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Project Testing and Commissioning Procedure

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1.0 PURPOSE

The purpose of this procedure are as follows:

1. To identify the main responsibilities and deliverables of each party involve in the Commissioning Process for a design-bid-and-build project delivery method.

2. To identify the test requirements and procedures for the Testing and Commissioning of Building Services and Fire/Life Safety Systems that the Main Contractor is contracted to conduct during the construction and post-occupancy phases.

3. To identify the checking/holding points in overseeing the Commissioning Process from design to handover and close out stages.

4. To act as a user guide when walking through the White Book “Project Testing and Commissioning Guideline” - by identifying the reference documents related to the Commissioning Process.

This procedure applies to works performed under all Government construction projects executed throughout the Kingdom of Saudi Arabia.

2.0 SCOPE

This procedure illustrates the flow of the Commissioning process and documents review from the design, construction testing, pre-commissioning, system stand-alone testing, integrated testing, and doomsday test (full-load power failure test) to post-occupancy stage as defined in ASHRAE Standard 202, ASHRAE Guideline 0, LEEDv4, NFPA 3 and NFPA 4 for Fire and Life Safety Systems.

3.0 DEFINITIONS

Definitions	Description
Data Point Schedule (DPS)	A representation of points to be controlled and monitored in table format. Functions such as control and monitoring (especially that of the HVAC) are listed and represented in Input and Output (I/O) Points to and from the controller
Sequence of Operation (SOO)	A written explanation to describe how the HVAC equipment and system is intended to work in air side and water side distribution.
Process and Instrumentation Diagram (PID)	A schematic representation showing the equipment, field devices, and input/output to the Direct Digital Control (DDC) for the purpose of simplifying the functional description of the equipment and system.
Owner Project Requirements (OPR)	A Client/Owner generated mandatory pre-design document by ASHRAE, LEED, and NFPA, which is the basis of the Basis of Design (BoD) preparation, construction, acceptance, and operational requirements. The document contains the specific and detailed functional requirement (in less technical terms) of the project and expectations for how the project will be used and operated.
Basis of Design (BoD)	An Architect/Engineer generated mandatory pre-construction document by ASHRAE, LEED, and NFPA which is the basis of preparation for the Systems Manual, Commissioning Plan, and Construction Documents. The BoD covers the OPR in more detailed, specific, and technical terms.
Commissioning Record	Testing and Commissioning documentation that includes issues log, commissioning plan & methodology, progress reports, submittal and O&M manual reviews, training record, test schedules, construction checklists, start-up reports, functional tests, and trend log analyses.
Integration Testing Plan	Is a part of the overall T&C Plan which is a strategic project specific procedure on how to complete the T&C for a given scope of work in a given project time duration. It outlines the scope and extent of the work,

Definitions	Description
	organization, schedule, recording, allocation of resources, and coordination planning.
Integration Methodology	Is a part of the overall Testing and Commissioning methodology and is a written protocol which defines procedures and expectations for testing conducted on equipment, assemblies, systems, and interfaces (or integration). The document includes test prerequisites, testing conditions, limitation and tolerance, tools and instruments to be used, schematics, and safety risk assessment.
First Fix	Refers to the installation of piping, valves, cable conduits, and supports.
Second Fix	Refers to the installation of piping insulation, above ceiling equipment, piping painting works, cabling, and devices.
Third Fix	Refers to the installation of ceiling, wall, and floor fixtures and devices such sprinkler head, diffusers, Access Points, smoke detectors, light fixtures, speakers, manual pull stations, convenience outlets, water closets, floor drains, clean out, etc.
Architect / Engineer (A/E) Consultant or Design Firm	Designer appointed by the Project Management Company to undertake the whole or part of the permanent works design
Owner/Entity/Client	Whenever the term is used in this procedure, it pertains to the entity, authority, ministry, project direct engineering management staff, and end-users (security, IT, maintenance, medical representatives, etc.) representing the government interest which main responsibility is to develop the OPR prior to the design development stage.
Commissioning Authority (CxA)	Company appointed by the Owner / Entity / Client to oversee the Testing and Commissioning activities. The Commissioning Authority acts independently of other parties and reports directly to the Owner / Entity / Client. A CXA may not be appointed for all projects depending on scale and complexity.

ACRONYMS	DEFINITION
ASHRAE	American Society of Heating Refrigerating and Air-Conditioning Engineers
NFPA	National Fire Protection Association
LEED	Leadership in Energy and Environmental Design
DPS	Data Point Schedule
SOO	Sequence of Operation
PID	Process and Instrumentation Diagram
OPR	Owner Project Requirement
BdD	Basis of Design
I/O Point	Input and Output Point
SoW	Scope of Work
T&C	Testing and Commissioning
FAT	Factory Acceptance Testing
TTC	Type Testing Certificate
BMS	Building Management System
VFD	Variable Frequency Drive

OCPD	Over Current Protective Device
CxA	Commissioning Authority
HVAC	Heating, Ventilating, and Air-conditioning
UTP	Unshielded Twisted Pair
STP	Shielded Twisted Pair
ELV	Extra Low Voltage
AHJ	Authority Having Jurisdiction
O&M M	Operation and Maintenance Manual
EPMO	Entity Project Management Organization
FPT	Functional Performance Test
CX	Commissioning

4.0 REFERENCES

Document Number	Title of the Document
EPM-KT0-GL-000003	Project Testing and Commissioning Guideline
EPM-KT0-RG-000007	Testing and Commissioning Checklist and Templates
EPM-KE0-GL-000008	Fire and Life Safety Integration Guideline
EPM-KE0-GL-000007	ELV System Integration Guideline
EPM-KE0-GL-000009	BMS and other Mechanical System Integration Guideline

