

Certified Commissioning Specialist - CxS

Key Terminology

Flashcards



ACG CxS

Key Terminology Flashcards

Certified Commissioning Specialist (CxS) Exam

ACG Guideline Part I · ASHRAE/IES Standard 202-2024

Final Exam Review

Domain 1: Commissioning Deliverables (21%) — 51 terms

Domain 2: Cx Process, Phases & Approach (33%) — 78 terms

Domain 3: Roles - Commissioning Providers (14%) — 34 terms

Domain 4: Roles - Others (13%) — 30 terms

Domain 5: Construction Process / System Knowledge (19%) — 52 terms

245 terms · Beyond Smart Cities

Domain 1 - Commissioning Deliverables: Owner Requirements, Design & Plans**Owner's Project Requirements (OPR)**

Owner-owned living document of objectives and expectations; "the primary tool for benchmarking success and quality at all phases" (Std 202; §3.5)

Current Facility Requirements (CFR)

Existing-facility counterpart of the OPR, stating current owner requirements; developed for EBCx projects and shares many OPR features (§3.5)

OPR template headings

Introduction, Key Owner's Requirements, Project Description, Objectives, Functional Uses, Occupancy, Budget, Performance Criteria, Sustainability, Version History (§3.5.3)

OPR Version History

OPR section recording each revision; owner must formally vet and approve every change after initial acceptance (§3.5; §3.5.3)

Basis of Design (BoD)

Design-team document recording concepts, calculations, decisions and product selections used to meet the OPR and regulatory requirements (Std 202; §4.4)

BoD narrative

BoD portion written in relatively nontechnical language so owners, occupants and end users can understand key design decisions (§4.4)

Domain 1 - Commissioning Deliverables: Owner Requirements, Design & Plans**Commissioning Plan (Cx Plan)**

Document outlining the organization, schedule, allocation of resources and documentation requirements of the commissioning process (Std 202; §4.3)

Cx Plan life cycle

Framed in Project Initiation, written in Design, revised throughout; the final version is included in the Final Commissioning Report (§4.3)

Commissioning Specification

CxP-written construction-team Cx roles, responsibilities and requirements, incorporated into the Project Manual during the Design Phase (A.2; §4.5)

Project Manual

Design team's written documents, except drawings, giving design intent direction to bidders and contractors: specifications, conditions, bidding instructions (A.2)

Equipment List

Matrix of major equipment and hardware; created by the owner with design input, used by the CxP to develop the Cx Plan (§3.4.2)

Scope of commissioning services

Contractually defined Cx activities, deliverables and building systems to be commissioned, stated in the owner-CxP agreement (§3.4.1)

Domain 1 - Commissioning Deliverables: Owner Requirements, Design & Plans**Building systems to be commissioned**

Systems the owner selects for Cx scope based on facility type, energy goals and critical spaces; the CxP may recommend (§3.4; A.6)

Commissioning Design Review

Review of design documents for OPR compliance, including coordination between systems and access for testing and maintenance (Std 202; §4.7)

Design review comments

CxP's written design review findings, shared respectfully with the design team and tracked until each comment is resolved (§4.7)

Design Phase Commissioning Report

CxP's primary Design Phase deliverable summarizing Cx results to date; Standard 202 calls it the Design Cx Report (§4.9)

Construction Phase Commissioning Report

CxP report of status at the end of Construction; expands the Design Phase report; Std 202 "preliminary Cx Report" (§5.12.3)

Final Commissioning Report

Record of Cx activities and results, developed from the final Cx Plan with all its attached appendices (Std 202; §6.5)

Domain 1 - Commissioning Deliverables: Logs, Checklists & Reports**Commissioning Progress Report**

Written document detailing completed Cx activities and significant findings, continuously updated during the project (Std 202; §5.12.2)

Daily report

Also called a field report; CxP record of each site day forming a historical log of commissioning activities (§5.12.1)

Issues and Resolution Log

Formal, ongoing record of problems or concerns and their resolution, compiled by the CxP Group during the Cx process (Std 202; §5.7)

Issue closure rule

Log items are not marked resolved until the CxP verifies the fix and the owner confirms it is acceptable (§5.7)

Resolution Tracking Form (RTF)

Retired 2005 ACG term; ACG now treats it as obsolete, replaced entirely by the Issues and Resolution Log (§5.7)

A/E punch list

Design team list of items to resolve before substantial completion; unlike the Issues Log, it does not record how items closed (A.2)

Domain 1 - Commissioning Deliverables: Logs, Checklists & Reports**Checklists (Std 202)**

Project- and element-specific checklists developed and used during all phases of the Cx process to verify the OPR is achieved

