SECTION 01 91 00
GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Commissioning is a quality oriented process for achieving, verifying, and documenting the facility's performance to meet its operational needs within the capabilities of the design as well as to meet the design documentation and the owner's functional criteria.

C. The commissioning process does not alleviate the requirement for the Contractor and all Installers and suppliers to be responsible to provide a completely finished, tested and fully functional project based on the contract documents.

D. Commissioning is for the benefit of the owner and is led by a Commissioning Authority (CxA) selected by the Owner. It is not a substitution for project testing, or acceptance testing, but is a process to document and assure the testing desired by the Owner has been accomplished satisfactorily.

E. Acceptable testing results and completion of required documentation is a condition for payment. Identify in bid, costs included for test equipment and load banks for all testing and for labor included for level 5 integrated system testing (IST).

F. Commissioning shall:

1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations and installation instructions, and industry minimum standards and that they receive adequate operational checkout by Installers.
2. Verify and document proper performance of equipment and systems.

G. Commissioning shall include HVAC, Electrical, fire alarm and fire suppression systems, control systems and building monitoring systems (BMS). Refer to DLR's Commissioning and Benchmarking Process Guidelines and the mechanical and electrical specification sections for additional information on systems to be commissioned.

1.2 RELATED DOCUMENTS

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

B. Owner's Project Requirements (OPR) and Basis of Design (BoD) documentation are included by reference for information only.

C. DLR Commissioning and Benchmarking Process Guidelines.

D. Commissioning Authority's commissioning plan specifications.

E. Related Sections:

1. Division 23 Section 23 08 00 "Mechanical General Commissioning Requirements" for commissioning process activities for mechanical systems, assemblies, equipment, and components.

2. Division 26 Section 26 08 00 "Electrical General Commissioning Requirements" for commissioning process activities for electrical systems, assemblies, equipment, and components.

1.3 DEFINITIONS

A. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. CxA: Commissioning Authority.

D. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This includes the DLR Commissioning Process Overview documentation and the system design basis (developed by the Design Team).

E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM

A. Members Appointed by Contractor(s), Sub-Contractor(s) and Installer(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.5 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA and each Contractor for information and use.

B. Owner has prepurchased equipment for the project. Copies of prepurchase specifications or Bill of Materials (BOM) will be made available. The prepurchased equipment has been bought with the following manufacturer's services.

Equipment	Start-up	Level 4 Acceptance Testing	Level 5 Integrated System Testing
ATS	As required	Refer to specs/BOM	Refer to specs/BOM
Switchboard	As required	Refer to specs/BOM	Refer to specs/BOM
UPS Systems	As required	Refer to specs/BOM	Refer to specs/BOM
PDU Systems	As required	Refer to specs/BOM	Refer to specs/BOM
Generators	Bought through local rep	Refer to specs/BOM	Refer to specs/BOM
CRAC Units/Condensers	As required	Refer to specs/BOM	Refer to specs/BOM
Exhaust Fans	As required	Refer to specs/BOM	Refer to specs/BOM
Make Up Air Units	As required	Refer to specs/BOM	Refer to specs/BOM
Square D Meters	As required	Refer to specs/BOM	Refer to specs/BOM

C. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

D. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6 COMMISSIONING TEAM'S RESPONSIBILITIES

A. Each Contractor, Sub-Contractor and Installer shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Attend commissioning team meetings held on a weekly basis at the normal meetings and more frequently as level 4 and 5 commissioning get closer and daily during level 4 and 5 commissioning.
2. Integrate and coordinate commissioning process activities with the construction schedule.
3. The construction schedule shall incorporate the commissioning process. Start-up, Testing and Balancing (TAB), Level 4 Acceptance Testing and Level 5 Integrated Systems Testing shall be detailed for each system/area. CxA will identify duration of level 4 and 5 tasks.
4. Review and accept construction checklists provided by the CxA.
5. Complete paper and electronic construction checklists as Work is completed and provide to the Design Team and the Commissioning Authority on a weekly basis.
6. Review, comment and accept commissioning process test procedures provided by the Commissioning Authority.
7. Complete commissioning process test procedures.
8. Assure compliance with the commissioning schedule by organizing and planning to have appropriate personnel, equipment and material available when required. Coordinate

vendor's personnel for all furnished and assigned owner's pre-purchased equipment. Provide as much advanced notice to vendors as possible.

9. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
10. Cooperate with the CxA for resolution of issues recorded in the Issues Log.

1.7 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Provide commissioning plan.

C. Convene commissioning team meetings.

D. Provide Project-specific construction checklists and commissioning process test procedures. Indicate on test procedures that start and stop times for each test shall be recorded. Approximately 4 weeks prior to activity to allow time to review and comment.

E. Verify the execution of commissioning process activities. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When an item does not meet the requirement, the CxA will report the failure in the Issues Log.

F. Prepare and maintain the Issues Log.

G. Prepare and maintain completed construction checklist log.

H. Witness systems, assemblies, equipment, and component startup.

I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

J. Define required test equipment and who shall supply.

1.8 RETESTING

A. Repeat, at no additional cost to the owner, the complete functional test procedure for each test in which acceptable results are not achieved. Repeat tests until acceptable results are achieved. Compensate the owner, design team, and CxA for direct costs incurred as the result of tests repeated to achieve acceptable results.

B. Correct test deficiencies promptly, during testing period if possible while all parties are available, and schedule retests so as to not delay building occupancy.

