanical (HVAC) systems in a typical building project. It provides detailed step-wise installation guide for the various complex processes involved in the complete Mechanical (HVAC) system right through to the completion and testing of the system. It shall act as a reference guide for various processes involved in the Mechanical (HVAC) system and the complete system as a whole.

### 8.1 HVAC Ductwork

HVAC ductwork generally includes all types of Supply Air Duct, Return Air Duct, Fresh and Exhaust Air Duct and their accessories such as duct elbows, offsets, transformation pieces branch off pieces, tee connections, access doors, Fire Dampers, Volume Control Dampers, Sound Attenuators, flexible ducting and insulation. The following installation procedure will follow:

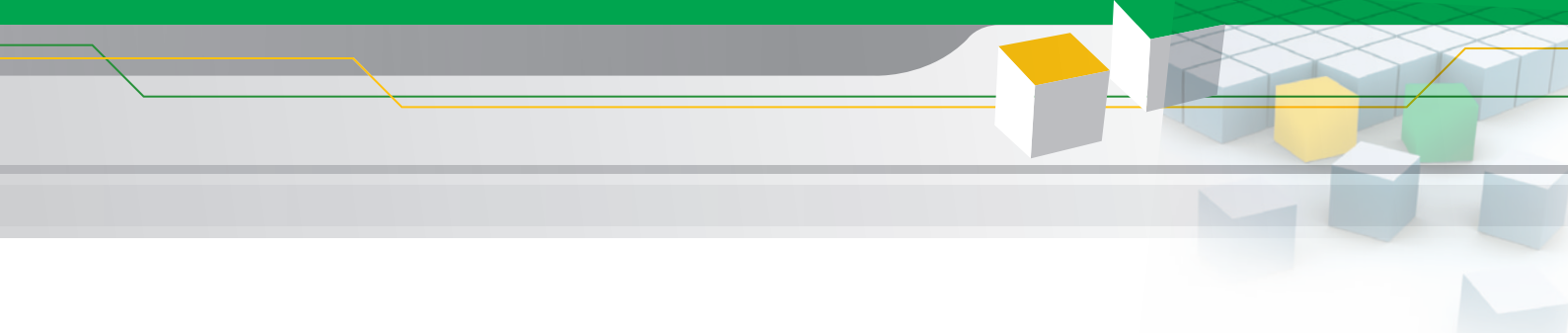
1. Prior to commencement of work coordination will be done with other.
2. Determine the position of duct supports as per approved construction layouts and specification.
3. Prepare and fix the duct supports as per approved construction drawing and specification.
4. Any cut edges of angles, channels or threaded rods will be touch up with Zinc rich paint.
5. Transport the Duct pieces and fittings to final location.
6. Pre-assemble the Duct pieces and fittings as per approved shop drawing ensuring the alignment.
7. Acoustic insulation will be carried out wherever required.
8. Raise the duct work on to the supports ensuring that each length is aligned with preceding length as per dimensions shown on approved shop drawings.
9. Approved duct sealant shall be applied on the joints. Any excess sealant so that the joint left in clean and tidy condition.

10. Ensure that duct work is clean and no tools/ construction debris exists within duct work before proceeding to next length.
11. All open ends of the duct works shall be temporarily sealed with polythene sheets/ply wood before leaving the job site to prevent moisture and dirt.
12. Ensure that all accessories like Volume control dampers, Fire dampers, Access doors, Test points, Sensors are installed in accordance with approved shop drawings.
13. Install Sound Attenuators according to approved shop drawings
14. Installation of duct work (complete with accessories) shall be checked before applying insulation at joints.
15. Leak test will be carried out for duct work as applicable in DW144 standard.
16. Insulation of duct work will be completed as per manufacturer's recommendations.
17. Ensure the duct surface is clean and dry before applying any insulation material.
18. Ensure the thickness of insulation as per approved shop drawing.
19. Ensure that all edge joints are closely butted and ends are flush and seated properly.
20. Apply ALUGLASS Tape (Self Adhesive Aluminum Foil Laminated on Glass fabric) at Joints of insulation.
21. Ensure the continuity of vapor barrier and other protective coatings on insulation surface as well as at connections.
22. Ensure firm adherence of insulation around ducting by using approved adhesive between sheet metal and Insulation material.
23. Where insulated duct work passes through fire rated wall/partitions the gap between sleeve and duct work shall be filled with approved fire barrier.

## 8.2 Insulation of Spiral Round Ducting & Accessories

GI Spiral round ducting generally installed in for FCU return air, and supply air as shown in approved shop drawing includes spiral round ducting, fittings such as elbows, tees, couplings, reducers, collars etc, volume control dampers, flexible ducting insulation. The following installation procedure will follow:

1. Prior to commencement of work coordination will be done with other services.
2. Determine the position of duct supports as per approved Shop drawings and coordinated layouts and specification.
3. Prepare and fix the duct supports as per approved construction drawing and specification.
4. Any cut edges of angles, channels or threaded rods will be touch up with Zinc rich paint.
5. Transport the duct pieces and fittings to final location.
6. Before assembly ensure that all ducts are free from dirt.
7. Check that ducts and fittings are undamaged. This is especially important with regard to the rubber gaskets.

- 
8. Assemble the Duct pieces and fittings as per approved shop drawing ensuring the alignment.
    - a) Push the fittings into the duct right to the stop. Turning the fitting a little makes insertion easier.
    - b) Fasten fittings to the duct with self tapping screws or centered pop rivets.
    - c) Distribute the screws or pop rivets evenly around the circumference, ensuring the rubber gaskets are not damaged i.e. placing them approx. 10mm from stop and end of the duct. In the event of incorrect assembly, holes caused by screws or pop rivets must be sealed.
  9. Raise the duct work on to the supports ensuring that each length is aligned and leveled with preceding length as per dimensions shown on approved shop drawings.
  10. Ensure that duct work is clean and no tools/ construction debris exists within duct work before proceeding to next length.
  11. All open ends of the duct works shall be temporarily sealed with polythene sheets / plywood before leaving the job site to prevent moisture and dirt.
  12. Ensure that all accessories like Volume control dampers, Test points, Sensors are installed in accordance with approved shop drawings.
  13. Installation of duct work (complete with accessories) shall be checked before applying insulation at joints.
  14. Insulation of duct work will be completed as per manufacturer's recommendations.
    - a) Ensure the duct surface is clean and dry before applying any insulation material. Apply thinner /cleaner where necessary to make the area grease free.
    - b) Apply glue recommended by manufacturer with an even spread on complete surface of insulation sheet.
    - c) Once the glue on the sheet gets dry, apply glue on the GI duct and let it dry, then stick the sheet on one end and slowly press the sheet on the duct from one end to the other so as to ensure that the sheet sticks on the GI duct completely avoiding air bubbles between the insulation sheet and GI duct.
    - d) In the areas where the GI duct comes into contact with the duct hangers, rigid support is recommended such as wood. The wood piece should be glued onto the duct hanger and layer of rubber to be glued on the wood, so that there is no direct contact between the duct insulation and the wooden piece thus preventing tearing of the duct insulation. In case the positioning of the support is available in advance, wood by itself can be used. In this case it has to be made sure that insulation will be glued to the wood from both sides accordingly.
  15. Where insulated duct work passes through fire rated wall/partitions the gap between sleeve and duct work shall be filled with approved fire barrier.



## 8.3 Testing & Insulation of Chilled Water System

Chilled water piping system includes chilled water pipes, fittings, valves and accessories used for transportation (supply and return) chilled water for AHU's and FCU's through Chilled water pumps. Pipes and fittings up to 50 NB dia. size shall be threaded type and 65 NB and above shall be either grooved or welded type. The following installation procedure will follow:

1. All welding activities will be carried out by certified welders only.
2. Supervisor/Foremen will carryout a site survey and mark the route of Chilled water piping as per approved shop drawings. In the event that there are any discrepancies or difficulties in executing the work, these will be brought to the notice of Project Engineer for corrective action.
3. Determine the position of supports and fix the supports using anchor bolts and ensure all fixing are tight and secure.
4. Any cut edges of angles, channels or threaded rods will be touch up with Zinc rich paint.
5. Install the pipes in position by using suitable lifting equipments ( If necessary).
6. Assemble the pipes and fittings as per approved shop drawing.
7. After installation of pipe work check for correct leveling, position alignment and proper grooving/ threading or welding.
8. Where the pipes of dissimilar materials are to be joined together necessary; dielectric unions shall be used.
9. Sufficient spacing shall be maintained between pipes for insulation.
10. Spacing between supports / hangers will be maintained in accordance with latest approved shop drawings.
11. Ensure all open ends of pipes, fittings and valves are covered with polyethylene sheet before leaving work space.
12. All high point on piping system will be provided with an air vent. Drains; will be provided at low point with an access. High point vents will be connected nearest drains.
13. INSTALLATION OF VALVES AND ACCESSORIES
  - Install system valves and accessories as per latest approved shop drawings.
  - Ensure that system equipment, valves and accessories are secure and rigid
  - The installation shall be done allowing sufficient access to all Valves/strainers/Gauges as per Manufacturer's recommendations.
14. INSTALLATION OF CHILLED WATER RISERS
  - Pipe sizes will be identified first as per latest approved shop drawing and shifted to respective floors.
  - Install the supports as per approved shop drawing.
  - The pipe shall be thoroughly cleaned prior to joining.
  - On completion of joining, install the pipes using necessary equipment / manpower.
  - After installation of risers check the pipeline for proper alignment and supports.



## Hydrostatic Pressure Testing

1. Complete pipe work will be subjected to hydraulic pressure tested as per technical specification. Depending on ongoing Construction activities sectional hydro testing will be under taken to meet the requirements of the programme. Test pressure will not be less than 1.5 times the working pressures but not less than 1035 KPa (for 24 hour period) which ever is greater. Prior to any testing the system pressure will be detailed on the pressure testing documentation.
2. Pressure gauges used for Pressure testing will have valid calibration certificate.
3. After successful Pressure testing ensure that piping system is fully drained and released for chemical cleaning which will be carried out at later date as per approved method statement.

## Insulation

1. Before application of thermal insulation, Chilled water pipes will be; painted with a primer paint as per specification. Painting of welded joints will be carried out after pressure testing.
2. Insulation of chilled water pipe work will be carried out as per details as shown in approved submittals. Thermal insulation of welded joints will be carried out after pressure testing.
3. Ensure thickness of insulation is as per approved drawing.

## 8.4 Fan Coil Unit (FCU)

Fan Coil Units generally be installed in locations shown in drawings, serving apartments mechanical rooms etc.; both in concealed areas and exposed supplying cold dehumidified air conditioned space. The following installation procedure will follow:

1. Prior to commencement of work coordination will be done with other services.
2. Determine the position of Fan Coil Unit on the ceiling and mark the location of supports as per approved shop drawing.
3. Prepare and fix the Fan Coil Unit supports as per approved construction drawing and specification.
4. Ensure that Vibration Isolators of approved make, type and model are installed.
5. Install the Fan Coil Units by lifting it slowly by using suitable lifting aids (if necessary). Manufacturer's recommendations shall be followed during installation.
6. Any cut edges of angles, channels or threaded rods will be touch up with Zinc rich paint.
7. Fan Coil Units will be connected with Piping Connections complete with valves and accessories as indicated in approved shop drawing.
8. Ensure that Dielectric unions are used for piping connection to FCU's.
9. FCU Valve packages shall be provided with drain pan as shown in approved shop drawing
10. Ensure that drain connections are made with adequate slope with running trap.
11. Complete the duct connections to Fan Coil Units as shown in approved shop drawing.
12. Complete the Electrical power connection includes earthing a all respects as per approved electrical drawing and Manufacturer's recommendations.
13. Ensure that adequate space for maintenance of fan coil units and valve package is available.
14. Install the thermostat control units as per shop drawing/ Architectural drawing.
15. Complete the BMS interfacing with DDC controllers as per approved BMS drawings.