5.0 RESPONSIBILITIES

5.1 Owner/Entity/Client

The Owner /Entity/ Client ensure that the Owner Project Requirements (OPR) is created and updated from the design stage, construction stage, up to the occupancy stage and are responsible for ensuring that all Specialty Contractors directly under them (especially for Construction Management type of contract), are mobilized as per the construction schedule. The OPR should contain the requirements as specified in the document EPM-KT0-GL-000003, Project Testing and Commissioning Guideline. For the detailed Scope of Work (SoW) for the Owner/Entity/Client during design, construction and occupancy refer to T&C document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline

5.2 Commissioning Authority (CxA)

The Commissioning Authority supports the owner to create the owner project requirements and validate that they are implemented throughout the project life cycle. The commissioning authority also provides the overall supervision, guidance and oversees the commissioning process. The Commissioning Authority reports directly to the Owner /Entity// Client regarding the status of achieving the OPR. For the detailed SoW during design, construction and occupancy refer to T&C document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline.

The Commissioning Authority acts independently of other parties involved in the project (Designer, Contractor).

The Owner/Client/Entity/ will decide whether the appointment of an independent Commissioning Authority is required through due consideration of the scale and complexity of each project

5.3 Architect/Engineer (A/E) - Designer

The Architect / Engineer is responsible for the design and provides high level (related to design) technical assistance and clarification to all enquiries during the construction phase related to T&C. For the detailed

SoW during construction and occupancy refer to T&C document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline.

5.4 Owner Representatives - Consultants, Project Management or Construction Management

Provides low level (related to construction) technical assistance and clarification to all enquiries during the construction phase related to T&C work. Conduct site inspections and supervise the T&C implementation to ensure quality control. For the detailed SoW during construction and occupancy refer to T&C document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline.

5.5 T&C Agent - Main Contractor In-house T&C Entity or Specialized Third Party

Conducts the rigorous T&C Works and coordinates, supervises, and leads the integrated testing activities with Trade Contractors. Supervises Trade Contractor installation and testing activities based on approved T&C Plan and Methodology and ensures that quality control measures are implemented. For the detailed SoW during construction and occupancy refer to T&C document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline.

5.6 Operation and Maintenance Personnel (OMP)

Address operational and maintenance requirements of the systems and participate in testing of the systems as standalone and as integrated. For the detailed SoW during construction and occupancy refer to T&C document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline.

6.0 COMMISSIONING PROCESS

6.1 Initial planning stage

1. The Owner/Entity/Client shall lead the development of the Commissioning Authority services contract (as deemed required base on project scale and complexity).
2. The Owner/Entity/Client shall identify and form the Commissioning Team.
3. The commissioning authority shall support the Owner/Entity/Client to develop the OPR.
4. The commissioning authority should support the Owner/Entity/Client commissioning team to prepare the preliminary Commissioning Plan. For the contents of the Commissioning Plan, refer to document EPM-KT0-GL-000003 (Project Testing and Commissioning Guideline) section 6.1.2.
5. The Owner/Entity/Client commissioning team should estimate the budget for commissioning work and integrate cost into the project budget along with the support from the commissioning authority team.
6. The Owner/Entity/Client commissioning team should identify the Initial stakeholder engagement and permitting plans along with the support from the commissioning authority team.
7. The commissioning authority will support The Owner/Entity/Client commissioning team to prepare the Initial handover plan.

6.2 Tender for design

1. The commissioning authority will support The Owner/Entity/Client commissioning team to include the commissioning requirements in the scope of work.
2. The Owner/Entity/Client shall establish codes and other regulatory requirements.

6.3 Design stage

1. The A/E shall review and clarify the OPR content with the commissioning authority and the Owner/Entity/Client commissioning team and seek any approval of changes if required. The A/E shall develop the Basis of Design reference to the Preliminary OPR. Any ambiguities in the OPR shall be clarified with the help of the Owner/Entity/Client commissioning team and the CxA. The BoD shall be reviewed for completeness and clarity and acceptance by the Owner/Entity/Client and the CxA.
2. Upon approval of the BoD the A/E shall proceed with the design. The complete design package shall be prepared and contains the following documents.
    a. Fire Detection and Alarm System Cause and Effect Matrix
    b. BMS Data Point Schedule, Sequence of Operation, and Process & Instrumentation Diagram (PID)
    c. Evacuation Plan
    d. Calculations which include systems related to Fire and Life Safety such as smoke evacuation and pressurization.
    e. A separate Commissioning Specification from that of the General Specification.
3. The commissioning authority will review and validate the design deliverables to meet OPR.
4. the A/E shall prepare
    a. The preliminary Commissioning Methodology (with checklists).
    b. The commissioning Scope
    c. The commissioning Plan based on the design developments.
5. The CxA should update the OPR to incorporate commissioning requirements identified for design stage enquiry.
6. The A/E, owner commissioning team and CxA shall respond to clarification made by contractors regarding issues related to the Commissioning Process.

The responsibilities of the commissioning team during the design review and the required deliverables during the design stage

6.4 Tender for construction stage

1. The Owner/Entity/Client commissioning team and A/E should ensure the commissioning scope of work is included in the tender document.
2. The Owner/Entity/Client commissioning team and A/E shall assess capabilities of the bidding contractor with regards to the T&C Work during the pre-qualification process along with the support of CxA.
3. The A/E, Owner/Entity/Client commissioning team and CxA shall respond to clarification made by contractors regarding issues related to the Commissioning Process.