Construction checklist

Std 202 form used by the Cx Team to verify materials are on site, ready, correctly installed, functional and OPR-compliant (§5.8)

Design checklist

Std 202 form developed by the CxP Group to verify that elements of the design comply with the OPR (§5.8)

CxP checklist

ACG quality-control tool prepared by the CxP and populated mainly by installing contractors; not a manufacturer start-up checklist (§5.8)

System Verification Checklist (SVC)

Retired 2005 ACG term, shortened and simplified to "checklist" in the current Guideline

Pre-functional checklist

U.S. DOE name for installation checklists completed before functional performance testing, stressing their prerequisite role (§5.8)

Domain 1 - Commissioning Deliverables: Logs, Checklists & Reports**Test procedure**

Written protocol defining methods, personnel and expectations for tests that verify compliance with the OPR (Std 202)

Submittal review report

Std 202 record of submittals reviewed, review dates and items possibly not OPR-compliant; copied into the Final Cx Report (§5.6)

Point-to-point document

ATC contractor's record of verified control-point wiring, terminations and device responses, reviewed by the CxP (§5.10.2)

TAB report

TAB agency's record of measured air and water flows against design values, reviewed and spot-verified by the CxP (§5.10.3)

Meeting agenda

Distributed before Cx meetings so attendees prepare their topics; reused afterwards as a reference; may carry the milestones schedule (§3.2.3)

Meeting minutes

Record of Cx meeting discussions, action items and issues, shared with Cx Team members as soon as possible (§3.2.4)

Domain 1 - Commissioning Deliverables: Turnover & O&M Documents**Attendance sheet**

Pre-printed sheet or pre-populated online form tracking Cx meeting participation and capturing contact information (§3.2.2)

Commissioning schedule

CxP-drafted Cx Plan schedule placing each commissioning activity at the right point in the overall project schedule (§5.3)

Building systems milestones schedule

Chronological key-milestone schedule embedded in every Cx meeting agenda and minutes during the Construction Phase (§5.3)

Risk register

Collaborative project tool for identifying, assessing, prioritizing, monitoring and mitigating risks with other project team members (§1.11)

Systems Manual

System-focused composite of design and construction documents, Facility Guide, O&M, training and Cx records for occupancy use (Std 202; §6.4)

Systems Manual timing

CxP begins assembling it in the Design Phase and delivers it to the owner in the Occupancy and Operations Phase (§6.4)

Domain 1 - Commissioning Deliverables: Turnover & O&M Documents**Facility Guide**

Standard 202 Systems Manual component: basic description of building systems with operating plan, setpoints and schedules for operators and occupants

O&M Manual

Installing contractors' instructions for operating and maintaining equipment and systems, without installation steps; reviewed by the CxP (A.2; §6.3.1)

IOM Manual

Installation, Operation and Maintenance manual from suppliers or manufacturers; installation instructions distinguish it from an O&M Manual (A.2)

O&M Training Plan

CxP-developed plan defining training content, materials, sessions, roles and attendance; Standard 202 calls it the "training plan" (§6.3.2)

Training records

Agendas, attendance, materials and recordings of O&M training sessions, kept to verify training was delivered as specified (§6.3.3)

As-built (record) drawings

Drawings showing how systems were actually built; also red-line drawings; prime contractor submits the final set at completion (A.2)

Domain 1 - Commissioning Deliverables: Turnover & O&M Documents**Sequence of operation
(SOO)**

EOR-written document, not the CxP's, giving detailed directions for operating systems: setpoints, alarms, interlocks and control strategies (A.2)

**Ongoing Commissioning
Plan (OCx Plan)**

Plan defining OCx scope systems, duration, OCx Team responsibilities and objectives; a preliminary version is drafted during warranty (§6.7)

**Measurement and
verification (M&V) plan**

Procedures, instrumentation and scheduling for measuring, collecting, analyzing and archiving data supporting OCx or energy management (A.2)

Domain 2 - Process, Phases & Approach: Framework & Phases**Commissioning process
(Cx)**

"A quality-focused process for enhancing the delivery of a project," verifying systems are planned, designed, installed, tested, operated and maintained to meet the OPR (Std 202)

**Comprehensive
building systems
commissioning**

CxP contracted from Project Initiation through all four phases; Cx that starts in the Construction Phase is not comprehensive (A.2)

ACG's four phases

Project Initiation, Design, Construction, and Occupancy and Operations, following the scheme in ASHRAE Guideline 0 (§1.5)

Project Initiation Phase

First phase: OPR or CFR developed, systems and Cx scope confirmed, Cx Team assembled and Cx Plan outlined (A.2)