## 8.5 Fan Installation

Fans generally are installed in locations shown in drawings. Types of fans used in mainly classified as Toilet extract fans(TEF),Kitchen extract fans(KEF),Refuse fans, Lobby pressure relief fans(LRF), Stairwell pressurization fans(SPF),Car park exhaust fans, Jet fans etc. The following installation procedure will follow:

1. Prior to commencement of work coordination will be done with other services.
2. Make sure that fans are free from damage and all internal components are complete and in good condition.
3. Fan assemblies will be transported to the nearest point of erection. Care will be taken while handling the units to avoid damage/distortion.
4. Manufacturer's recommendation will be followed for installation of fans.
5. Fans will be installed in location as per approved shop drawing.

### Installation Of Floor Mounted Fans

1. Ensure that builders work foundation is provided as per approved shop drawing.
2. Ensure the level of Foundation by spirit level.
3. Check the size and orientation of foundation for its suitability to install the fans.
4. Fix the Vibration Isolators to foundation as per approved submittal.
5. Install the Fan assembly mounting brackets on vibration Isolators as per manufacturer's recommendations.
6. Complete the ductwork / damper installation as per approved shop drawing.

### Installation of in line Mounted Fans (Ceiling Suspended)

1. Fans can be mounted either horizontally or vertically as per approved shop drawing.
2. Support the fans by using threaded rods to the fan casing as per manufacturer's recommendations.
3. Provide vibration isolators (approved type) as per manufacturer's recommendations on the mounting brackets/holes.
4. Complete the ductwork/damper connection as per approved shop drawing.
5. Ensure that sufficient space is available to allow removal of access covers and subsequent removal of fan and motor assemblies etc. as per manufacturer's recommendations.
6. Complete all electrical connections as per approved electrical drawing and manufacturer's terminal diagram.
7. Earthing shall be provided as per requirements.
8. Complete the labeling of electrical connections as per schematic drawings.
9. Fan rotation shall be checked before duct connection.



## 8.6 Chilled Water Pumps

Chilled water Pumps generally to be installed in locations shown in drawings in the Plant Rooms. The following installation procedure will follow:

1. Prior to commencement of work coordination will be done with other services.
2. Make sure that the Pumps are free from damage and all internal components are complete and in good condition.
3. Chilled Water Pumps assemblies will be transported to the nearest point of erection. Care will be taken while handling the units to avoid Damage/distortion.
4. Ensure that foundations of Chilled Water Pumps are as per approved shop drawing.
5. Install Inertia base assembly on the foundation as per approved shop drawing. Ensure the oriental axis and level of inertia base is as per approved shop drawing.
6. Fix the vibration isolators to inertia base as per approved shop drawing. Ensure that the locations are matching with Chilled Water Pump base anchoring details.
7. Complete the concrete filling in the Inertia base as per approved shop drawing.
8. Concreting of Inertia bases will be carried out by Main Contractor.
9. Install the chilled water pumps on the inertia base with vibration isolators connected to chilled water pump base frame.
10. Ensure the orientation axis and level of pump as per approved shop drawing.
11. Ensure that pump and motors are properly aligned.
12. Complete the piping connections, including Valves and accessories/flexible connections to pump suction and discharge sides as per approved shop drawing.
13. Piping connections shall be erected to allow access for operation and maintenance of pump motor and valves.
14. Make sure that the piping connections are supported properly and no imposed load of piping is transferred to the pump.
15. Complete all instrument mountings required as approved shop drawing.
16. Complete all electrical connections to pump motor with all necessary electrical protection and controls as per approved electrical shop drawing.
17. Complete the final alignment of pump and motor under manufacturer's representative's supervision.
18. TESTING
  - a. The piping connections to pumps shall be pressure tested to 1.5 times the working pressures.
  - b. Strainer shall be cleaned after initial flushing of Chilled water piping system.
  - c. Insulation of piping to be done after pressure testing.
  - d. Electrical circuits / controls and connections are to be checked.

## 8.7 Air Handling Units (AHU)

Air Handling Units generally be installed in locations shown in drawings, serving corridors and supplying treated fresh air to the lobbies and apartments located at various floors. The following installation procedure will follow:

1. Prior to commencement of work coordination will be done with other services.
2. Check the foundation of AHU for size, orientation and finishes as approved shop drawing
3. Make sure that AHU's are free from damage and all internal components are complete and in good condition.
4. AHU's will be installed in location as per approved shop drawing.
5. Install the AHU's on concrete foundation by using suitable equipment recommended by manufacturer (eg. Rollers/jacks etc.). Manufacturer's recommendations will be followed during erection of AHU.
6. Multi-section units will be joined as per Manufacturer's instructions. Ensure to remove Shipping Bolts.
7. Ensure the orientation of AHU's as per approved shop drawing during installation.
8. Serrated rubber pads (Neoprene Isolator) will be provided below AHUs.
9. AHU's which are ceiling suspended will be mounted by using threaded rods, spring hangers etc. as per approval.
10. Any cut edges of angles, channels or threaded rods will be touch up with Zinc rich paint for ceiling suspended AHU's.
11. Connect all piping and accessories to AHU's as per approved shop drawing.
12. Ensure that Dielectric unions/Flanges are used for piping connection to AHU's.
13. Ensure that drain connections are made with adequate slope and approved U-trap.
14. Complete the duct connections to Air handling Units as shown in approved shop drawing.
15. Filters of specified sizes will be provided.
16. Check that adequate space for maintenance of Air Handling Units is provided as per approved shop drawing.
17. Complete the Electrical power connection including earthing in all respects as per approved electrical drawing and Manufacturer's recommendations.
18. Complete the BMS interfacing with DDC controllers as per approved BMS drawings.



## 8.8 HVAC Testing, Adjusting & Balancing

The HVAC system testing, adjusting, and balancing is the process of checking and adjusting all environmental systems in a building to produce the design objectives. This process Includes:-

- Balancing air and water distribution systems
- Adjusting the total system to provide design quantities.
- Electrical measurements.
- Establishing quantitative performance of all equipment.
- Sound measurements.

The above procedures are accomplished by

- Checking the installations for conformity to design.
- Measuring and establishing the fluid quantities of the system as required to meet design specifications.
- Recording and reporting the results

The following installation procedure will follow:

1. Testing, adjusting and balancing of HVAC systems installed will be carried out as per the specialist commissioning procedures attached by specialist commissioning agency.
2. Commissioning Manager ensures that all manpower deployed by Specialist agency is competitive and sufficient to complete the TAB work.
3. All the test documentation will be recorded on the test sheets attached to the Specialist commissioning procedures.
4. Manufacturer's Representative will be associated for start equipment and as required.
5. Status of Testing and commissioning will be maintained and reported periodically to Consultant.

## 8.9 Flushing & Chemical Treatment of Chilled Water System

Chilled water system includes pipes, fittings and valves used for transportation of chilled water to FCU's, AHU's through chilled water pumps. Flushing of system ensures removal of all contamination that may occur during manufacturing, storage and installation of piping.

Chemical cleaning ensures the removal of oxides, oils and greases by using chemicals such as acids, alkalis, complexing agents etc;. Continuous monitoring of the condition of the cleaning solution by the cleaning specialist will be necessary throughout the chemical cleaning process. The following installation procedure will follow:

## Pre Requisites For Flushing

1. Chemical cleaning of the system will not be undertaken until the system installation has been completed, pressure tested and approved by consultant, vented and filled with clean water, static and dynamic flushing completed and circulating (system) pumps are available for operation.
2. Full access to all parts of system to be available, including access panels in ceilings, to enable access to valves, drains and vents etc.
3. Flushing will be carried out for each tower & each chilled water circuit (secondary and tertiary) separately. A detailed procedure is indicated here, which is common for all the circuits. Marked up schematic drawings for each secondary and tertiary chilled water circuit for each tower, for flushing are enclosed for reference. Following points are identified and marked in the enclosed schematic drawings for each circuit:
  - a) Number of floors covered in the circuit.
  - b) Number of Terminal units (Heat exchangers, AHUs, FCUs) at various levels.
  - c) Fresh water filling point.
  - d) Drain point from where the system water will be drained out.
  - e) Number of terminal units at various levels, where temporary bypass loops shall be provided.
4. Before flushing work commences ensure that:
  - a) All pipe ends are looped/ closed prior to filling the water.
  - b) All valves except drain valves (gate/butterfly/globe/DRV/commissioning set valves) are fully open. Drain valves will be closed. All 2 way control valves are fully isolated. Inlet and outlet valves for terminal units, where bypass loops are not provided will be closed to avoid flushing water passing through the coils. Water will be drained from these units at the final stage of flushing before adding final chemical.
  - c) All necessary temporary bypasses installed around terminal units (heat exchangers, AHU's and FCU's) to be verified as fully open.
  - d) Sufficient fresh and clean water supply is available continuously with adequate pressure at water filling point.
  - e) Drain points are properly connected / kept ready for connection to nearest drain point. Drain points will be decided in consultation with plumbing / drainage department and will be approved by Consultants.
  - f) Portable storage tanks to store drained water will be arranged, as required.
5. The objective of the flushing and cleaning treatment process is to provide acceptable water quality (defined in 6.0) and internal pipe conditions that will permit the commissioning of the systems and provide a foundation from which an effective ongoing regime of water treatment and system management can commence.
6. At all stages of the flushing and cleaning process the system will be offered for witnessing by the Consultant. The witnessing will include water quality, water quality, water analysis, pressure readings and strainer, deposits. The witnessing will be a continuous exercise and the full involvement of all witnessing parties will be required. During every stage of flushing process, for each circuit, samples of water will be taken from top & bottom level of each stage and tested an after satisfactory report next sage of flushing will commence.



## Flushing Process

Generally flushing will be carried out in following steps for each secondary and tertiary chilled water circuit.

### A. STATIC FLUSHING:

1. Complete system to be filled with clean water from bottom most point of the system AND vented through air vents at various locations and at the high points of the system
2. System pumps to be operated for a period of 1.2 hours to agitate any debris within the system
3. With pumps switched off, drain system at lowest point(s) of system all drains and air vents to be opened at same time to expedite the flushing. It is to be ensured that drain point maximum to drain any: large sized debris in side the system. Ensure that all system is drained & no water is remained inside the pipes
4. Check quality of drained water. Water be drained shall be collected in a separate tank (as required) and then disposed off safely or will be drained in nearest manhole available.
5. Upon completion of draining, system to be re-filled and vented with cleans water

### B. DYNAMIC FLUSHING:

6. Once the entire system is full of water, then valves at the branch connection to the riser at each level/floor will be closed & only valves of top five levels/floors in the circuit and the plant room floor will be opened for water circulation.

The flushing velocities will be achieved by utilizing the installed circuit pumps. The number of pumps running will depend on the amount of the circuit being flushed. Prior to starting the pumps, direction, alignment and installation will be checked.

The removal of general contaminant from the system will be achieved by using a dynamic balanced flushing procedure. System pumps will run and draw water to drain, but only at the rate at which clean water is introduced. At all times the system pressure will be maintained at such a level so as to exceed the static head. The system will not be drained during the dynamic flushing, to prevent the induction of air, which could accelerate the rate of corrosion, and also lead to air locks.

During this process, water will be drained from the lowest point at the rate fresh water is introduced in to the system. Also during this process, all the strainers in each level/floor will be opened & cleaned. Also water will be drained from the end points to ensure that dirt is not settled in the system. After every 8 to 10 hours, valves at the branch connection from the riser of the top five levels/floors will be closed & valves of next five (lower side) levels/floors will be opened for flushing. Same procedure will be followed till all the levels/floors for the entire circuits are completed. After that finally, valves at the branch connection from the riser for all the levels/floors, for the entire circuit will be kept open for water circulation for 3 to .5 hours. During this process, all the strainers in each level/floor will be once again opened & cleaned as required. At all the time during the entire process, water samples from top level & bottom level of each stage in the system will be checked for water quality.