6.5 Construction stage

1. The Main Contractor shall complete all preparatory work prior to the T&C Work. Preparatory work shall include the following:
    a. Labelling and tagging for all electro-mechanical installation
    b. Signing-off of all Electro-mechanical installation
    c. All required calculations to prove the resiliency and correctness of the installation submitted and approved by the Client Representatives
    d. Lock-out/tag-out and other safety procedures and methodologies are prepared for implementation.
2. The Main Contractor shall ensure that all resources required for the testing and commissioning activities such as potable water, drainage system, and permanent/stable power, etc are available prior to the T&C Works. Temporary and unstable power sources shall not be used to protect electronic equipment such as Variable Frequency Drive (VFD) controllers from damage.
3. The Owner/Entity/Client commissioning team along with the support of CxA shall take lead in assuring that the Main Contractor shall
    a. Update the Testing and Commissioning Plan, include required resources in the scope and incorporate such changes in the General Construction Schedule.
    b. Update the Testing and Commissioning Methodology.
4. Power studies to include short circuit analysis, coordination of OCPD (Over Current Protective Devices), and Arc Flash Study shall be conducted by the Main Contractor through a Specialist and shall be reviewed and approved by and the owner commissioning team and Client Representative.
5. The Main Contractor shall conduct and pass all construction testing for mechanical and electrical installation prior to conducting the T&C Works. Construction testing shall include the following;
    a. Mechanical installation pressure testing
    b. Mechanical installation gravity or air testing
    c. Plumbing flow testing
    d. Pressure and leakage testing for HVAC ducts
    e. Complete mechanical system installation testing
    f. Electrical wiring continuity and insulation resistance testing
    g. Electrical cold testing (refer to document EPM-KT0-GL-000003, Project Testing and Commissioning Guideline for the scope of cold electrical testing)
    h. All test for control wiring such as point-to-point testing and loop testing.
6. Prior to conducting T&C Works, the Main Contractor in coordination with all Trade Contractors and equipment suppliers shall submit the Factory Acceptance Testing (FAT) Certificates and Type Testing Certificate (TTC) for all mechanical and electrical equipment.
7. The design team and construction team shall ensure that all documentation to aid the completion of the T&C Work is available. Documentation shall include:
    a. Fire Detection and Alarm System Cause and Effect Matrix
    b. BMS Data Point Schedule, Sequence of Operation and Process and Instrumentation Diagram (PID)
    c. Evacuation Plan
    d. As-Built Drawings
8. The Main Contractor and his T&C Agent shall prepare a comprehensive Testing Plan and Methodology for the Electro-Mechanical Systems as both stand-alone systems and as an integrated system to be approved by the owner commissioning team and Owner

Representatives. The T&C Plan and Methodology shall conform to the Code, Standards, and best construction practices.

9. The Main Contractor shall ensure that field devices procurement and installation shall be coordinated with the T&C schedule and re-certification shall be based on the date of installation or use and not on the date of the last test. All required testing should immediately commence upon installation.
10. The main contractor shall ensure that all devices used for the testing and commissioning are calibrated prior to and during the testing and commissioning stage.
11. The Main Contractor in coordination with his Trade Contractors and equipment suppliers shall conduct site pre-commissioning testing to cover Equipment Pre-Start Up or Pre-energization Testing, Functional or Operational testing and Site Equipment Performance Testing. Site Equipment Performance testing shall be conducted as per the requirement of the contract.
12. All Low Current Systems (or Extra Low Voltage – ELV, in British Standard) cables such as UTP or STP, shall pass the required testing after the installation of third fix. The construction team shall ensure the availability of As-Built drawings especially for the Data Infrastructure System active devices patching plan. All IP Based Low Current System field device IP address shall be coordinated to the Data Infrastructure Administrator for programming and configuration of the Main Data Server.

    Attachment 1.2, Testing and Commissioning Flow Charts/Project Stage Gates shows the responsibilities of the commissioning team during the Construction Stage and the required deliverables.

6.6 Testing and Commissioning stage

1. The Main Contractor in coordination with his T&C Agent shall conduct Live Testing after the energization of the electrical system. Live testing shall include testing as specified in document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline, with testing exceptions for projects that comply with the standard color-coding for cables.
2. The Main Contractor shall conduct all required testing for electro-mechanical system as stand-alone, as specified in the T&C Document EPM-KT0-GL-000003 part 5, applicable as per the availability of the Building Services System in the Specification and contract.
3. Once all stand-alone testing is completed for Low Current Systems, other Building Services Systems, equipment, devices, and appurtenances for architectural items (as required by the contract), the Main Contractor and his T&C Agent in coordination with all Trade Contractors shall conduct integration works and testing for; (1) Fire/Life Safety Systems as covered under document EPM-KE0-GL-000008 Fire and Life Safety Integration Guideline, (2) Low Current Systems as covered under document EPM-KE0-GL-000007 Low Current System Integration Guideline, and (3) mechanical systems covered under document EPM-KE0-GL-000009 BMS and Mechanical System Integration.
4. Upon the completion of the required integration works, the Main Contractor and his T&C Agent in coordination with all Trade Contractors and equipment suppliers shall conduct “Doomsday Testing” to simulate an emergency condition during the normal and peak operation of the building. The testing shall require transfer of the electrical power from the normal to essential using the emergency power system when all Building Services Systems, electro-mechanical systems, transport equipment, and other equipment (including transient such as fire pumps) are functioning. The testing shall also include occupant evacuation process and recording the time of evacuating the building.
5. The Doomsday Testing shall be repeated until all Building Services Systems, equipment, devices, and appurtenances are proven and working as a single system for the purpose of functionality and fire/life safety. The testing shall be witnessed and accepted by the AHJ (or Civil Defense) for preliminary handover and occupancy purpose.
6. Prior to Preliminary Handover, the Main Contractor shall submit the O&M Manual (to include all T&C records), System Manual, and As-built drawings to prove the completeness of the Building Services System testing to the Client duly approved by the Commissioning Authority and the

Client Representative. The submission shall also include snag list (or punch list) indicating minor balance of works to be completed by the Main Contractor with end dates.