Design Phase

Second phase: design team produces BoD and Project Manual; CxP reviews them, writes the Cx Specification and updates the Cx Plan (A.2)

Construction Phase

Third phase: installation and start-up; CxP reviews submittals, issues checklists, observes, coordinates tests and maintains the Issues Log (A.2)

Domain 2 - Process, Phases & Approach: Framework & Phases**Occupancy and Operations Phase**

Final phase: deferred tests, warranty activities, O&M training, Systems Manual, near end-of-warranty review and Final Cx Report (A.2)

2005 ACG five-phase process

Pre-Design through Post-Acceptance; today's Occupancy and Operations Phase combines the old Acceptance and Post-Acceptance Phases (§1.5)

Standard 202 and phases

Std 202's mandatory text neither names nor prescribes phases; its Informative Appendices use the Guideline 0 four-phase scheme (§1.5)

ASHRAE Guideline 0

ASHRAE's Commissioning Process guideline; ACG's comprehensive process draws on its process and four-phase structure (§1.3)

ANSI/ASHRAE/IES Standard 202

Consensus standard of minimum commissioning process requirements; the 2024 edition covers new buildings and new systems

Informative appendix

Non-mandatory Std 202 appendix giving helpful sample documentation; not required for conformance with the standard (A.3)

Domain 2 - Process, Phases & Approach: Framework & Phases**Design Intent Document (DID)**

Retired 2005 ACG term, succeeded by the Basis of Design together with the OPR or CFR

Design review stages

Schematic design, design development and construction documents, all within the Design Phase, each with distinct CxP review priorities (§4.7)

Three design review goals

CxP understands the design and intent, identifies potential issues and alerts the design team, and advocates for the OPR (§4.7)

Project Manual review

CxP review for errors, conflicts and inconsistencies from a Cx perspective, so they are resolved before construction begins (§4.6)

Value engineering (VE)

Process, usually by the design team, of changing scope or design to cut first costs; CxP gives objective owner feedback (§4.8)

Total cost of ownership (TCO)

Analysis of financial and operational impacts of design alternatives over the facility's whole life, not just first costs (A.2; §4.8)

Domain 2 - Process, Phases & Approach: Construction & Start-Up**Construction Phase
kick-off meeting**

Onsite Cx meeting the CxP schedules as soon as practical to introduce the Cx Plan, roles and expectations (§5.2; A.10)

**Construction
observation**

Regular, purposeful CxP site visits to observe installation of commissioned systems and document what is found (§5.9)

**Installation
coordination**

Aligning Cx activities with construction work through close communication with the GC or CM to avoid delays (§5.9.2)

Coordinated planning

CxP integrates Cx activities into installation sequences so the Cx schedule aligns with the overall project schedule (A.2)

Rough-in

Construction stage installing ducts, piping and conduit before ceilings and walls close; CxP observes before concealment (§5.9.1)

**Construction submittal
review**

CxP reviews submittals for OPR compliance and comments; the design team approves or rejects them (§5.6)

Domain 2 - Process, Phases & Approach: Construction & Start-Up**Submittal sampling**

Standard 202 permits sampling of submittals; ACG does not recommend it and requires owner approval before sampling (§5.6)

Start-up

Initial energization or operation after installation; a systematic process with checklists, planned by installing contractors and reviewed by the CxP (A.2)

Installation tests

Contractor tests before or after start-up, some diagnostic, e.g. pressure tests; CxP observes and documents them (§5.10.1)

Acceptance tests

Discrete test types performed at a factory or in the field; distinct from Cx observations, tests and IST (§5.10.1)

Factory witness testing (FWT)

Acceptance test at the manufacturer's facility, directed by the manufacturer and observed by the owner's representative (A.2)

Point-to-point verification

ATC contractor confirms control wiring is terminated correctly and devices respond as the BAS shows; done on site only (§5.10.2)

Domain 2 - Process, Phases & Approach: Construction & Start-Up**Two-technician
point-to-point**

Best practice: one technician commands points from the BAS workstation while another observes the field devices respond (§5.10.2)

Ready for testing

Milestone when the installing contractor acknowledges a system is fully prepared for a predetermined test; replaces "ready for commissioning" (§5.11.1)

Pre-test (trial test)

Contractor run-through before the formally witnessed test, confirming readiness; a common prerequisite for Cx testing (§5.11.1)

Observations and tests

CxP-developed procedures performed by Cx Team members and observed by the CxP Group after installation and start-up (§5.11.2)

**Functional performance
test (FPT)**

Cx test verifying a system functions and performs as required in all modes; appears only in Std 202 informative appendices (§5.11.2)