7. The aim of the flushing process will be to initially remove all large debris from the pipe work. The pumps will be continually rotated during this process so the strainers can be cleaned. The flow in the pipes will be measured (through commissioning sets) and accordingly velocities will be recorded. These will be monitored and the strainers shall be cleaned if flow decreases. The main isolating valves may be set to create a balanced flush.
8. All strainer screens within the system will be checked and cleaned at regular intervals during the flushing process, until the screens no longer show any signs of contaminant.
9. Drain point will be kept as near to the filling point as possible to ensure that water is circulated completely in the system. Water will be drained (and make up water is introduced at the same rate), until it is as clean as the make up water. Dynamic Flushing will continue until water quality is at acceptable levels (defined in 6.0).

## Chemical Cleaning

1. Cleaning chemical M-235 will be introduced into the system. M-235 to be remained in system for 24 hours and not to exceed 72 hours.
2. The chemical will be circulated throughout the system to establish an even concentration. Water samples will be taken at the lowest point, highest point and intermediate floors (if necessary) and far points of the system (locations will be identified in chilled water riser diagram and to be approved prior to precede with flushing) and tested at regular intervals.
3. The dynamic flushing process will then be carried out again for the entire circuit, until it is free of contaminants. The parameter for acceptance of the system will be:
  - TDS (total dissolved solids) - within 10% of incoming mains water.
  - Iron - below 1 ppm.
  - Visual - clear, bright and free from particulate matter.
4. Upon successful completion of the cleaning and flushing process, system to be re- filled with clean water and vented completely. Long term corrosion inhibitors (M-381) and a chemical biocide (M-403) will be introduced into the system, in proportion to the system volume.
5. The corrosion inhibitor and biocide will be circulated throughout the system and tests undertaken to establish full circulation and correct concentration.
6. All temporary bypass loops will be removed and all Heat exchangers, AHUs & FCU coils will be back flushed. Heat exchangers, FCU / AHU coil connections will be completed for normal working conditions.

## Acceptance Criteria

The acceptance criteria for the results of the witnessed measurements carried out in Clause 5.2.4 & 5.3.3. are that:

### STATIC FLUSHING

- (1) The TDS levels achieved at the end of each high velocity flush are not greater than 10% above the incoming mains water.



## DYNAMIC FLUSHING

- a) Before Cleaning Chemical Addition –
  - Water appearance : Clear, Yellowish
  - Iron Level : Less than 10ppm
  - TDS : within 10% of incoming mains water
- b) After Cleaning Chemical Addition –
  - Water appearance : Clear
  - Iron Level : Less than 1 ppm
  - TDS : within 10% of incoming mains water

- (2) The velocities during each high velocity flushing stage are in excess of 1.36 m/s in the largest pipe in the system.

### Disposal Of Effluent

The chemically treated water shall be discharged in to mobile tankers and discharged properly as per local authority regulations.



# 9

## Electrical Installation Guide

### Introduction

This section provides the Installation guide for Electrical systems in a typical building project. It provides detailed step-wise installation procedure for the various complex processes/ equipments involved in the Electrical system right through to the completion and testing of the system.

### 9.1 PVC Conduits Concealed in Concrete Slab & Columns

This procedure defines the method used to ensure that all conduit and associated accessories: bends, tees, couplers, reducers and all accessories associated with systems installed are correct and acceptable. The following installation procedure will follow:

1. Supervisor will ensure that all the grid lines and datum lines are marked by the surveyor and all the route and marking are based on the datum line provided by the surveyor.
2. Supervisor will carryout a site survey and marks the route of conduits as per approved drawings. In the event that there are any discrepancies or difficulties in executing the work, these will be brought to the notice of engineer for corrective action.
3. PVC conduits of correct sizes will be used for concealment of electrical services in the concrete walls & slabs.
4. Cast in conduits are of high impact and of approved make and conform to BS 4607 Part 1, 3 & 5, BS 6099 Parts 1 & 2 and BS 5490.
5. The minimum conduit size used will be 20 mm dia. The conduit size selection is completely as per technical specifications, local statutory authority regulations and as per approved shop drawings.
6. Wherever conduit to be installed in vertical walls the run of conduit will be kept straight.
7. The bending of conduits will be done using proper bending springs and the straight lengths of conduits are coupled using standard couplers glued using good quality PVC sealant.

8. All the cast in conduits will be firmly bended to the steel rebar and conduits is placed sandwiched between rebar's so that future drilling of anchors should not damage cast in conduits and the installed wires.
9. Near DB end conduits are terminated on to thick thermocol placed under concrete so that future alignment of conduit will be easier.
10. Wherever cast in conduits to be terminated on to back boxes standard conduit accessories approved in the material submittal will be used.
11. All the due care will be taken to ensure none blocking of cast in conduits during concreting and contractor's representative will be present at the throughout of concrete period to ensure no conduits gets damaged during casting of concrete slabs.
12. The guide line for conduit size selection will be as per the following table.

Cross Sectional Area of Conductors	Size of Conduit		
	Maximum number of cable drawn		
	20	25	32
1.5 mm <sup>2</sup>	7	12	-
2.5 mm <sup>2</sup>	5	9	12
4.0 mm <sup>2</sup>	3	6	9
6.0 mm <sup>2</sup>	-	5	8

## 9.2 G.I. & PVC Conduit on Surface

- Surface GI Conduiting is generally installed in Electrical rooms and plant rooms, lift motor rooms, sub-stations and outside buildings, partially open ceilings, service areas.
- PVC Conduits are used only the area covered by false ceiling.
- Installation of GI surface conduits shall be done in accordance with the project specifications and drawings.

The following installation procedure will follow:

1. Supervisor will carryout a site survey and marks the route of conduit as per approved drawing. In the event that there are any discrepancies of difficulties in executing the work, these will be brought to the notice of project engineer for corrective action.
2. Standard length of conduits shall be cut to the required length.
3. For G.I. conduits threaded shall be done using a threaded machine and correct size die-set. Threaded will be kept to a minimum when showing from coupling and boxes.
4. Cold galvanizing paint is applied to the threaded part of G.I. conduit just before fixing.
5. Where required conduits of size 20mm and 25mm shall be bent to the required radius using manual bending machine. Manufactured bends are used for conduits size 32mm and 50mm.
6. Conduits are fixed to the building fabric by means of distance bars saddle with appropriate metal screws and plugs. A space of 3mm minimum shall be maintained between conduit and the building surface.
7. Check all mechanical connections are internally smooth for pulling wiring in no burrs or sharp edge will be allowed.

8. The route of this steel conduits are restricted to horizontal and vertical runs except for the areas where approved to follow the line of an architecture.
9. Conduit support are fixed in regular interval as mentioned in table:-

#### Spacing of Conduit Supports

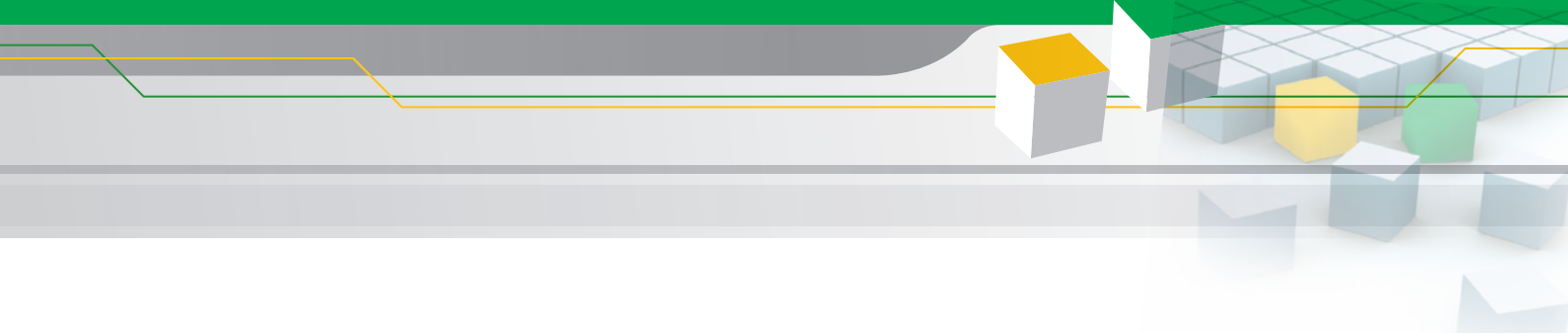
Conduit Size (mm)	Maximum Distance Between Support (M)			
	Rigid Steel		Pliable	
	Horizontal	Vertical	Horizontal	Vertical
20	1.75	2.0	0.4	0.6
25	1.75	2.0	0.4	0.6
32	2.0	2.25	0.6	0.8

10. Ensure the conduit installations are in straight line.
11. Conduits shall be fixed so that no water enters, if it is not practicable a 3mm hole is drilled at the lowest point of the conduit to drain the water out.
12. All terminal boxes are marked on the appropriate location (i.e. wall or ceiling) as per approved shop drawing and fixed with metal screws and plugs. Suitable braze bushes are used where conduit enters the boxes to avoid any damage to the wires.
13. Wherever necessary draw wires shall be pulled into conduit runs and kept at pull boxes for future use.
14. Any rusting of steel conduits occurred during construction shall be removed.

### 9.3 Cable Tray & Ladders

Cable Tray system is generally installed in electrical rooms, plant rooms, service corridors as detailed in approved shop drawings. The following installation procedure will follow:

1. After the civil clearance to proceed with MEP installations, ensure the area is clean and ready to start the works.
2. Mark the trays and ladders routes as per approved shop drawing; ensure these are of horizontal & vertical runs only.
3. Co-ordinate the routes, levels and ensure there are no clashes with other services.
4. Maintain enough clearance for cable pulling and any access for future maintenance.
5. Mark the support, fix the threaded rod supports with appropriate metal plugs, and then fix the 'L' angles / Slotted 'C' channels with nuts. A maximum of 1.2 M distance is maintained between the supports to avoid sagging of trays and ladders. Provide adequate supports for bends, branches and offsets.
6. Cut the standard length / ladder to required length with appropriate cutting tools. Use mushroom head screws on the cable route to avoid the cable insulation damage during pulling.
7. All the fittings shall be from manufacturer.

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8. Expansion provision shall be provided at all the building expansion joints.
  9. Manufacturer's instruction for installation shall be followed.
  10. Approved fire sealant shall be provided wherever the installation crosses the fire rated walls.
  11. Sleeves shall be provided at all the wall crossing.
  12. Copper earth link shall be installed at every joint to maintain continuity throughout the installation.
  13. Ensure the installation of tray / ladders are neat, in straight line. Trim the extra projected supports.
  14. All sharp edges and burrs shall be cleaned for pulling the cables.
  15. Treat the cut & Drilled part with zinc paint rich paint immediately after cutting and before installation.
  16. Provide identification labels as specified to identify the service.
  17. Inspection shall be offered for QC verification.
  18. The entire installed cable tray to be protected from damages.

## 9.4 Cable Trunking System

This procedure defines the method used to ensure that all cable trunking and associated fittings: bends, tees, couplers, reducers, flanges, relevant bracket work, supports rods, anchors and all accessories associated with integrated cable management systems installed are correct and acceptable. The following installation procedure will follow:

1. Work will be carried out as per manufacturer's recommendations.
2. Supervisor will carry out a site survey and marks the route of cable trunking as per approved drawings.
3. Dedicated cable trunking of size as approved in the shop drawing will be provided for lighting/ power and extra low voltage (ELV) services.
4. For connection of PVC/GI conduits to GI trunking installation details shown in approved shop drawing will be followed.
5. Cable trunking will be in accordance with BS 4678 Part 1 and made of galvanized steel.
6. Adjoining lengths of trunking will be correctly aligned and the two sides at right angles to the cover will be joined to the corresponding side of the trunking piece by means of an internal fish plate connector.
7. Standard manufacturer's fittings will only be used except when necessitated by site conditions, the consultant engineer's approval will be obtained.
8. All the joints of trunking both at straight lengths or accessories will be fitted with a copper bonding strap and will be secured by screw, nuts and washers. The earth bonding links will be external to trunking and will make good contact with the trunking and continuity will not depend on the contact through screws. Jointing screws will be installed with exposed thread and nut/ spring washer external to the trunking.