7. The Main Contractor in coordination with Trade Contractors and equipment suppliers shall conduct training and orientation to the End-users and Maintenance Personnel for all Building Services Systems and equipment.
8. The main contractor shall issue that Initial acceptance request along with outstanding work if applicable for owner's review and approval.

Attachment 1.3, Testing and Commissioning Flow Charts / Project Stage Gates shows the responsibilities of the commissioning team during the Commissioning Stage and the required deliverables.

Attachment 1.4, Testing and Commissioning Flow Charts / Project Stage Gates shows the responsibilities of the commissioning team during the Post Occupancy Stage and the required deliverables.

Attachment 2 - Testing and Commissioning Flow Chart EPM-KT0-PR-000006 which illustrates all activities associated with Testing & Commissioning with logical sequences and interdependencies.

6.7 Handover and closeout stage

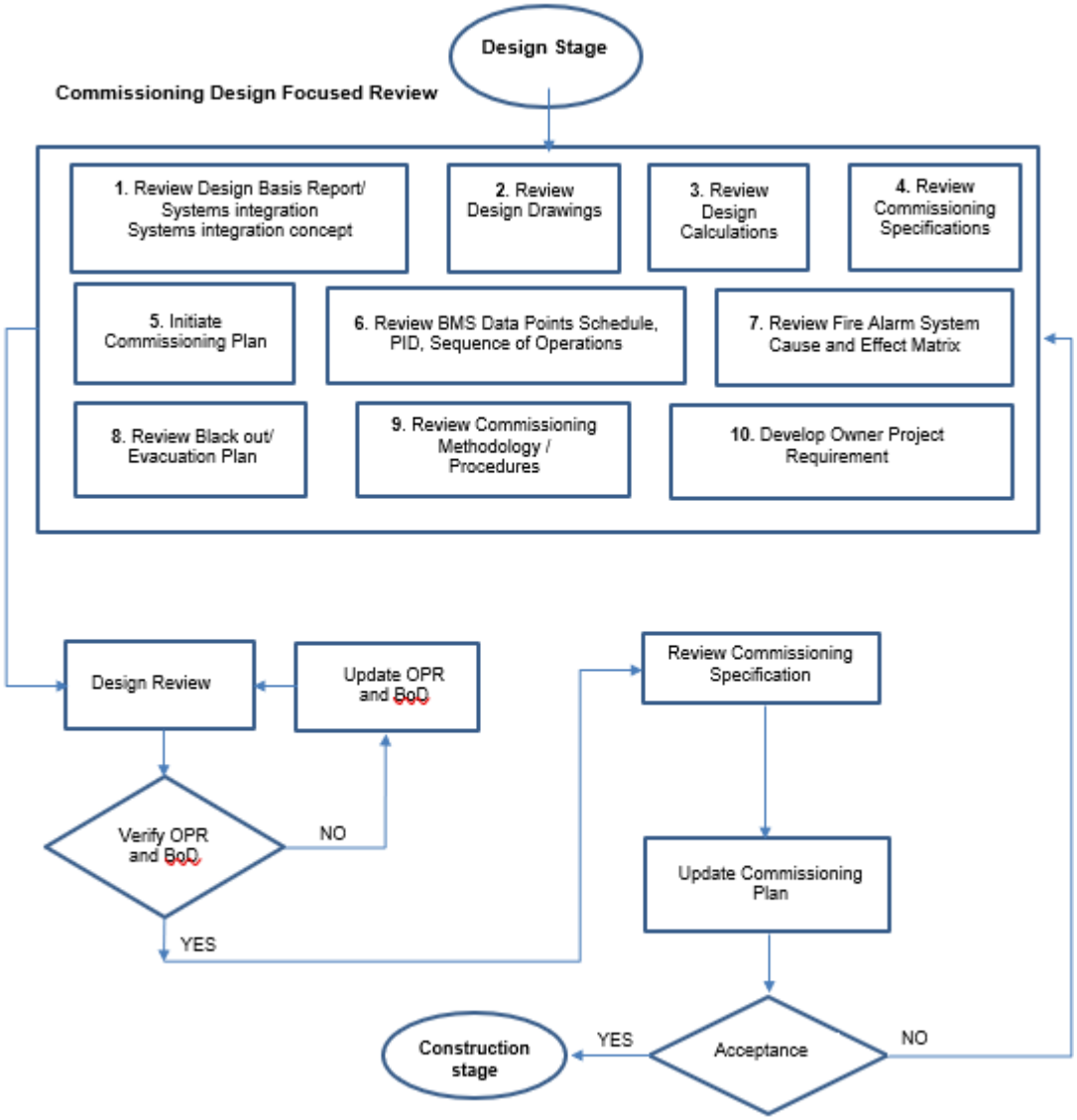
1. The Main Contractor with his T&C Agent shall conduct post- occupancy testing and commissioning work to cover the following, reference to document EPM-KT0-GL-000003 Project Testing and Commissioning Guideline:
    a. Phase balancing for convenience outlets
    b. Harmonic correction
    c. Thermal scanning
    d. Final Site Survey for Wireless Network as applicable
    e. Seasonal HVAC Testing and Commissioning (as applicable for project with dual season)
    f. LEED requirement for Building Services performance assessment after 10 months from preliminary handover (as applicable).
2. The main contractor shall submit a clear plan to address the outstanding work if any for owner and his representative approval.