Testing (Std 202)

"The process of verifying that a material, product, assembly, or system meets defined performance criteria" set out in protocols (§5.11.2)

Domain 2 - Process, Phases & Approach: Testing & Sampling**Hierarchical testing**

Testing from individual elements through intermediate levels up to interconnected systems of the whole building (§5.11.2)

Pass/fail criteria

Predefined acceptance criteria for each test, stated in the Cx Specification and test procedures and traced to the OPR (§4.5)

Trend logging

BAS recording of points over time, set up by the ATC contractor during tests, revealing sequence and control faults

Integrated systems testing (IST)

Extension of FPT to multiple interconnected systems, after each is individually tested, proving they work together per the OPR (A.2; §5.11.4)

Worst-case scenario simulation

Core of an IST: e.g. simulated power loss forces integrated systems through their complete sequence of operation (§5.11.4)

Partial IST

IST on partially installed systems during Construction to find issues early; timing and procedures stated in the Cx Plan (§5.11.4)

Domain 2 - Process, Phases & Approach: Testing & Sampling**IST timing**

After individual systems are tested; usually in Occupancy and Operations, with exceptions such as partial IST (§5.11.4)

Discrete testing

Testing between individual components, usually on a one-to-one basis, to evaluate the interfaces between them (A.2)

Failure mode testing

Testing a system's response to, and recovery from, failures of other systems connected to it (A.2)

Sampling strategies

Owner-approved methods of testing some, not all, identical elements; documented in the Cx Specification and Cx Plan (A.2; §5.11.3)

Random sampling

Selecting elements by chance; quantity equals total identical elements multiplied by the approved sampling rate (§5.11.3)

Investigative (stratified) sampling

Data-driven sampling where earlier results steer later picks; subsets get different rates while the overall minimum holds (§5.11.3)

Domain 2 - Process, Phases & Approach: Testing & Sampling**Prototypical sampling**

Testing programmable features, settings and sequences on one example of each unique element type; suits low-voltage systems (§5.11.3)

Targeted sampling

Not a true sampling strategy: deliberately selecting critical or hard-to-reach elements that must be examined (§5.11.3)

Sampling rate

Owner-approved percentage of identical elements examined; should be statistically meaningful and rise with criticality or complexity (§5.11.3)

Maximum allowable failure rate

Cx Plan limit paired with the minimum sampling rate; if exceeded, elements are reexamined after corrective work (§5.11.3)

Second-round sampling

After substantial deviations in a first 5-10% random sample, another 5-10% is tested; repeat failure means noncompliance (§5.11.3)

Scope limitation

Limiting Cx by size, rating or location, e.g. only panelboards of 400 A or more; not a sampling strategy (§5.11.3)

Domain 2 - Process, Phases & Approach: Occupancy, Warranty & Beyond**Pausing commissioning activities**

When high failure rates are prevalent, the CxP may suggest suspending Cx work until underlying problems are fixed (§5.11.3)

Deferred observations and tests

Tests that could not be done during Construction, mainly due to unsuitable weather, completed in Occupancy and Operations (§6.6)

Seasonal testing

Deferred testing under design seasonal conditions: heating modes in heating season, cooling modes in cooling season (§6.6)

Shoulder seasons

Early fall and late spring, typically 45–65 °F (about 7–18 °C) outdoors; preferred window for seasonal tests (§6.6)

Warranty period

Period, typically starting at substantial completion, in which contractors fulfil warranty provisions; deferred tests often fall within it (A.2)

Warranty activities

Deferred tests, extra O&M training, resolving open issues, OCx Plan, near end-of-warranty review and document updates (§6.7)

Domain 2 - Process, Phases & Approach: Occupancy, Warranty & Beyond**Near end-of-warranty review**

Cx Team meeting at about months 9–10 of a 12-month warranty (75–85%) to capture issues while still covered (§6.8)

Near end-of-warranty timing risk

Held too early, later issues go unreviewed; too late, there is no time to fix them before closeout (§6.8)

Lessons learned workshop

Occupancy-phase session in which the CxP convenes the team to discuss best practices and lessons learned (§6.7)

Building systems turnover

Transfer of O&M responsibility from the construction team to O&M staff, with training, manuals and deferred tests (A.2)

Closeout

Last construction stage, from substantial to final completion: punch list resolution, inspections, document submission and turnover (A.2)

Ongoing commissioning (OCx)

Continuation of the Cx process well into occupancy to continually improve performance to meet current and evolving CFR or OPR (Std 202)