9. Trunking fixing centers are not to exceed those listed below and only in case of 50x50 trunking there will be a center fixing only. All other sizes will have two fixing at appropriate fixing centers as given below:

Cross Sectional Area of Trunking	Distance between Supports	
	Steel Trunking	
	Horizontal	Vertical
1. Upto 2500 mm <sup>2</sup>	1.20 M	1.5 M
2. Above 2500 mm <sup>2</sup> and up to 6000 mm <sup>2</sup>	1.20 M	1.8 M
3. Above 6000 mm <sup>2</sup> and up to 10000 mm <sup>2</sup>	2.3 M	2.5 M
4. More than 10000 mm <sup>2</sup>	3.0 M	3.0 M

10. All trunking accessory fittings will be secured not more than 150mm from the jointing points.
11. Additional support will be provided if required.
12. Cable tray will be inspected before pulling the wires.
13. Trunking will be installed in such a way that adequate clearance will be provided for access to wiring. Covers will be installed on to the exposed side of trunking. Where trunking installed horizontal plane with lid on to bottom side then conduit connection will be done from top and side.
14. Earth continuity will be available through out the trunking including bends and offsets.
15. Cable trunking crossing the fire rated walls will be provided with fire protection barriers of approved materials according to civil defense regulations and will be by main contractor's scope.
16. Any cuts made to the trunking will be debarred for rough surface and treated with cold galvanized paint.
17. The supervisor in charge and QC inspector will monitor the activities to ensure that all components indicated in the approved construction drawing installed as per the contract requirements and manufacture recommendations.



## 9.5 Earthing System

### Applicable Location

Basement, Ground level, Roof, Mechanical & Electrical rooms at all levels. All mechanical services exposed will be bonded to the earthing system.

The following installation procedure will follow:

1. As per approved drawing identify location of earth pit.
2. Co-ordinate with civil contractor for installation of earth pits with approved fixing details.
3. The copper earth rod will be driven manually in earth. After achieving a minimum depth of approximate 3 meters, the earth resistance will be measured, If the earth resistance value is not satisfactory, the process of adding further earth electrodes shall be continued till expected resistance value of less than 1 ohm is achieved.
4. Adjacent earth electrodes shall be spread to atleast 1 length of one of the driven electrodes (6 mtrs) to achieve result of less than 1 ohm. Inspection request to be issued.
5. The earth pit shall be installed after completion of installation of earth rods and a clear gap of 50 mm shall be maintained between top of earth electrode and earth pit cover. The top of earth pit shall be in level with the finished floor level in the area.
6. The PVC sheathed single core earthing cables of specified size as per shop drawing shall be laid between the earth pit and the earth bar inside the building and terminated with approved type lugs/ clamps.
7. The interconnection of earth pit shall be as per approved shop drawing.
8. All earthing connections shall be made after cleaning the surface thoroughly and tightness checks for each connection shall be performed.
9. Continuity of earth connections shall be checked for every link in the network by QA Engineer, Issue Inspection request.
10. The down-stream earthing connections from earth bars shall be made to the panel boards, frames and other equipment as per approved shop drawing.
11. Alongwith all power cables one earth cable of size as per approved shop drawing shall be laid and it shall be terminated to the earth bar of the panel/ equipment which it feeds, in addition with local earthing from earth bar.
12. On completion of total earthing system and testing, inspection request will be submitted for approval to design consultant.

### Installation of Equipotent Bonding

1. The metallic frame of all electrical equipments shall be connected to the nearest earth bar with a specific size of earth cable.
2. The earthing continuity of cable tray and trunking shall be maintained with earth links on each joints of cable trays and trunking shall be connected to earth bar with specified size of earth cable.
3. Flexible earth cable shall be used for the earthing connections when there is possibility of expansion/ contraction and also where vibrating equipment is installed.
4. The metallic water lines shall be bonded by an earthing cable of size not less than 6mm<sup>2</sup>.
5. All bonding connections shall be checked for correct tightness and cleanliness.
6. Inspection Request will be issued for signature of consultants.

## 9.6 Lightning Protection System

The following installation procedure will follow:

1. The dedicated rebar is selected from the pile cap and the cable is clamped with the rebar by CR730 clamp and connected to the dedicated rebar of the selected column as per approved shop drawing.
2. Fix G.I. Box 160x80x35 at 500mm from SSL (for testing purpose) on the column. The box shall be tied with reinforcement rod and the box cover will be flush with the finish wall.
3. The dedicated rebars of the column as per shop drawing shall be connected to a 70 sq.mm PVC cable using CR 705 Furse clamp for the extension till it reaches the roof.
4. Expanded polystyrene shall be applied to seal the hole within the concealed disconnect link box and tied with steel binding wire to prevent concrete / cement entering into the box.
5. Prior to concreting, earth continuity between reinforcement rods and dedicated rods shall be checked with a.d.c. ohm meter.
6. In each tower final test sheet shall be offered to consultant for witness and sign-off.
7. Once rebar has reached up to the height as shown in the drawing for bonding, the work shall be coordinated with Civil Contractor. This is applicable in locations as shown in design drawings.
8. At roof G.I. box 160x80x35mm shall be fixed at 500mm from SSL with fixed of PC116 furse earth point with pre-welded joint. The box shall be tied with reinforcement rod and box cover shall be flush with finish wall 25x3 copper tape run on roof perimeter as shown in shop drawing bonded with non ferrous bonding point. All mechanical i.e. AHU's , pole structure, petal structure etc. shall be bonded with 25x3 copper tape.
9. 25x3 copper tape shall be fixed on top of parapet wall at 1 m intervals as shown in shop drawing with Non-ferrous bonding point.
10. Inspection shall be offered for QC verification in stages.
11. Inspection request shall be raised at least 24 hours in advance for consultant's inspection, prior to concrete pour/ cover-up work.
12. Final inspection shall be carried out collecting all the data from previous inspection requests and finally verified for the anticipated results.

## 9.7 Pulling & Testing of Electrical Wires

Electrical wires shall be enclosed in conduit, trunking and with in short lengths of flexible conduit for final connections to the various items of the equipment. Installation wires will be carried out as per the project specifications and drawings and authority regulations. The following installation procedure will follow:

1. Where in single core PVC insulated cables are enclosed with in the conduits, core will be taken that no damage will occur to the cables during their installation.  
Where conduits is to be installed in damp conditions or out doors rubber sealing gaskets will be installed behind besa/ adaptable box lids.
2. Number of cables to be pulled into the conduit will be as per TABLE 1 & 2. The sum of all factors for the cables, as given in TABLE 1 shall not be greater than the factor for the conduits as given in TABLE 2.

### Factors for single core PVC insulated cables enclosed in a conduit

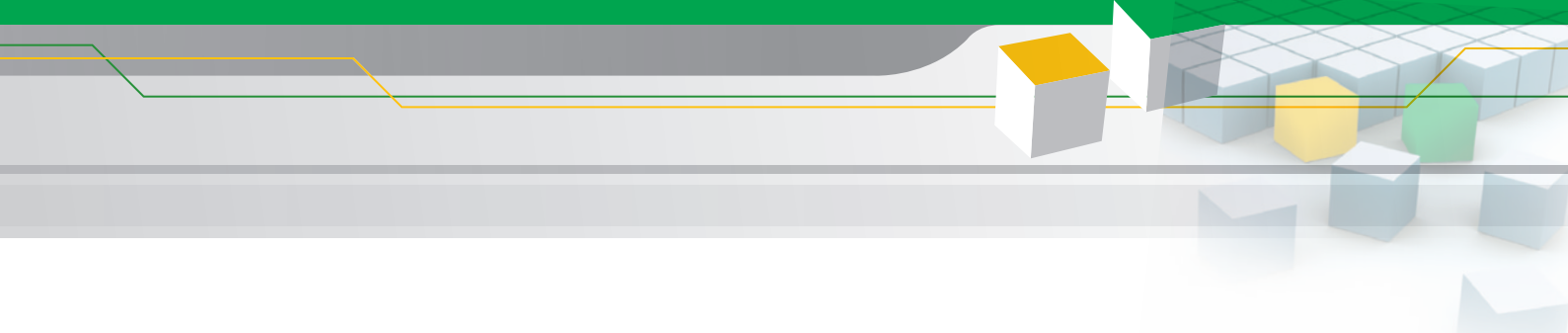
Conductor size of cables (mm <sup>2</sup> )	Factors	
	For short runs	For long runs or runs with bends
1.5	27	22
2.5	39	30
4.0	58	43
6.0	88	58
10	146	105



### Factors for the conduits

Type of run conduit size (mm)		Straight run			Run with 1 bend			Run with 2 bends		
		20	25	32	20	25	32	20	25	32
Length of run	2m	(460)	(800)	(1400)	286	514	900	256	463	818
	3m	460	800	1400	270	487	857	233	422	750
	4m	286	514	900	256	463	818	213	388	692
	5m	278	500	878	244	442	783	196	358	643
	6m	270	487	857	233	422	750	182	333	600
	7m	263	475	837	222	404	720	169	311	563
	8m	256	463	818	213	388	692	159	292	529
	9m	250	452	800	204	373	667	149	275	500
	10m	244	442	783	169	358	643	141	260	474
	11m	238	433	764	-			-		
	12m	233	424	748	-			-		
	13m	228	416	735	-			-		
	14m	223	408	721	-			-		
	15m	218	401	708	-			-		

- NOTE:
1. Short run means a straight run not exceeding 3m long. Long run means straight run exceeding 3m long.
  2. The conduit factors shown in brackets shall only be used in conjunction with the corresponding cable factors for short runs.
  3. For cables and ro conduits not indicated in Table 1 & 2 the number of cables drawn in to a conduit shall not exceed space factor of 45%.
  3. Before pulling wire into cast in conduits, ensure that nylon draw ropes have been installed and the containment system has been found to be clear of any obstruction.
  4. The use of lubricants, grease, graphite or talc will not be used to assist the drawing of cables.
  5. Cables of different circuit categories will not be mixed with in the same conduit.
  6. While preparing cable ends, ensure that conductor stands are not damaged and the strands are twisted together with pliers to ensure neat and firm connection.
  7. While removing the conductor insulation, ensure that no excess exposed conductor shall be left.
  8. Each circuit will incorporate a separate protective conductor selected in accordance with IEEE regulations (TABLE 54 G latest). Earth continuity will be maintained according to authority's regulations.
  9. Final sub circuits will be installed in continuous lengths and no joints will be permitted along the cable run. The final sub circuits will be wired in the loop – in method and all terminations are made will be accessible.

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10. Neutral conductors of lighting will be wired direct to the lighting points and will not pass through switch boxes.
  11. Where PVC insulated sheathed cable enters or exit the trunking system the hole will be lined up with rubber grommets or bushes.
  12. Where cables are enclosed in the same trunking and connected to different distribution boards, they shall be distinguished by separating the cables by insulating taping at an approximate interval of 2.0M and also with an identification labeling indicating circuit type and reference.
  13. Color identification sleeve to denote phase, circuit reference and/or terminal reference and/or terminal number to which it is connected coding of wires will be followed.

## 9.8 Bus Bar Trunking System

Bus - bar trunking system generally includes standard straight lengths, special straight lengths (wherever necessary), elbows (vertical and horizontal), offsets, T - joints, standard component tap off boxes, feeder boxes, fixing elements, flanges, support systems and end connections etc; various items of the equipment. Installation of bus ducts will be carried out as per the project specifications and drawings and DEWA regulations. The following installation procedure will follow:

1. Bus bar installation will be carried out as per approved bus bar lay out/isometric drawings. Before starting the installation of bus bar system, proper co ordination shall be done with other trades.
2. Manufacturer's installation instructions attached will be followed for handling, storage, installations and testing.
3. Determine the position of the bus bar supports as per approved construction drawings and mark them on concrete surfaces.
4. Fix the support as per manufacturer's installation instructions.
5. Provide sufficient horizontal and vertical clearance from walls and ceilings to provide easy access to joints, both for permanent installation and possible future removal of section when required.
6. For vertical bus bars, ensure that no joints or expansion joints are installed in the slab thickness.
7. Bus bar will be leveled and mounted at the correct height.
8. Elbows offset and tap off boxes etc., will be installed as per approved construction drawings and as per manufacturer's instructions.
9. Cable gland plates for tap off boxes and fixing elements shall be installed as per the recommendations of the Manufacturer and as per approved schematics.
10. Cable gland plates for tap off boxes and fixing elements shall be installed as per the recommendations of the Manufacturer and as per approved schematics.
11. Bus bar should be installed so that the orientations of phase from the front side will be GRY&N. The cabling from tap off shall be from side or bottom.