7.0 ATTACHMENTS

1. Stage Gates Testing and Commissioning Flow Chart - Project Stage Gates
2. Commissioning Process Map
3. Testing &Commissioning Flow Chart

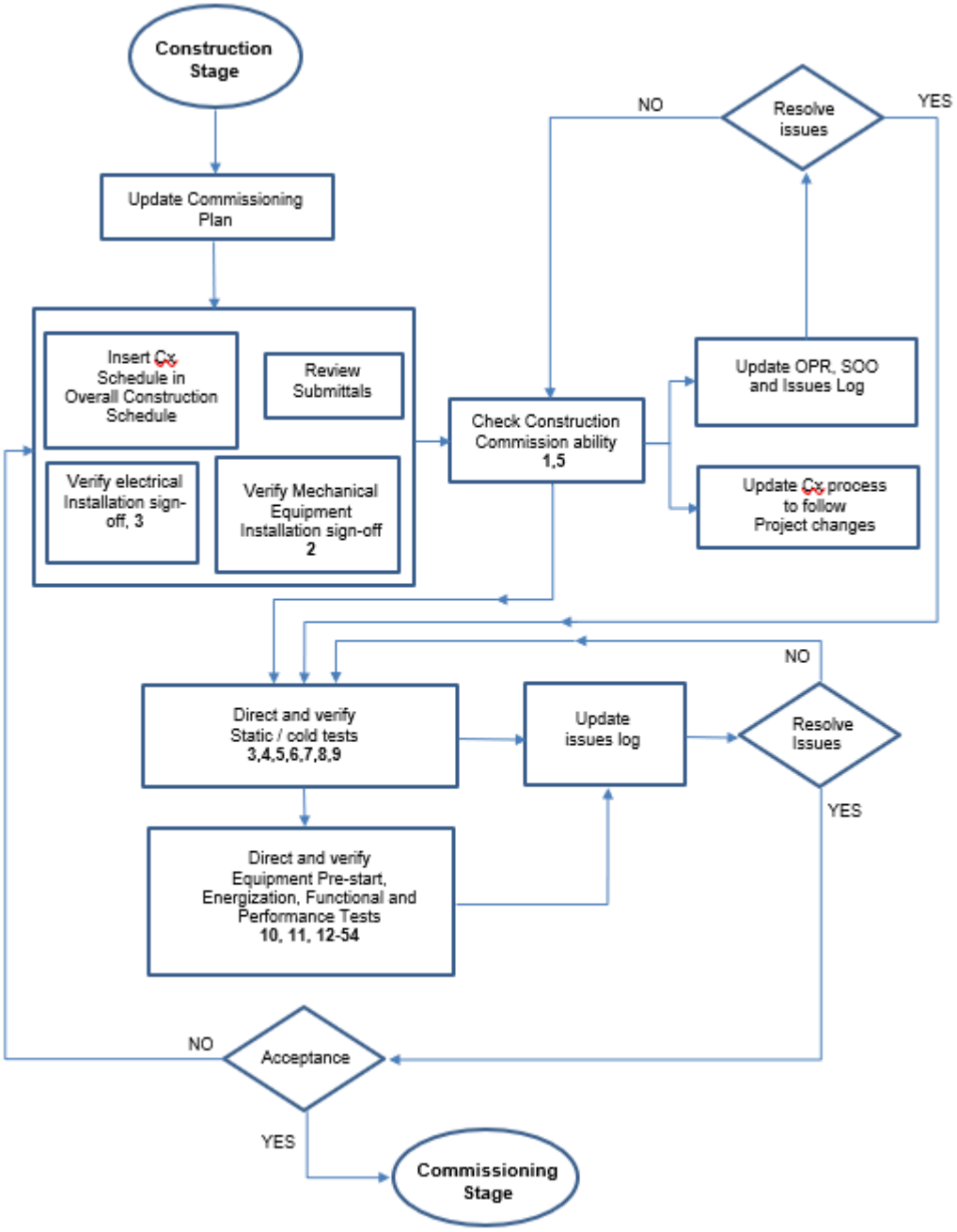
Attachment 1 - Testing and Commissioning Flow Charts/Project Stage Gates

1.1 Design Stage



1	Review Design Basis Report/Systems integration	EPM-KT0-GL-000003 EPM-KE0-GL-000007 EPM-KE0-GL-000008 EPM-KE0-GL-000009
2	Review Project drawings	EPM-KT0-GL-000003
3	Review Design Calculations	EPM-KT0-GL-000003
4	Review Commissioning Specification	EPM-KT0-GL-000003
5	Initiate Commissioning Plan	EPM-KT0-GL-000003
6	Review BMS Data Points Schedule, Sequence of Operation, PID	EPM-KT0-GL-000003
7	Fire Alarm System Cause and Effect Matrix	EPM-KT0-GL-000003
8	Review Black Out/Evacuation Plan	EPM-KT0-GL-000003
9	Review Commissioning Methodology and Procedures	EPM-KT0-GL-000003
10	Develop Owner Project Requirement	EPM-KT0-GL-000003