Domain 2 - Process, Phases & Approach: Occupancy, Warranty & Beyond**Monitoring-based commissioning (MBCx)**

Technology-driven subset of ongoing commissioning using continuous monitoring and analysis of building system data (§1.1)

Existing building commissioning (EBCx)

Planning, investigating, implementing, verifying and documenting that existing systems are operated and maintained to meet the CFR (Std 202)

Retrocommissioning

Commissioning applied to an existing building that was never commissioned, to restore and optimize system performance

Recommissioning

Repeating the commissioning process on a previously commissioned existing building to verify and restore performance

Fault detection and diagnostics (FDD)

Using standard or custom algorithms to detect and diagnose faults or inefficiencies in system performance, often in real time (A.2)

Commissioning meetings by phase

CxP organizes and leads Cx Team meetings in every phase, ideally scheduled alongside regular project meetings (§3.3)

Domain 2 - Process, Phases & Approach: Value & Risk**Risk management**

Identifying, analyzing and prioritizing risks, then monitoring and mitigating them; may be added to the Cx scope (A.2; §1.11)

Commissioning as risk mitigation

Cx is traditionally quality assurance, but ACG stresses it is also a strategy for mitigating project risks (§1.11)

Typical commissioning benefits

Improved design, fewer change orders and delays, faster turnover, better O&M, efficiency, resiliency, comfort and IEQ (§1.1)

Energy conservation measure (ECM)

Initiative expected to cut energy use by equipment or systems with a positive ROI based on engineering calculations (A.2)

Facility improvement measure (FIM)

Initiative improving building conditions without necessarily saving energy or producing a positive ROI (A.2)

Hybrid meetings

IT-enabled meetings joining on-site and remote attendees; CxP may use them to save time and raise attendance (A.2)

Domain 3 - Roles & Responsibilities: Commissioning Providers**Commissioning Provider (CxP)**

Entity identified by the owner who leads, plans, schedules and coordinates the Cx Team to implement the Cx process (Std 202; §1.7.2)

CxP authority limits

CxP plans and implements Cx for the owner but has no authority to direct the work of most Cx Team members (§1.7.2)

Commissioning Provider Group (CxP Group)

Specialists and support staff employed or subcontracted by the CxP; Standard 202 calls it the CxP Team (A.2; §1.7.3)

Certified Commissioning Authority (CxA)

ACG credential for independent Cx professionals: education, experience and exam; three-year certification cycle; ANAB-accredited (A.2)

Certified Commissioning Specialist (CxS)

ACG entry-level credential, called CxT until May 2026, for staff of ACG member firms supervised by a CxA

CxS eligibility

Two years' relevant experience (one year for licensed P.E.s or architects) plus six months with an ACG member company (Study Guide)

Domain 3 - Roles & Responsibilities: Commissioning Providers**CxS examination**

115 multiple-choice questions in four hours; closed book, no calculator needed; 75% passing score (Study Guide, May 2026)

"Commissioning authority" (retired)

Obsolete ACG term for the commissioning professional, dropped in favor of Commissioning Provider (CxP)

Independent CxP

Answers to the owner, not designers, builders or vendors, enabling impartial, unbiased testing, verification and reporting (A.2; §1.4)

Third-party CxP

CxP contracted separately from the project's primary design and construction contracts and their tier-level agreements (A.2)

Direct-for-owner CxP

CxP contracted directly with the project's owner or owner's representative (A.2)

Independent commissioning company

Firm selling no design, construction, manufacturing or installation services that could conflict with objective Cx reporting (A.2)

Domain 3 - Roles & Responsibilities: Commissioning Providers**ACG independence requirement**

Members must be independent of contractors, equipment manufacturers or any entity that could affect an independent Cx report (§1.4)

ACG core values

Independence, certification, and the combination of training and education (§1.4)

Objective advocate for the owner

CxP's role: impartially upholding the owner's OPR while also advocating for O&M staff, occupants and end users (§2.3)

OPR facilitation

When contracted, the CxP leads OPR development with owner, users and O&M staff; the OPR remains the owner's property (§3.5.2)

Request for Qualifications (RFQ)

Owner solicitation evaluating CxP qualifications, experience and references against selection criteria (§2.3)

Request for Proposal (RFP)

Owner solicitation for a CxP's scope, approach and fees, evaluated with a published scoring rubric (§2.4)

Domain 3 - Roles & Responsibilities: Procurement & Contracts**Two-stage qualifications-based procurement**

ACG-advocated RFQ followed by RFP, instead of single-stage proposal-based procurement through a standalone RFP (§2.4)

Scoring rubric

RFP evaluation system, ideally published in the RFP, used to score and rank responses as objectively as possible (§2.4)