## JOINT ASSEMBLY

12. Ensure that all contact surfaces are clean and free of containments.
13. Align the bus bar ends of adjoining sections, verifying proper phase alignment, and slide the sections together (use joints pullers, if required).
14. Expansion joints if required as shown in approved construction drawings will be installed as manufacturer's instructions attached.
15. After completing the jointing of assemblies, torque the joints bolts to the specific value.
16. Where a bus bar extends through a inside block. Shear walls, an internal transverse barrier supplied by manufacturer will be installed.
17. Bus ways to be properly covered during the installation to protect them from moisture or other types of contaminants.
18. All the floor/wall crossing of bus bars is to sealed with approved type of fire sealant.
19. Bus bar enclosure continuity shall be ensured with proper bounding and connected to the main earthing grid through return paths al LV Panel end.

## Testing

After complete installation of Bus bar systems, Bus bars are subjected to following tests as recommended by Manufacturer:

- Checking of all joint connections for tightness.
- An Insulation Resistance test, carried out with a calibrated Megger insulation tester, to ensure that system is free from short circuits and grounds (phase-to-ground, phase-to-neutral and phase-to-phase). It should be noted that readings vary inversely with the length of run and width or number of bars per phase.
- Verify that system phasing matches the busway phasing before reconnecting all connections to switchboards.
- Continuity tester will be used to check electrical continuity of SS/QCE phase bus bars, neutral bus bar and earth bus bar.



# 10

## Plumbing Installation Guide

### Introduction

Introduction describes in detail the procedure for installation of plumbing system for a typical building project. It provides detailed step-wise installation procedure for the various processes/ equipments involved in the Plumbing System right through to the completion and testing of the system.

### 10.1 Concealed Drainage Piping

Installation of drainage pipes within the concrete slab in toilets, garbage rooms, balconies etc shall be done in accordance with the project specifications and drawings. The following installation procedure will follow:

1. Main Contractor's Surveyor to mark the locations of Floor gullies, sanitary fittings etc as per approved shop drawing and revised architectural drawing on shuttering before putting the reinforcement. Information regarding completion of marking to be given to VL Supervisors etc.
2. Civil Contractor to fix bottom reinforcement and inform VL supervisors. VL to install all pipes and fittings as per approved shop drawing and as follows.
  1. Ensure that the pipes are cut square before they are placed inside the reinforcement.
  2. Use cleaning fluid on both surfaces to be joined. This removes all dirt and machine release agents for the chemical solvent weld. Failure to do this can result in joint failure.
  3. Apply solvent cement evenly over mating surfaces of both pipe and socket.
  4. Insert pipe into socket with slight twisting action to full socket depth.
  5. Surplus cement should be removed with a cloth.
  6. The joint should be firm enough to handle in 5 minutes.
  7. Pipe runs are to be placed and tied to reinforcement considering proper slope and gradient as per approved shop drawings.

3. Pipes and fittings which are push fit types are to be connected as follows
  1. Lubricate the pipes cut in square and chamfered as well as fittings with rubber lubricant and push fit to full socket depth.
  2. Withdraw pipe 5 mm on waste system and 10 mm on soil system to allow for expansion.
  3. Soil fittings with spigot ends should be inserted into sockets to depth marks engraved on spigot.
  4. This procedure automatically allows for expansion.
  5. Pipe runs are to be placed and tied to reinforcement considering proper slope and gradient as per approved shop drawings.
4. Main Contractor to install Top reinforcement in the slab taking adequate care to ensure that drainage pipes / fittings are not damaged / disturbed etc. VL to ensure that pipes are tied securely to bottom, top reinforcement and stirrups so that they are not displaced at the time of concreting.
5. All Fire Stopping related works to MEP services viz. pipes entering / exiting Fire rated Walls etc to be done by Main Contractor.

### Testing

1. Hydraulic testing of the pipes jointed with solvent cement should be done after 1 hours of jointing.
2. Check for gradient and slope before filling water.
3. Extend one of the pipe ends to attain the required head of 1.5 m for hydraulic testing.
4. Compression type rubber plugs are to be used to plug all open pipe ends.
5. Fill the entire pipe network with fresh clean water up to the required height of 1.5 m from the highest point.
6. Keep the water with the head required for 6 hours for testing.
7. Check the joints for any leakage also the fall in water level in the Vertical Pipes. Any leakage found is to be rectified immediately and tested again.
8. Concreting to be done only after hydraulic testing of pipes has been successful and witnessed by the engineer.
9. Concreting to be poured over the pipe using mortar pans and compacting to such that needles do not touch the hydraulically tested pipes. Main Contractor to ensure that the pipes / fittings etc are not disturbed during concreting operations. This is critical to ensure alignment of pipe work is maintained as well as preventing damage.
10. Water filled into pipes to be retained and monitored for the entire duration of concreting so that at any displacement of joints and, subsequent leakages can be monitored.
11. If the above mentioned situations arise, concreting over that particular area is to be stopped, 'and rectification of displaced, pipes,' sealing of joints etc to be taken up immediately. Main contractor to wait until the rectification is carried out properly to VL Supervisor/Foreman's satisfaction.
12. Follow items 1-8 above after rectification.

### Post Installation Procedure

1. Ensure to prepare As-Built Drawings as soon as possible after the work is completed.
2. Location of the concealed drainage piping will be marked on the suffix as per As-built or redline (As-built marked up) drawings to avoid any drilling or related activity to prevent damage to the concealed drainage piping.



## 10.2 Above Ground Drainage Piping

Above Ground drainage piping is generally be installed in podium, risers and lobby areas as per locations shown in approved shop drawings. The following installation procedure will follow:

### Horizontal Runs

1. Mark the route of above ground drainage piping on the soffit of slab.
2. Determine the position of support and fix the supports using anchor bolts and ensure that all fixings (threaded rods, angles, clamps etc.) are straight and secure.
3. Install the Drainage pipes on to the supports. Ensure proper slope and gradient is maintained for all horizontal runs of Drainage piping.
4. Install all pipes and fittings as per the following procedure.
  - Ensure that the pipes are cut square before they are joined.
  - Use cleaning fluid on both surfaces to be joined. This removes all dirt and machine release agents for chemical solvent weld. Failure to do this can result joint failure.
  - Apply solvent cement evenly on mating surfaces of both pipes and socket.
  - Insert pipe into socket with slight twisting action and full socket depth.
  - Surplus cement should be removed with a cloth.
  - The joint should be firm enough to handle in 5 minutes.
5. Pipes and fittings which are push fit types are to be connected as follows:
  - Lubricate the pipes cut in square and chamfered as well as fittings with rubber lubricant and push fit to full socket depth.
  - With draw pipe 5mm on waste system and 10mm on soil system to allow it for expansion.
  - Soil fittings with spigot ends should be inserted into sockets to depth marks engraved on spigots. This procedure automatically allows for expansion.

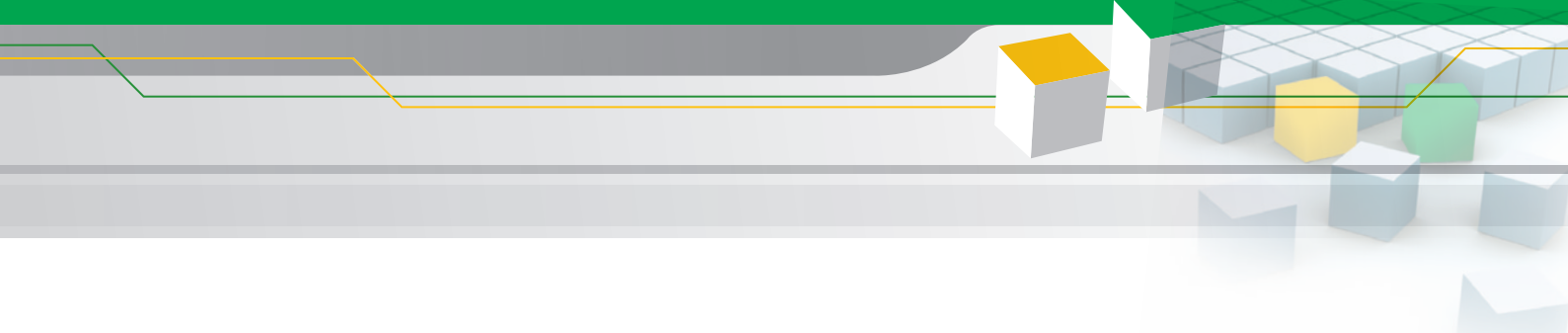
### Vertical Risers

1. Ensure that the shafts are clear and through up to maximum 6 floors above.
2. Ensure that the required provision for maintenance of shaft piping is provided in the block work as per approved drawing.
3. The inside faces of shaft to be finished before fixing of the vertical riser pipes.
4. Mark sure that proper working platforms are made for safe working inside the shaft.
5. Make sure that all pipes protruding out from the slab of the corresponding toilets are in plumb.
6. Mark the location of vertical riser and fix the supports (as per approval) at intervals as specified.
7. Fix the pipe fittings on the outlet pipes protruding from the slab and align to the plumb of the vertical riser.
8. Joining of pipes and fittings will be carried out as per clause 2.4 & 2.5 above.
9. Fix the clamps (as per approval) to vertical riser pipes at specified intervals of 1.6M which are already fixed to the structural members.
10. At every five (5) levels additional support with U- Clamp will be provided. Anchor supports to be provided for vertical loads at each directional change.
  - Each directional change or water testing of riser pipes will be carried out after completing the installation of riser pipe.
  - Riser to be tested with minimum 1.5m water head at eight point / air tested. While testing risers all horizontal floor toilets / WP's etc. will be disconnected / isolated.

## 10.3 Domestic Hot & Cold Water Supply Piping

Domestic Water Supply Piping System includes Hot Water Supply Piping, Cold Water Supply Piping, Risers, fittings, valves and accessories used for supply of water to Toilets, Kitchen and Utility rooms. The following installation procedure will follow:

1. Foremen will carryout a site survey and mark the route of water supply Piping ( Hot & Cold) as per approved shop drawings. In the event that there are any discrepancies or difficulties in executing the work, these will be brought to the notice of Project Engineer for corrective action.
2. Co-ordination with other trades will be carried out while marking the route of piping.
3. Determine the position of support and fix the supports using anchor bolts and ensure all fixing are tight and secure. While drilling the soffits, ensure that there is no damage to embedded services in the slab.
4. Any cut edges of angles, channels or threaded rods will be touch up with Zinc rich paint.
5. Install the pipes in position on the supports. Wherever possible pre-assembly of pipes and fittings at ground level will be carried out.
6. Assemble the pipes and fittings as per approved shop drawing.
7. Assemble of U-PVC pipes and Fittings by using Solvent cement. Ensure that joints are clean before applying solvent cement.
8. For joining of PP-R Pipes and Fittings manufacturer's recommendations will be followed (Copy enclosed).
9. For fixing PEX pipes, ensure that wall chases are done properly by Main Contractor as per locations shown in approved shop drawing.
10. Fix the female elbow with cover to be located at proper height as per approved shop drawing. Ensure the line and alignment with wall tiling.
11. Install the PEX pipes with sleeves (Conduit) in the wall chases. Ensure that joint between PEX pipe and female elbow is proper and leak free.
12. Fix the PEX pipe to Water supply lines by using male adaptors.
13. Spacing between supports / hangers will be maintained in accordance with latest approved shop drawings/ manufacturer's recommendations
14. Ensure all open ends of pipes, fittings and valves are covered with polyethylene sheet before leaving work space.
15. INSTALLATION OF VALVES AND ACCESSORIES
  - 15.1 Install system valves and accessories as per latest approved shop drawings.
  - 15.2 Ensure that system equipment, valves and accessories are secure and rigid.
  - 15.3 The installation shall be done allowing sufficient access to all valves/ strainers/ gauges as per Manufacturer's recommendations.
16. INSTALLATION OF WATER SUPPLY RISERS
  - 16.1 Pipe sizes will be identified first as per latest approved shop drawing and shifted to respective floors.
  - 16.2 Install the supports as per approved Shop drawing/ Manufacturer's recommendations.
  - 16.3 Joining of pipes will be carried out as per above procedure (refer clause 6.2.7 & 8).
  - 16.4 After installation of risers check the pipeline for proper alignment and supports.
17. HYDROSTATIC PRESSURE TESTING
  - 17.1 Complete pipe work will be subjected to hydraulic pressure tested as per technical specification. Depending on ongoing Construction activities sectional hydro testing will



be under taken to meet the requirements of the programmed. Test pressure will not be less than 1.5 times the working pressures but not less than 1035 KPa (for Two hour period) which ever is greater. Prior to any testing the system pressure will be shown on the pressure testing documentation.