PART 2 - PRODUCTS AND TESTING FIRMS

2.1 SHOP DRAWINGS

A. Commissioning Authority (CxA) shall receive and review a copy of all shop drawings from the General Contractor, or from the Owner for pre-purchased equipment, related to equipment or systems to be commissioned.

2.2 EQUIPMENT

A. General Contractor shall provide two-way radios to facilitate all level 4 and 5 testing.

1. Provide 15 fully charged radios for use by all in attendance.

B. General Contractor shall provide four stop watches for use by all in attendance to time events.

C. Test equipment and additional stop watches, data recorders, temperature sensors, etc. required to complete the commissioning shall be provided by the Commissioning Agent and/ or a testing agency coordinated by the Commissioning Agent.

2.3 INSTRUMENTS AND BENCHMARK

A. During level 5 and Benchmark testing, the General Contractor shall provide the services of independent testing firms and personal qualified and certified by national organizations for the testing they are to perform. Personnel shall be certified and experienced in the testing they are to perform and with the instruments they will be using.

B. All instrumentation shall be calibrated within 12 months of the beginning of level 5 testing. Instrumentation shall bear a certification sticker that was placed by a certified testing and calibration company.

C. Provide a DLR approved thermo-graphic infrared scanning firm associated with TEGG, with certified personnel to perform the following testing per NETA standards:

1. Scan and document all the power terminations under load from the utility service and generator to the PDU level.
2. Scan all temporary power cables and terminations for hot spots.
3. Provide a report of thermographic testing that documents all terminations under load. At a minimum provide testing per NETA standards. For database purposes record all relevant information including equipment and termination identification, color photograph and thermographic photograph of each item, and electrical load at the time of test.
4. Identify any observed abnormalities and any concerns. Report abnormal issues immediately if warranted, otherwise issue a summary report daily.
5. Provide colored hard copy and electronic copy of pictures and report within 7 days of completion of testing.

D. Provide a NETA certified firm and personnel to provide and connect test instruments to record normal and abnormal operations during level 4 and 5 testing. Provide metering as follows:

1. Synchronize time stamps with BMS system.
2. Provide required voltage and current probes.
3. Include software required to download data.
4. Record times of all testing stages, switching, transfers, etc. for comparison to meter readings.
5. Record meter locations on a one line drawing. Submit for review at same time as level 5 script review.
6. TM2 – Fluke 1735 Datalogger meter shall record electronically and on an external LCD screen all power system parameters for all phases including voltage, amperage, power factor, kVA, kW, kVAR, and kWH. Meter shall capture trends and waveforms.
7. TM2 – Wave form capture meter shall record electronically and on a printer all power system parameters, surges, sags, spikes and dips. Unit shall record continuously during testing. Set up unit for event recording. Record and timestamp any event that is outside the ITIC CBEMA curve values.
8. During Level 5 testing provide TM1 trending meters in the following locations:
    a. Each main service (utility) at loadside of switchboard CB to record total load.
    b. Each generator service at loadside of switchboard CB to record total load
    c. As required to determine all loads minus UPS loads so a ratio of IT loads to total loads can be calculated. (switchboard meters can be used if they exist and one commissioned).
9. Provide TM2 event capture meters as follows:
    a. Output switchboard of UPS after wrap around maintenance feeder CB.
    b. Output of a PDU or panel on UPS at 120/208V. Cross check switchboard and UPS meters with TM1 and TM2 meters. Record all meters (equipment TM1 and TM2

meters) at each step for voltage, amperage, kW, kVA, Pf and THD for each phase and system.

10. Provide TM1 meter for generator acceptance testing and UPS battery discharge testing.
11. Synchronize times on all equipment and meters. Record when all transfers and switching occurs and verify proper operation and response of the power system and equipment.

E. Measurements During Testing

1. Place a data logger and a fast reacting digital thermometer in the center of each cold aisle. Mount six feet above raised floor over the perforated tiles. Locate every 30 feet per ASHRAE TC9.9 recommendations. Stand shall not block air flow from perforated tile. Stagger locations along length of cold aisles to get a representative room layout. Provide more than one location per aisle if required. Indicate proposed location on a floor plan for owner and design team review during review phase of Level 5 testing script.
2. Place data logger and a fast reacting digital thermometer outdoors near heat rejection equipment to sense ambient air conditions
3. Synchronize times on all equipment and meters. Record when all transfers and switching occurs and verify proper operation and response of the cooling system and equipment.
4. Monitor and record water flow, pressure, chiller capacity, pump speed, etc on supply and return during testing.
5. Record at the start of testing (zero load) and at each load step 25%, 50%, 75%, 100% and during all transfer and equipment failure testing and during cooling system failure tests.
6. Review temperatures and humidity levels as compared to ASHRAE Thermal Guidelines (TC9.9) recommendations.
7. Review meter graphs during testing and transfers to visually verify no power abnormalities. Record times of each step to correlate with electronic data. Redo testing if abnormalities are observed.
8. During level 5 testing record the following values at zero load, 25%, 50%, 75%, and 100% at each meter:
    a. Voltages, PH-PH and PH-N
    b. kW, kVA
    c. kWH
    d. Power factor (leading or lagging)

PART 3 - EXECUTION

3.1 SCHEDULE

A. The typical time frame for level 4 and 5 commissioning and benchmarking is two weeks for a 1.125 MW UPS data center pod. Level 5 testing typically takes three 12 hour days.

END OF SECTION