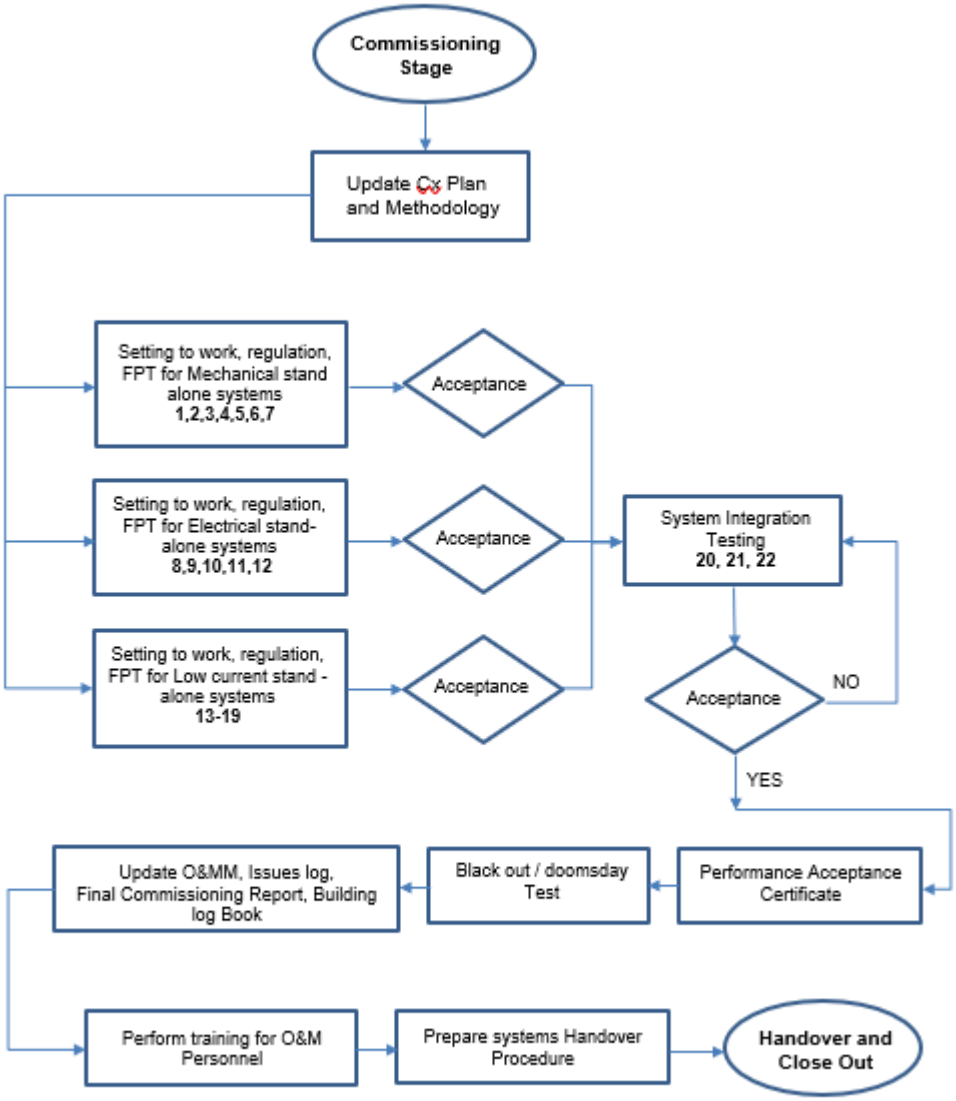
1.2 Construction Stage



1	**1**.Lock-out/ Tag-Out safety procedure/**2,3**Signing-off of Electro-mechanical installation /**4.** Labelling and tagging of Electro-mechanical installation/**5**.Checking equipment and systems Commission ability	1.EPM-KSS-PR-000031 2.EPM-KCE-TP-000003(M) 3.EPM-KCE-TP-000008(E) 4.EPM-KEO-TP-000022 5.EPM-KT0-TP-000003
2	Static Equipment Checklist Template/ Rotating Equipment Checklist Template	EPM-KCE-TP-000001 EPM-KCE-TP-000002
3	Electrical installation	EPM-KT0-GL-000003
4	Plumbing flow testing, gravity/pressure test /air testing	EPM-KT0-GL-000003
5	Pressure and leakage testing for HVAC ducts	EPM-KT0-GL-000003
6	Plumbing Testing and Balancing	EPM-KT0-GL-000003
7	Electrical wiring continuity and insulation resistance testing	EPM-KT0-GL-000003
8	Electrical cold testing	EPM-KT0-GL-000003
9	All test for control wiring such as point-to-point testing and loop testing	EPM-KT0-TP-000054
10	Pre-start up for Pumps	EPM-KT0-TP-000001
11	Pre-start up for Fire Pumps	EPM-KT0-TP-000002
12	Pre-start up for Fans	EPM-KT0-TP-000003
13	Pre-start up for AHU	EPM-KT0-TP-000004
14	Pre-start up for VAV	EPM-KT0-TP-000005
15	Pre-start up for FCU	EPM-KT0-TP-000006
16	Pre-start up for CRAC	EPM-KT0-TP-000007
17	Pre-start up for Chillers	EPM-KT0-TP-000008
18	Pre-start up for Cooling Towers	EPM-KT0-TP-000009
19	Pre-start up for Heat Exchangers and Calorifiers	EPM-KT0-TP-000010
20	Pre-start up for Boilers	EPM-KT0-TP-000011
21	Pre-start up for Condensate Recovery Unit	EPM-KT0-TP-000012
22	Pre-start up for Water Treatment Plant	EPM-KT0-TP-000013
23	Pre-start up for Wastewater Treatment Plant	EPM-KT0-TP-000014
24	Pre-start up for Elevator	EPM-KT0-TP-000015
25	Pre-start up for Escalator and Moving Walks	EPM-KT0-TP-000016
26	Pre-start up for Building Management Unit	EPM-KT0-TP-000017
27	Pre-start up for Generator Set	EPM-KT0-TP-000018
28	Pre-energization for HV/MV Switchgear	EPM-KT0-TP-000019
29	Pre-energization for Switchboards	EPM-KT0-TP-000020
30	Pre-energization for Transformers	EPM-KT0-TP-000021
31	Pre-energization for Ring Main Unit	EPM-KT0-TP-000022
32	Pre-energization for Capacitor Banks	EPM-KT0-TP-000023
33	Pre-energization for Automatic Transfer Switch	EPM-KT0-TP-000024
34	Pre-energization for UPS	EPM-KT0-TP-000025
35	Pre-energization for MCC and Distribution Boards	EPM-KT0-TP-000026
36	Pre-energization for HV/LV Cables	EPM-KT0-TP-000027
37	Pre-energization for Grounding / Earthing System	EPM-KT0-TP-000028
38	Functional and Performance Test for Fire Pumps	EPM-KT0-TP-000029
39	Functional and Performance Test for Pumps	EPM-KT0-TP-000030
40	Functional and Performance Test for Fans	EPM-KT0-TP-000031
41	Functional and Performance Test for AHU	EPM-KT0-TP-000032
42	Functional and Performance Test for CRAC	EPM-KT0-TP-000033
43	Functional and Performance Test for FCU	EPM-KT0-TP-000034