17.2 Pressure gauges used for Pressure testing will have valid calibration certificate.

17.3 After successful Pressure testing ensures that piping system is fully drained and released for insulation and other related activities.

#### 18 INSULATION

18.1 Insulation of water pipe work will be carried out as per details as shown in approved submittals. Thermal insulation of joints will be carried out after pressure testing.

18.2 Make sure that Pipes are clean before applying any insulation. Follow manufacturer's recommendation for insulation of water supply piping (copy enclosed).

18.3 Ensure thickness of insulation is as per approved drawing.

18.4 Identification Bands/ Labeling will be located at is at access panel locations.

## 10.4 Electric Water Heater

The following installation procedure will follow:

### Ceiling Suspended Water Heaters

- Install the fabricated water heater support as per approved details.
- Install the water heater on the support.
- Remove the end caps on the inlet, outlet points. Complete the piping and valve package installation as per approved drawings.
- Install the electrical power connections as per approved drawings.
- Check and ensure availability of adequate access for removal and maintenance of water heater.
- Provide grounding wiring as per approved drawings / suppliers instruction.
- Ensure compliance to the manufacturers instructions while installing the water heaters.
- After completion of the installation, Inspection Request shall be raised for Consultants approval.

### Floor Mounted Water Heaters

- Mark the locations of the Water Heater base frame and hole locations on the foundation.
- Drill the suitable size holes in the foundations.
- Install the water heater on the foundation.
- Remove the end caps on the inlet, outlet points. Complete the piping and valve package installation as per approved drawings.
- Install the electrical power connections as per approved drawings.
- Connect the P&T valve to the nearest floor drain.
- Check and ensure availability of adequate access for removal and maintenance of water heater.
- Provide grounding wiring as per approved drawings / suppliers instruction.
- Ensure compliance to the manufacturers instructions while installing the water heaters.
- After completion of the installation, Inspection Request shall be raised for Consultants approval.



## 10.5 Domestic Water Supply Pumps

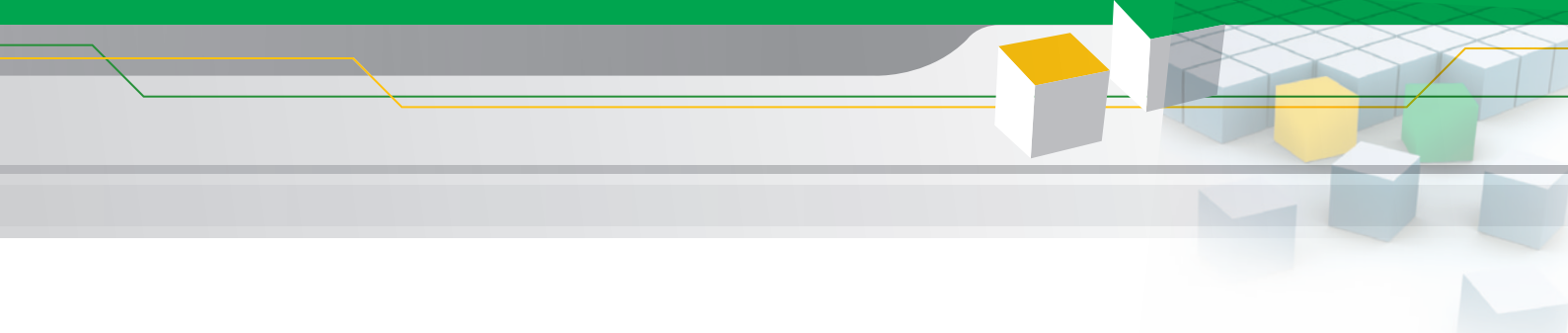
The following installation procedure will follow:

- Mark the locations of the pump base frame and hole locations.
- Drill the suitable size holes in the foundations.
- The pump and the other associated accessories including the piping manifold are pre-assembled on a base frame. Shift the pumps to the place of installation in safe manner. Use hand trolley / folk-lift/ crane as applicable/ required as per site conditions.
- Check and ensure free rotation of the shaft.
- Position the pump frame assembly on the foundation and fix the anchor fasteners.
- Water level the pump assembly by placing the shim plates below the base frame as required. After the installation the pump supplier shall recheck the gap between motor and pumps before testing as applicable.
- Position the pressure vessel and do the interconnecting pipe work as per approved drawings.
- Ensure proper coupling guards are provided if required.
- Complete the piping and valve package installation as per approved drawings. Remove the end caps fixed on the inlet flange.
- Install the electrical control panel and power connections as per approved drawings.
- Provide grounding wiring as per approved drawings / manufacturers instruction.
- Follow the manufacturer's instructions while installing the pump.
- After completion of the installation, it shall be checked and certified by the local supplier.

## 10.6 Sanitary Fixtures

The following installation procedure will follow:

1. Prior to starting the installation of Sanitary fixtures, fittings and accessories it will be ensured that all pipe work in the toilets/kitchens are installed properly and tested according to approved methods, and there is no damage to the pipe work. In short all first fix and second fix of the plumbing services will be completed before sanitary wares are installed.
2. All pipe supports, valves, floor drains, floor clean out will be checked for accuracy of installation.
3. The locations and sizes of piping and drainage outlets will be checked for their compatibility with sanitary fixtures.
4. All other works, especially floor and wall tile work painting are completed prior to installation of sanitary ware.
5. Ensure that all drainage pipe work is flushed out and debris removed from the pipe work.
6. Identify the models of Sanitary Ware to be installed as per approved drawings/submittals.
7. WATER CLOSET
  - Ensure that no damage has occurred due to transport to site, and all fittings, fixing screws are available inside the packing.
  - Fix the water supply angle valve to the pipe connection on the wall with escutcheon plate.
  - Cut the soil drain pipe to the required length to fit the W.C. bowl outlet.
  - Install the approved sealing flange connector supplied by the manufacturer on the drainage outlet.

- 
- Place the closet in the locations and adjust to the dimensions as per
  - Approved shop drawing. Follow manufacturer installation instructions.
  - Mark the holes for fixing screws on the floor, and drill with correct size drill bit to the required depth. Place the anchors in the drill holes.
  - Clean the floor under the W.C. closet and put in place fixing studs carefully observing the levels at all times.
  - Seal the base of the water closet unit with approved sealant and allow it to dry.
  - Assemble the flushing mechanism of the water cistern ensuring that all rubber seals for the screws and water connecting pipes are in place.
  - Connect the cistern with water supply angle valve using a connecting piece of pipe of appropriate length supplied along with sanitary ware.
  - Fix the seat and cover to the W.C. bowl using fixing screws provided by the manufacturer.
  - Secure the W.C. unit against misuse/damage by using proper protection.

#### 8. BIDET

- Check the location and position of bidet based on approved shop drawings.
- Re-examine the rough in connections for hot and cold water supply and waste outlet trap connection.
- Fix the angle valves with escutcheon plate on the rough in pipe connections for the cold and hot water supply and tighten till flush to the wall.
- Cut the waste outlet pipe to the required length and fix the waste coupling provided on the pipe end as per manufacturer recommendations.
- Fix the mixer on the bidet and tighten the underside nut, connect the plug lever arm to the waste coupling.
- Place the bidet in position and mark the holes for the fixing screws ensuring that waste opening is aligned with waste piping.
- Drill the holes with correct size of drill bit to the required depth and anchor fasteners. On completion clean the floor in position of the bidet.
- Place the bidet in position and insert the fixing screws in the holes and tighten them carefully.
- Connect the Bidet mixer and the angle vales by using a connection piece of pipe supplied and tighten them with coupling nuts.
- Place the waste strainer in the drain opening of bidet.
- Apply sealant around the base of the bidet.
- Secure bidet against misuse/ damage by using proper protection.

#### 9. BATH TUB

- Check the location and type of bath tub and mixer according to approved shop drawing.
- Examine the rough in piping connections for hot and cold water supply and waste out let. Check the distances and tolerances as per approved shop drawing, and manufacturer's recommendations.
- Mark the position of the bath tub and ensure the waste connection is centered with the waste coupling and the height from the floor is correct as per approved drawing.
- Place the bath tub on block work as recommended by manufacturer.
- Adjust the level of the tub using s spirit level and fix the waste strainer on the waste opening and tighten the screws.

- Fix the bath tub Make by placing the concrete, mortar under and around it as recommended by manufacturer. Ensure that there is no damage to the bath tub while carrying out civil works around it. Civil works by Main Contractor.
- After civil works are completed and location is clean and ready, fix the bath tub mixer and hand shower, shower rail as per approved drawing.
- Protect the bath tub against any misuse/ damage by appropriate methods.

#### 10. SHOWER TRAY

- Examine the location and position of the shower tray according to the approved shop drawing.
- Check in rough in piping connections for hot and cold water supply to the shower mixer and waste piping connections for their locations according to approved shop drawing.
- Place the shower tray in position and align the waste opening. Adjust the level of shower tray using spirit level.
- Fix the waste strainer on the waste opening and tighten the screws.
- Place the concrete mortar under the shower tray according to manufacturer's instructions and complete the finishing works regarding tiling and wall finishes shower cubicles etc. as per approved shop drawing.
- Place the protective coverings over shower tray and mixer.

#### 11. WASH BASIN

- Examine the location and place of wash basin as per approved shop drawing.
- Identify the model of the wash basin, check all dimensions, tolerances, and levels of the rough in water and drainage piping are matching with the wash basin to be installed as per approved shop drawing.
- Mark the holes for fixing stud on the walls, using template provided by the manufacturer.
- Drill the holes with the correct size of drill bit to the required depth and anchor fasteners in position.
- Place the threaded studs in the holes and fix the wash basins with washer and nuts.
- Check the level of the wash basin by spirit level and coordinate the levels with counter top position.
- Install bottle trap on waste out, fix the strainer on wash basin and tighten the strainer screw.
- Connect to the waste pipe on the wall and fix the escutcheon plate supplied by manufacturer to conceal piping joint.
- Fix the angle valves for cold and hot water supply flush to the wall, using escutcheon plates.
- Install water mixer on the wash basin and connect the mixer and angle valves by using tubes. Tighten the coupling nuts ensuring that installation is tidy.
- After complete installation protect the wash basins from any misuse/damage.



## 12. KITCHEN SINK

- Check the rough in dimensions for cold and hot water supply and waste pipe ensuring that all pipe sizing and positions are as per approved shop drawings.
- Identify the model of kitchen sink as per approved shop drawing and carefully transfer the unit to installation location to match with counter top.
- Install the angle valves for hot and cold water supply. Place the kitchen sink in place and adjust its level and location to match with counter top. Support the sink on counter top and apply silicon sealant around sink edges with the counter top.
- Connect the mixer with flexible hose to the angle valve and tighten them with coupling nuts.
- Connect the bottle trap assembly to the sink bowl and fit with the drain pipe in wall and seal the joint with rubber sealing connector of appropriate size.