Selection default provisions

RFP terms letting the owner negotiate with its second, then third, choice CxP if PSA talks with the first fail (§2.4)

Execution default provisions

RFP/PSA terms for nonconforming services: CxP undoes and redoes rejected work without charge; also force majeure (§2.4)

Pre-bid meeting

Mandatory RFP meeting and site tour; CxPs who skip or fail to register may be downgraded or rejected (§2.4)

Professional services agreement (PSA)

Owner-CxP contract defining Cx scope, schedule, compensation, billing and adding or removing systems (A.2; §2.5.1)

Domain 3 - Roles & Responsibilities: Procurement & Contracts**Standard operating procedures (SOPs)**

Internal CxP-company procedures for PSA data, modifications, invoicing and payments, ensuring contractual obligations are met (§2.5.1)

Fixed price contract

Set price for a defined scope; best with well-defined scope and firm schedule; CxP bears cost-overrun risk (§2.5.2)

Cost-reimbursable contract

Owner reimburses actual legitimate costs plus an additional payment; suits indefinite scope or high risk of change (§2.5.3)

Time and materials (T&M) contract

Hours at preapproved rates plus non-labor expenses; shares risk; suits a definite goal with uncertain scope (§2.5.4)

Not-to-exceed (NTE) contract

T&M variation capping billable costs for the original scope and schedule, shifting financial risk toward the consultant (§2.5.4)

Retainer-based contract

T&M variation where the client pays a fixed amount at fixed intervals, e.g. monthly, for undefined future services (§2.5.4)

Domain 3 - Roles & Responsibilities: Procurement & Contracts**Red-flag words**

Terms CxPs should avoid as too absolute, liability-implying or vague, e.g. all, ensure, guarantee, certify, approve, shall (A.4)

CxA Code of Ethics

ACG code promoting honesty, integrity and quality workmanship; CxA applicants must affirm and sign it (A.5)

Cx Team facilitation

CxP leads using management, communication and technology skills, composing the Cx Team to boost collaboration and limit conflict (§5.4)

Fee development

CxP lists activities and deliverables per phase, assigns hours and CxP Group roles, applies rates, then checks history (§1.9)

Domain 4 - Roles & Responsibilities: Owner, Design & Cx Teams**Owner**

Defines the OPR, selects systems to commission, contracts the CxP and approves sampling, reports and issue resolutions (§1.7.1)

Owner sampling approval

Owner must approve sampling strategies, sampling rates and any departure from the Cx Plan's methods (§5.11.3)

Owner OPR ownership

Without a CxP, owner and design team develop the OPR together; the owner keeps control of its content (§3.5.1)

Commissioning Team (Cx Team)

CxP-led team doing Cx work: owner, selected design and construction members, O&M staff; Std 202 "Project Team" (A.2)

Project team (ACG)

Everyone participating in the project, whether or not involved in commissioning; much larger than the Cx Team (A.2)

Design team

Architects, engineers and designers who turn the OPR into designs, write the BoD and Project Manual, and act on submittals (§1.7.4)

Domain 4 - Roles & Responsibilities: Owner, Design & Cx Teams**Architect of Record
(AOR)**

Licensed architect legally responsible for stamped, signed and dated architectural design deliverables; a design team leader (A.2)

**Engineer of Record
(EOR)**

Licensed engineer legally responsible for stamped engineering design deliverables; typically writes the sequence of operation (A.2)

**Designer of Record
(DOR)**

Certified or licensed professional legally responsible for stamped, signed and dated design deliverables (A.2)

**Design team submittal
authority**

Design team approves or rejects submittals; CxP comments augment but do not replace owner and design team reviews (§5.6)

Owner-Architect-Contractor (OAC) meeting

Recurring decision-maker meeting, weekly to monthly, for progress and coordination; CxP attendance set in the PSA (§5.9.1)

Building occupants

Individuals or organizations populating a building long-term by ownership or tenancy; excludes O&M staff and service providers (A.2)

Domain 4 - Roles & Responsibilities: Owner, Design & Cx Teams**End users**

People using the building for its intended purpose, long or short term, e.g. office staff, patients, hotel guests (A.2)

Occupants on the Cx Team

If invited, occupants and end users usually become active only in the Occupancy and Operations Phase (§1.7.7)

O&M staff

Owner's operators who run and maintain systems after completion; usually join in Construction; their training is a priority (§1.7.6)

OCx Team

Team named in the OCx Plan, e.g. owner, O&M staff and building controls service provider, that carries out ongoing commissioning (§6.7)

Domain 4 - Roles & Responsibilities: Construction Team & Others**Construction team**