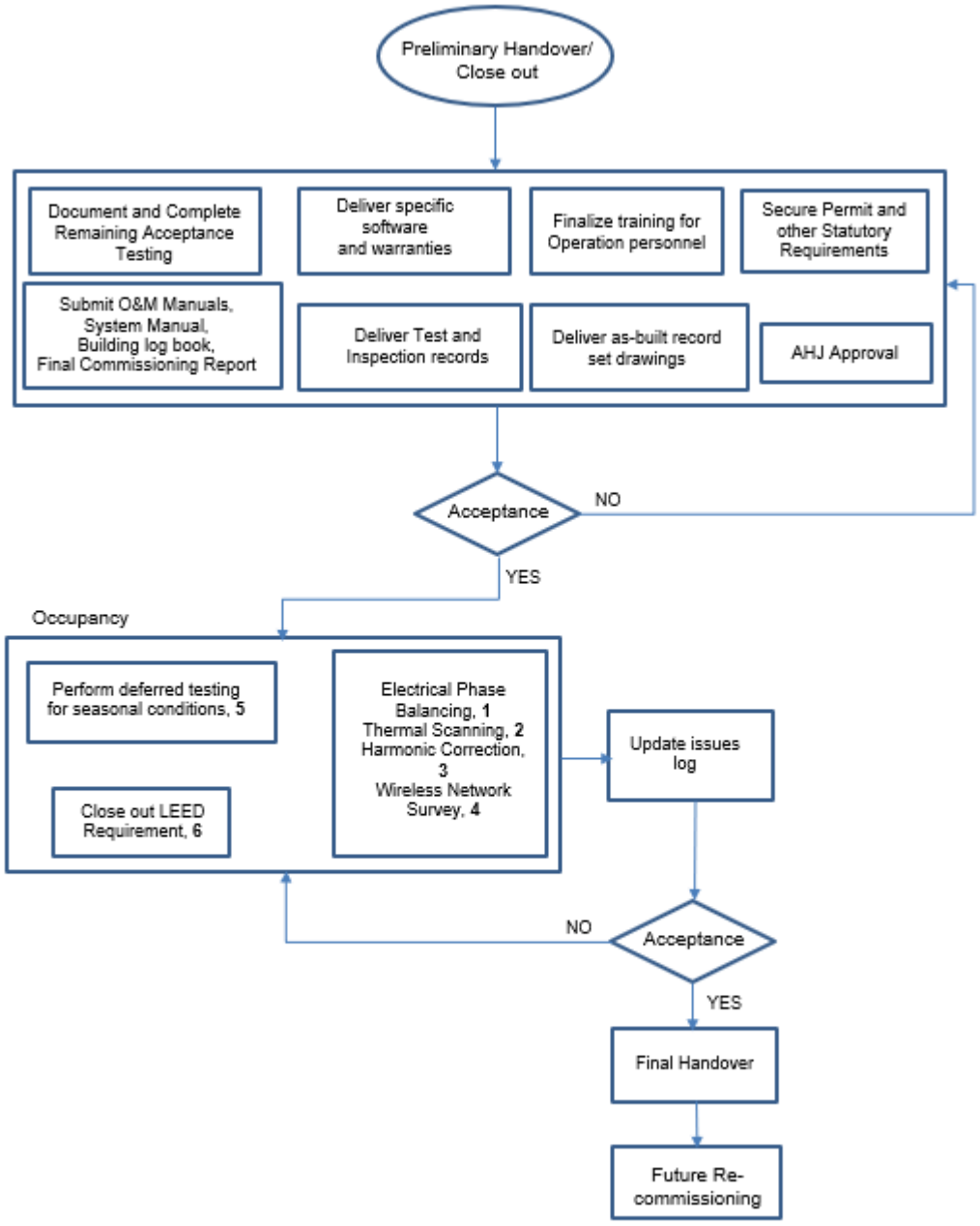
44	Functional and Performance Test for Cooling Towers	EPM-KT0-TP-000035
45	Functional and Performance Test for Boilers	EPM-KT0-TP-000036
46	Functional and Performance Test for Water Treatment Plant	EPM-KT0-TP-000037
47	Functional and Performance Test for Wastewater Treatment Plant	EPM-KT0-TP-000038
48	Functional and Performance Test for Condensate Recovery Unit	EPM-KT0-TP-000039
49	Functional Test for Elevators	EPM-KT0-TP-000040
50	Functional Test for Escalators and Moving Walks	EPM-KT0-TP-000041
51	Functional Test for Building Management Units	EPM-KT0-TP-000042
52	Functional Test for Capacitor Bank	EPM-KT0-TP-000043
53	Functional Test for UPS	EPM-KT0-TP-000044
54	Functional and Performance Test for VAV	EPM-KT0-TP-000056