# 11

## Fire Fighting Installation Guide

### Introduction

This section provides the detailed Installation guide for Fire Fighting system for a typical building project. It provides the detailed installation procedure for various Fire fighting components/ equipments and the Fire fighting system as a whole.

### 11.1 Fire Fighting Pipes & Fittings

Installation of Sprinkler and Fire Fighting Pipes and Fittings shall be done in accordance with the project specifications and drawings. The following installation procedure will follow:

1. Ensure that all tools needed for Installation are ready.
2. Layout for Pipe Supports locations based on the approved drawings are by means of a chalk line to ensure straightness & run parallel to alignment of adjacent building surfaces.
3. Measure locations of Supports and drill concrete slab and fix anchor bolts, continuous thread rod and ring hangers.
4. Pipe Risers will be supported by means of angle supports anchored to the floor slab or shear wall with u-bolts, nuts and washers.
5. Cross mains will be supported by means of ring hangers with nuts and washers suspended continuous threaded rod anchored to the concrete ceiling slab.
6. Cross mains will also be supported by rigid supports using steel angles with u-bolts which will be anchored to the concrete ceiling slab.
7. Pipe work will rest freely on supports and aligned properly before final connection.
8. Valves and other in line equipment will be installed where indicated in the approved drawings and as per Manufacturer's recommendation.
9. Install Automatic Air Release Valve at high point of the system as required.
10. All Fire Stopping related works on Fire Protection sleeves are to be done by Main Contractor.
11. Pipe ends and Equipment to be covered with polyethylene cover ensuring that no dirt will go inside.



## Jointing Method

1. By using Electric Pipe Cutter, cut the desired length of pipe to be joined and ensure the cut end of pipe is square and burr free.
2. For 65mm dia. and larger pipes, cut the pipe to suitable length and roll groove and bevel both ends by grooving machine.
3. For 50mm dia. and smaller, cut the pipe to suitable length and thread both ends by threading machine for fixing threaded fittings.
4. On threaded pipes apply Boss White and Teflon Tape, fix and tighten pipe and fitting using pipe wrenches.
5. Remove all dirt and moisture from pipe ends.

## 11.2 Sprinklers

Installation of Sprinklers shall be done in accordance with the project specifications and drawings. The following installation procedure will follow:

1. Ensure that all tools needed for Installation are ready.
2. Apply necessary Teflon Tapes and Shellac on the Sprinkler thread.
3. For Standard Upright and Pendent Sprinklers, mount the Sprinkler into the 25mmx15mm reducer finger tight, after ensuring alignment; tighten by using Sprinkler Wrench and Pipe Wrench. Install Sprinkler Guard where required.
4. For Concealed Pendent Sprinklers, mount the Sprinkler into the 25mm x 15mm reducer finger tight, after ensuring alignment; tighten by using Sprinkler Wrench and Pipe Wrench.
5. For Sidewall Sprinklers, mount the Sprinkler (with the inner escutcheon plate in place) into the 25mm x 15mm reducer finger tight, then tighten by using Sprinkler Wrench and Pipe Wrench, ensure alignment by using Spirit Level mounted on the deflector.
  - After Sprinkler is properly installed wrap Sprinkler with masking tape to protect from being painted when Bulkhead and walls are painted.
6. Upon False Ceiling, Bulkheads and Walls are finally painted, Concealed Sprinkler Head Covers shall be installed and Sidewall Sprinklers wrapping shall be removed and install Wall Escutcheon plates.

## Jointing Method

6. Remove all dirt and moisture from pipe ends.
7. Apply Teflon Tapes on Sprinkler thread, fix and tighten and by using Sprinkler Wrench and Pipe Wrench.

## 11.3 Fire Hose Cabinets

Installation of fire hose cabinets shall be done in accordance with the project specifications and drawings. The following installation procedure will follow:

1. Ensure that all tools needed for Installation are ready.
2. Drill the holes for fixing anchors and bolts. Ensure that the Bottom of the Cabinet is mounted 300mm above the finished floor.
3. Mount the Cabinet, ensuring vertical and horizontal alignments.
4. Mount the Fire Hose Reel into the Cabinet and connect the 25mm dia. Hose to the lock shield valve.
5. Wind the 25mm dia. Hose into the reel
6. Mount the Fire Rack into the Cabinet and connect the 65mm dia. Hose and Nipple to the Pressure Reducing Valve.
7. Hang the 65mm dia. Fire Hose and Nozzle in the Hose Rack properly.
8. Powder Fire Extinguishers beside the 65mm dia Fire Hose in the lower compartment of the Cabinet.

### Jointing Method

1. Remove all dirt and moisture from pipe ends.
2. Apply necessary Boss White and Teflon tape on Threads and install the water supply pipe nipple, pressure reducing valve and lock shield valve by using pipe wrenches.

## 11.4 Hydro-Static Testing of Sprinkler

Hydro-static Testing of Sprinkler & Fire Fighting Piping Network shall be done in accordance with NFPA 13 & 14 requirements & Project Specifications & Drawings. The following installation procedure will follow:

1. Ensure that all Equipment / Tools and Water are ready.
2. Fill up the Piping Network with Water, then with the use of the Pressure Pump slowly build up the pressure in the System and ensure trapped air is released thru the Air Release Valve. Check for leaks; inspect all Fittings while building-up the pressure.  
Disconnect the Pressure Pump from Piping Network and keep away from Testing Area.
3. Repair leaks and defects, if any, and re-test the Piping Network as follows;
  - a. Low Pressure Line at 200 psi (13.8 bar) pressure for 2 hours.
  - b. High Pressure Line at 456 psi (31.4 bar) pressure for 2 hours.
4. Ensure that during Hydro-testing, calibrated Pressure Gauges are used as follows;
  - a. Range at 300 psi for low pressure line.
  - b. Range at 600 psi for high pressure line.
5. Pressure testing documentation shall be submitted along with Inspection request.
6. Fill up the Inspection Request and ensure that all Signatures above Names of Witnesses are taken after satisfactory result is completed.



## 11.5 Fire Alarm System

Fire alarm system integrated with voice alarm system include fire/smoke detection, smoke damper monitoring, emergency voice evacuation system with paging system and firefighter's emergency telephone system. It will be ensure that complete system shall meet the requirements of Local Civil Defence Authority Regulations. The following installation procedure will follow:

1. General  
All installations shall be carried out as per the Project specifications and the applicable wiring practices as per BS 5839
2. Cable Installation
  - Ensure that cable containment (where applicable) as per approved shop drawing is installed, inspected and cleared for wire pulling.
  - Fire alarm cables will be directly cleated to soffit where there is no separate ELV containment is available in the areas covered by false ceiling, in private / core lobbies and car park areas.
  - Cable pulling through conduits from the drum end to the other end of the duct manually by using spring wire.
  - Ensure sufficient length of cable is maintained to connect to the device as per the approved shop drawings, before cutting the cable on both sides of conduit.
  - Upon completion of cable pulling. Inspection Request (IR) will be raised to Main contractor/ Consultant.
  - Perform insulation resistance test for each segment of cable and ensure the continuity of all cable cores.
3. Installation of Field Devices and Control Panel
  - 3.1 Manual call points, Smoke detectors, Heat detectors, Strobe light / Sounders:
    - Install Manual call points as per approved construction drawings and manufacturer's instructions.
    - Terminate cable to the device.
    - Check the soundness of installation and alignment of devices.
    - Device addressing by software using auto addressing feature. So separate labeling is not required. This will be carried by Manufacturer's authorized representative.
  - 3.2 Monitor Module:
    - Install Monitor Module as per approved construction drawings and manufacturer's instructions.
    - Check the soundness of installation and alignment of the device.
    - All the monitor modules to be installed near by the system from where it gets the input.
    - Terminate the cabling to the device.
  - 3.3 Line isolator and interface unit for flow switch:
    - Install the device as per approved construction drawings and manufacturer's instructions.
    - Terminate cable to the device.
    - Check the soundness of installation and alignment of devices.



3.4 Fire alarm control panel:

- Check the control panel and its internal components before installation for any damage.
- Install the device as per construction drawings and manufacturer's instructions.
- Check the soundness of installation and alignment of panel.
- Check the battery and its terminals.
- Complete the Cabling terminations (except power supply and battery connection).
- Clean inside the control panel.

4. Power Separation:

- Fire detection cables shall not be placed along side power cables or share the same conduit, channel or sleeve with electrical apparatus.
- Cable runs shall be installed at least 450mm from the nearest source of electromagnetic interference.

5. Labeling:

- Labels for all cables will be attached according to the specifications. Concealed cabling, due to space restrictions will be tagged with device address at the termination end.

6. Cable Records:

- Correct conductor polarity shall be maintained during connection to devices.
- Identification at the Main fire Alarm Panel and associated connector blocks shall be in accordance with standard industrial Practices.
- Prepare as -built drawings after completion of installations to allow Commissioning team to work.

7. Cable Testing:

- All cables shall be insulation tested using calibrated instruments.
- Any defects in the cabling system installation shall be replaced in order to ensure complete performance under installed conditions.
- All test results shall be recorded as per the format given and shall be signed by Main contractor and consultant.



## 11.6 Pressure Reducing Valve System

Installation of pressure reducing Valve shall be done in accordance with the project specifications and drawings. The following installation procedure will follow:

1. Ensure that all tools needed for Installation are ready.
2. Mount the Gate Valve on the flange with the gasket and all bolts in place then tighten all nuts by fingers.
3. Mount the pipe Spool with pipe nipple for Pressure Gauge with the gasket and all bolts in place then tighten nuts by fingers.
4. Mount the Pressure Reducing Valve on the flange with the gasket and all bolts in place then tighten nuts by fingers.
5. Mount the Pipe Spool with Pipe nipples for pressure gauge and safety relief valve with gasket and all bolts in place then tighten nuts by fingers.
6. Install the By-pass by repeating items 2 to 5.
7. Tighten all bolts and nuts alternately to ensure alignment by using a torque wrench.
8. Apply Boss White and Teflon Tapes on pipe nipples and install Isolating Valves and Pressure Gauges and Pressure Relief Valve.
9. Support the Pressure Reducing Station properly as specified.

# 12

## Electrical System

### Introduction

Each building requires an electrical system to provide power for the lights and to run various appliances and equipment. Electrical distribution is defined as the delivery of power to building premises, on poles or placed underground, from the power plant or substation through feeders and mains.

The power system is generally considered to be a combination of two sections: the transmission and the distribution. The difference between the two sections depends on the function of each at that particular time.

At times, in a small power system, the difference tends to disappear, and the transmission section merges with the distribution section. The delivery network, as a whole, is referred to as the distribution section and is normally used to designate the outside lines and frequently continues inside the building to include power outlets.

Most land-based power systems use alternating current (ac) rather than direct current (dc), principally because transformers can be used only with ac. An ac distribution system usually contains one or more generators (technically known as ALTERNATORS in an ac system); a wiring system of FEEDERS, which carry the generated power to a distribution center; and the DISTRIBUTION CENTER, which distributes the power to wiring systems called PRIMARY MAINS and SECONDARY MAINS. A representative transmission and distribution system is shown in figure 12-1.