GC or CM, installing contractors, subcontractors, suppliers, manufacturers' reps and testing agencies who build and start systems (§1.7.5)

General contractor (GC)

Prime contractor delivering the supply package; responsible for supervision, coordination, safety, quality and warranty provisions (A.2)

Construction manager (CM)

Construction leader handling project management, accounting and administration; usually works directly for the owner (A.2)

GC/CM directing authority

The construction team leader, not the CxP, directs construction team members to take part in Cx activities (§4.5)

Installing contractors

Trade subcontractors who place, install, connect and start equipment; assign Cx Team members and complete checklists (A.2)

Subcontractors

Parties contracted to another party already under contract, e.g. installing contractors working for the prime contractor (A.2)

Domain 4 - Roles & Responsibilities: Construction Team & Others**Manufacturers**

Entities fabricating products; provide start-up checklists and IOM or O&M manuals; usually not considered subcontractors (A.2)

Suppliers (vendors)

Entities providing products fabricated by others; may join start-up and tests; usually not considered subcontractors (A.2)

Testing agencies

Credentialed specialists doing specialized tests who report to the owner, not the GC, to avoid conflicts of interest (A.2)

ATC contractor

Automatic temperature controls contractor: installs and programs controls, performs point-to-point verification and sets up trends (§5.10.2)

TAB professional

Credentialed specialist who tests, adjusts and balances HVAC and plumbing air and water flows to design tolerances (A.2; §5.10.3)

Integrator of Record (IOR)

Party under owner contract for integration and programming services, who represents the owner after completion (A.2)

Domain 4 - Roles & Responsibilities: Construction Team & Others**Authority having jurisdiction (AHJ)**

Person or organization verifying code compliance or approving equipment, installations or procedures; enforces for occupant safety (A.2)

Contractor training role

Installing contractors, suppliers and manufacturers deliver O&M training; the CxP plans, manages and observes it (§4.5; §6.3.2)

Domain 5 – Construction Process & System Knowledge: Delivery & Documents**Design-bid-build**

Separate owner contracts for design and construction, contractor chosen after design; ACG's Cx process is based on it (A.2)

Design-build

Owner signs one agreement with a single entity responsible for both design and construction services (A.2)

Construction manager at risk (CMAR)

CM retained early in design negotiates a guaranteed maximum price and bears costs that exceed it (A.2)

Guaranteed maximum price (GMP)

Ceiling price for Construction Phase work negotiated during design under CMAR; the CM absorbs overruns (A.2)

Plan and spec

Delivery method essentially synonymous with design-bid-build: design plans and specs form the bid package (A.2)

Advanced work packaging (AWP)

Construction-driven planning that splits work into engineering, construction and installation work packages; suits design-build (A.2)

Domain 5 – Construction Process & System Knowledge: Delivery & Documents**Construction documents**

Evolving written record from bid package onward: drawings, specifications, addenda, RFIs and responses, change orders (A.2)

Contract documents

Documents forming the owner-contractor construction agreement, including construction documents, pricing, submittal and change order procedures (A.2)

Request for Information (RFI)

Formal written contractor question to the design team seeking clarification; responses become part of construction documents (A.2)

Architect's Supplemental Instruction (ASI)

Design team instruction clarifying documents or ordering minor changes without changing contract sum or time

Change order

Written owner-contractor agreement modifying the work, contract sum and/or contract time; part of the construction documents (A.2)

Construction submittals

Drawings, product data, samples and mock-ups submitted for owner and design approval before ordering or installing (A.2)

Domain 5 – Construction Process & System Knowledge: Delivery & Documents**Substantial completion**

Milestone (practical completion) when the owner can use systems for their intended purpose; typically starts the warranty (A.2)

Final completion

Milestone (final acceptance) when construction is 100% complete except warranty issues; follows substantial completion (A.2)

Core and shell

Project stage limited to core systems such as central plant and structure, plus the envelope; not occupancy-ready (A.2)

Fit-out

Stage after core and shell adding interior walls, fixtures, controls and finishes to prepare spaces for occupancy (A.2)

Supplemental Conditions

Project-specific modifications to the General Conditions; located in Division 00 of the Project Manual (A.2)

MasterFormat

CSI/CSC numbering system for organizing specifications; Cx general requirements sit in Division 01 (A.2)

Domain 5 – Construction Process & System Knowledge: Delivery & Documents**Building information modeling (BIM)**

Digital representation of physical assets characterizing functional and operational aspects of a facility and its systems (A.2)

COBie

Construction Operations Building Information Exchange: specification for capturing asset data, with BIM and CMMS, to support O&M (§1.10)