1.3 Commissioning Stage



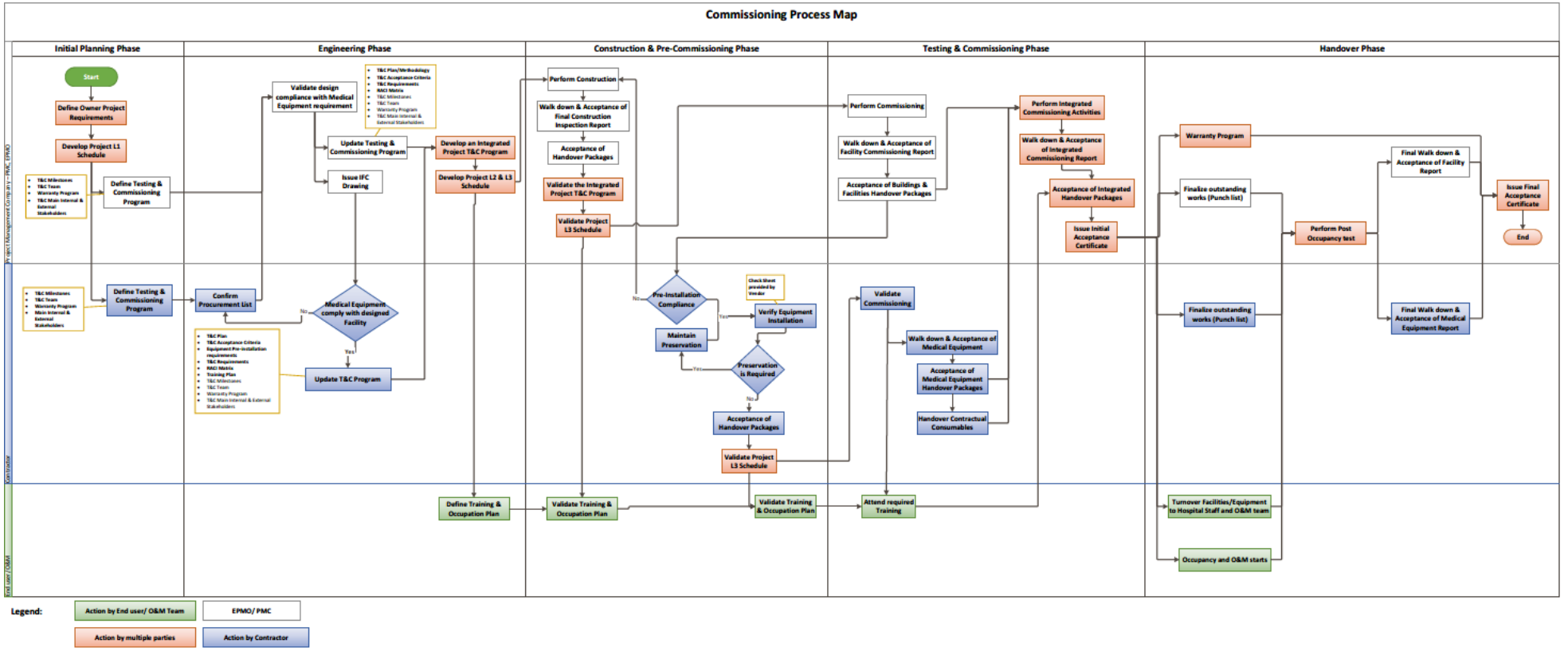
1	HVAC	EPM-KT0-GL-000003
2	Fire Dampers and Motorized Fire Dampers	EPM-KT0-GL-000003
3	BMS	EPM-KT0-GL-000003 EPM-KT0-TP-000051 EPM-KT0-TP-000052 EPM-KT0-TP-000053
4	Staircase Pressurization system	EPM-KT0-GL-000003
5	Smoke Management System	EPM-KT0-GL-000003
6	Fire Fighting System	EPM-KT0-GL-000003
7	Domestic Water System	EPM-KT0-GL-000003
8	Automatic Lighting Control System	EPM-KT0-GL-000003
9	Cable system live tests	EPM-KT0-TP-000054
10	Electrical Power Management System	EPM-KT0-GL-000003 EPM-KT0-TP-000053
11	Lightning Protection System	EPM-KT0-GL-000003
12	Earthing /Grounding System	EPM-KT0-TP-000047
13	Fire Alarm System	EPM-KT0-TP-000055 EPM-KT0-TP-000046
14	Security Access Control System -SACS	EPM-KT0-GL-000003 EPM-KT0-TP-000050 EPM-KT0-TP-000048
15	Closed Circuit Television System -CCTV	EPM-KT0-GL-000003
16	Public Address Voice Alarm System-PAVA	EPM-KT0-GL-000003
17	Voice Over IP/ Telephony System	EPM-KT0-GL-000003
18	Audio-Video System	EPM-KT0-GL-000003
19	IP Television System	EPM-KT0-GL-000003
20	Fire and Life Safety System integration	EPM-KEO-GL-000008
21	Low current system integration	EPM-KEO-GL-000007
22	BMS and Mechanical system integration	EPM-KEO-GL-000009

1.4 Handover and Close-Out Stage



1	Electrical Phase Balancing	EPM-KT0-GL-000003
2	Harmonic correction	EPM-KT0-GL-000003
3	Thermal scanning	EPM-KT0-GL-000003
4	Wireless network survey	EPM-KT0-GL-000003
5	Seasonal HVAC Testing	EPM-KT0-GL-000003
6	LEED Requirement	EPM-KT0-GL-000003

Attachment 2 – Commissioning Process Map



Attachment 3 - Testing and Commissioning Flow Chart