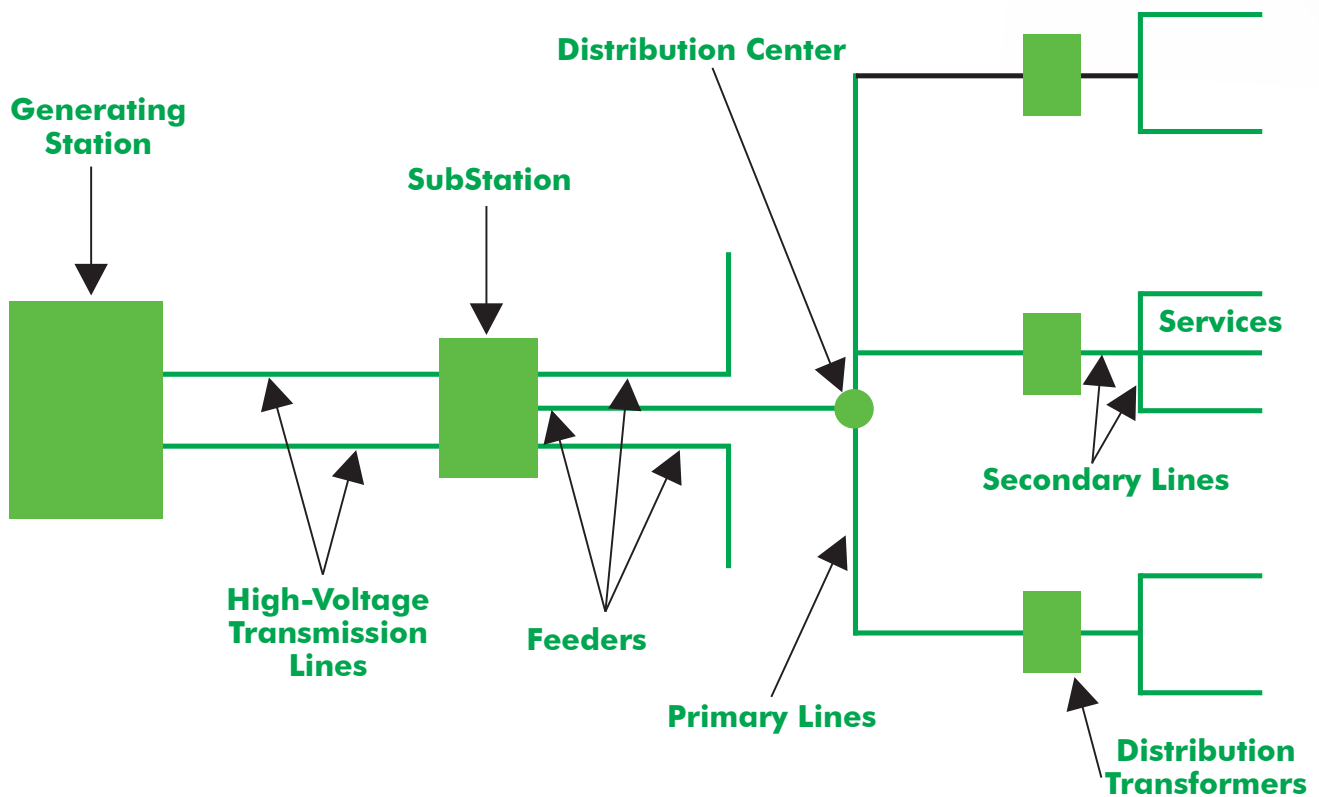


Figure 12-1- Electrical transmission and distribution system

Power from the generating station may be carried to the various points of consumption by overhead transmission and distribution lines, by underground cable, or by a combination of both. At most advanced bases, OVERHEAD feeder lines are commonly used because such lines are cheaper to build, simpler to inspect, and easier to maintain than UNDERGROUND cables. Obviously, the use of underground cables is preferred at airports and runways to prevent hazardous flight conditions.

## 12.1 Power Equipment & System

There is numerous power distribution system used for buildings. The system that is most appropriate for a specific building depend on the size of the building and the characteristics of the predominant loads, such as power ratings of the equipment voltages and phases. There are various levels of equipment in an electrical power system, starting with the power services, transformers and distribution equipments and ending with the load-end protection devices.

A Switchboards is an assembly of switches and circuit protection devices from which power is distributed. The switchboards serve as the main distribution center of a small system or as a portion of the distribution center of a large system.

A Panelboard is an assembly of switches and circuit protection devices as the final serving point of the power distribution system. Depending on the load to which it is connected, a panelboard may be identified as a lighting, power, heating, specialty, or combination panelboard.

A Transformer is power transmission equipment primarily intended to convert a system's voltage from one level to another. All transformers operate on the principle of magnetic induction: Primary and secondary coils are wound on a common silicon steel core.

Motor: Virtually any equipment requiring motion, such as a pump, elevator, fan, air conditioner, or even equipment as small as an electric clock, need one or more motors. Motors are classified according to size, system and equipment voltage, phase, etc.

## 12.2 Wiring Devices

Various wiring devices are used in electrical systems. All wiring system must be installed in code-approved boxes, regardless of the wiring system. Some of the wiring devices mentioned below:-

1. Switches
2. Low voltage Switches
3. Receptacles
4. Contractors & Relays
5. Dimmers

## 12.3 Telecommunication System (Low Current System)

Telecommunication system is defined as any electrical system that transmits, emits, or receives signals, images, sound, or information of any nature by wire, radio, video, or come other form of energy within the electromagnetic spectrum. Characteristics of telecommunication system are:

- Telecommunication systems do not require heavy electric power.
- Most telecommunication systems operate on 30V or less, either AC or DC.
- Telecommunication systems do not require a large space for equipment.
- Telecommunication systems future limitless functions and options.

### Classification of Telecommunication Systems

There are two major groups of telecommunication systems:

1. Communication system
  - a. Audio Public address, intercom, music, radio
  - b. Video TV, CATV, MATV, SATV, etc.
  - c. Telephone public private exchanges
  - d. Data modem, local area network, wide area network, etc.
  - e. Signals time, program, signal, etc.
  - f. Multimedia combination of audio/video/telephone and data, such as video conferencing and distance learning system
2. Building operational system
  - a. Safety fire alarm, sprinkler alarm, emergency evacuation, etc.
  - b. Security access control, CCTV intrusion detection, etc.
  - c. Automation BMS, BMAS, etc.
  - d. Specialty sound masking and systems unique for special building occupancies such as hospital, defence, retail stores, food services.

## 12.4 Fire Alarm Systems

Fire alarm systems are an integral part of a fire protection plan. They are basically electrical systems that are specially designed to announce the presence of fire or smoke. A fire alarm system is not limited to initiating an alarm during a fire; it may also serve to identify the location of fire, transmit audio or visual messages, activate fire-extinguishing systems, and interface with building management systems. A more sophisticated fire alarm system is in effect a fire management system.

### Type of Fire Alarm System

A fire alarm system is usually a combination of several basic systems. Among these are the following:

- Central station versus local system
- Manual or automatic system
- Coded or non coded system
- Supervised or nonsupervised system
- Signal or zoned system
- General alarm or presignal alarm
- Voice communication system
- Standalone or integrated system

## 12.5 Lighting Management System

Lighting is one of the most energy-consuming services in a building, also the one which is most visible and requires most adjustment to suit the needs and preferences of Individuals.

Lighting management provides the means of efficiently controlling, adapting and monitoring lighting to achieve cost and efficiency savings, and an enhanced environment for people working in the building.

Lighting management transforms a physical lighting installation into a virtual network, managed and monitored through graphical software.

An intelligent, addressable lighting management system achieves flexibility, energy efficiency and operational saving as well as enhancing occupant satisfaction.



## **Feature of Lighting Management System**

- Flexibility
- Energy saving
- Operational cost saving
- User control & choice
- Interoperable

### **Flexibility**

A traditional mains installation limits flexibility as many changes to switching arrangements involve disruptive alterations to the installation and mains wiring. An intelligent lighting management system enables all changes to switching arrangement to be achieved through head-end graphical software and without any wiring changes. The complete lighting installation is graphically managed and monitored through head-end software which shows:

- Lighting status
- Lamp failure
- Lamp hours-run
- Hardware status

### **Energy saving**

Energy saving is achieved through:

- Time-based control to switch lights off
- Presence-related control of lighting
- Daylight-linking of perimeter lighting
- Small area local control
- Dimming of lighting
- Integrated with other energy-consuming services

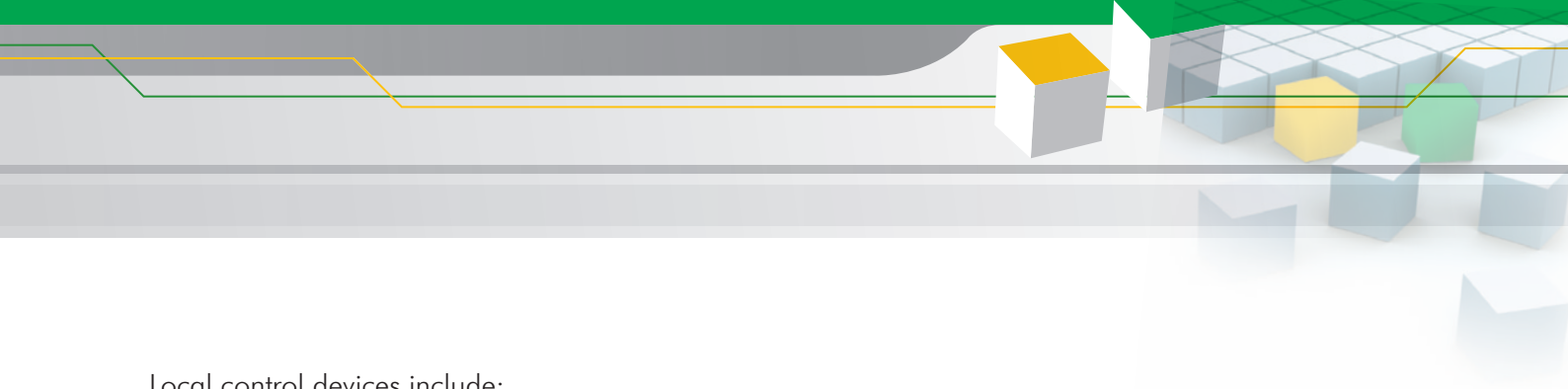
### **Operational cost saving**

Operational saving is achieved through:

- Real-time monitoring of the installation
- Lamp-hours logging optimizes re-lamping
- Lamp-failure alerts for proactive maintenance
- Monitoring & alarms via web or PDAs
- No disruption for switching layout changes

### **User control & choice**

Individuals are empowered with control of their lighting environment and can switch lighting on/off and adjust levels to suit their preference or task.



Local control devices include:

- Wall switches
- Presence detectors & multi-sensors
- Desktop controllers
- Hand held transmitters
- Telephone
- Web browser

## **Interoperable**

System using open protocols (eg. Lon) enable product from different manufacturers to share information and work together enhancing the efficiency of the building (eg. lighting and HVAC can both be linked to occupancy). Open protocol avoid clients being reliant on individual manufacturers for support and maintenance as a person versed in the open protocol can handle many systems.



## References

- 1 Mechanical and Electrical System in Buildings, third edition, by Richard R. Janis & William K.Y.Tao –Washington University, USA.
- 2 Dubai Electricity & Water Authority , Regulations for Electrical Installations 1997 edition.
- 3 The Associated General Contractors of America “Construction Planning & Scheduling” by Thomas E. Glavinich.
- 4 Project Management Institute (PMI) “Project Management Book of Knowledge” 3rd Edition, PMI Global Standards.
- 5 Project Management Institute (PMI) “Practice Standard for Work Breakdown Structures (WBS)” PMI Global Standards.
- 6 Project Management Institute (PMI) “Improving your Project Management Skills”.
- 7 Project Management Institute (PMI) “Effective Benchmarking for Project Management” PMI Global Standards.
- 8 Project Management Institute (PMI) “The Standard for Program Management” PMI Global Standards.
- 9 Project Management Institute (PMI) “Construction Extension to A Guide to the Project Management Body of Knowledge” 2000 Edition, PMI Global Standards.
- 10 American Association of Cost Engineering International “Skills & Knowledge of Cost Engineering”, 5th Edition by Dr. Scott J. Ammos, PE.
- 11 American Association of Cost Engineering International “CPM in Construction Management” 6th Edition by O’Brien Plotnick.
- 12 American Association of Cost Engineering International “Project Management, A Systems approach to Planning, Scheduling, & Controlling”, 9th Edition, Harold Kerzner, Ph. D.

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