Computerized maintenance management system (CMMS)

Software automating management of assets, work orders, inventories and preventive maintenance scheduling (A.2)

Preventive maintenance

Scheduled supplier-recommended tasks such as inspection, cleaning, lubrication and belt adjustment that prevent premature failure (A.2)

Infrared thermography

Thermal imaging of temperature distribution, revealing envelope air leaks and hot electrical connections (A.2)

Domain 5 - Construction Process & System Knowledge: Systems & Calculations**Building automation system (BAS)**

Computer system for centralized automatic control of HVAC, lighting, power and access systems; also called BMS or EMS (A.2)

BACnet

ASHRAE Standard 135 open data communication protocol for building automation networks, enabling multivendor interoperability

Open vs proprietary protocols

Open protocols such as BACnet are published for multivendor use; proprietary ones tie integration to one vendor (A.2)

Air-handling unit (AHU)

Equipment with fans, coils, filters and dampers that conditions air and distributes it through ductwork

Variable air volume (VAV)

System varying airflow to each zone at a set supply temperature; terminal boxes keep minimum airflow setpoints

Dedicated outdoor air system (DOAS)

Unit conditioning 100% outdoor ventilation air, often with energy recovery, separate from the zone cooling and heating equipment

Domain 5 - Construction Process & System Knowledge: Systems & Calculations**Airside economizer**

Control that raises outdoor air intake for free cooling when outdoor conditions are favorable, within high-limit settings

Chilled beams

Ceiling terminals cooling with chilled-water coils and induced room air; supply water kept above dew point to prevent condensation

Variable frequency drive (VFD)

Electronic drive that varies motor speed by changing supply frequency, saving energy in fans and pumps

Affinity laws

For fans and pumps: flow varies with speed, pressure with speed squared, and power with speed cubed

kW/ton

Chiller efficiency: electrical input in kW per ton of refrigeration (1 ton = 3.517 kW of cooling); lower is better

Air changes per hour (ACH)

Hourly airflow divided by room volume; $ACH = \text{cfm} \times 60 \div \text{room volume in cubic feet}$

Domain 5 - Construction Process & System Knowledge: Systems & Calculations**Cooling tower approach**

Leaving cold-water temperature minus entering-air wet-bulb temperature; range is entering minus leaving water temperature

Net positive suction head (NPSH)

Pump inlet pressure above vapor pressure; NPSH available must exceed NPSH required to prevent cavitation

Chilled-water delta-T

Return minus supply water temperature; low delta-T signals excess flow and reduces plant capacity and efficiency

Sensible heat equations

Air: $Q \text{ (Btu/h)} = 1.08 \times \text{cfm} \times \Delta T \text{ (°F)}$;
hydronic water: $Q = 500 \times \text{gpm} \times \Delta T \text{ (°F)}$

Power usage effectiveness (PUE)

Data-center metric: total facility energy divided by IT equipment energy; 1.0 is the ideal value

Domain 5 – Construction Process & System Knowledge: Power, Testing & IEQ**Emergency Power Supply System (EPSS)**

Entire backup power system: emergency source such as generator or batteries, distribution and transfer switches (A.2)

Level 1 system

NFPA 110 emergency power system whose failure could result in loss of human life or serious injury (A.2)

Level 2 system

NFPA 110 emergency power system whose failure is less critical to human life and safety (A.2)

Low voltage systems

Communications and security systems on power-limited structured cabling, typically operating at 50 volts or less (A.2)

Aquastat

Device with sensing bulb and switch keeping hydronic water temperature between low and high limits (A.2)

Hydrostatic pressure test

Installation test filling piping with water at elevated pressure to confirm no leaks before insulation or concealment

Domain 5 – Construction Process & System Knowledge: Power, Testing & IEQ**Duct leakage test**

Pressurizing sealed duct sections to measure leakage against the specified allowance before insulation is applied

Testing, adjusting and balancing (TAB)

Specialized process setting HVAC and plumbing air and water flows for each mode within design tolerances (A.2)

AABC National Standards for Total System Balance

AABC's TAB standard, 7th Edition (2016), referenced by ACG for TAB work (A.3; §5.10.3)

Building pressurization

Keeping a space slightly positive or negative relative to outdoors or adjacent spaces through supply-exhaust airflow difference

Indoor air quality (IAQ)

Overall assessment of measurable air conditions in a facility, e.g. particulates, VOCs, CO and CO₂ (A.2)

Indoor environmental quality (IEQ)

Broader than IAQ: also lighting, acoustics, temperature, humidity, ergonomics and other occupant-experience factors (A.2)

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