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# Part II

## Model Commissioning Plan --Design Phase--

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## Part II

# Model Commissioning Plan --Design Phase--

## Summary

The *Model Commissioning Plan—Design Phase* guides the commissioning activities during the design phase. It provides details of responsibilities called out in Part I, *Commissioning Requirements—Design Phase* for the architect, design engineers, commissioning authority, construction and project managers. The plan describes the duties of the A/E team and commissioning authority in developing the site-specific commissioning specifications and for developing the first two drafts of the *Commissioning Plan—Construction Phase*.

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*Appendix 3. Commissioning for Indoor Quality Checklist--Design Phase*

*A3-1*

## Instructions for the Owner Filling Out the Model Commissioning Plan—Design Phase

### ***Using the Plan with the RFP***

The *Model Commissioning Plan—Design Phase* should be used for obtaining design proposals which will include commissioning and to guide the commissioning work throughout the design process. The *Design Phase Commissioning Plan* is referred to as the *Model plan* when it is not yet filled out. Refer to the Overview of the entire *Model Commissioning Plan and Guide Specifications* for further instructions about using the plan during the design process.

### ***Instructions for Filling Out the Model Plan***

With the following directions, the owner’s staff can confidently fill out the Model Plan and RFP Requirements. The awarded commissioning authority or architect will later revise the plan as necessary. The Model Plan is intended as a true “boilerplate” for most projects and can be filled out by hand without any attachments. For projects with unusual contracting arrangements, editing the Model Plan may be necessary, and is provided on electronic media.

First fill out Section 2, Building Information, to provide the expected magnitude of the project in gross terms. Section 3 will not be filled out until the design contract is awarded.

Next, skip to Section 5, Commissioning Scope of Work. Here, the first decision to be made is to decide which systems will be commissioned. At a minimum, the HVAC, HVAC control system and lighting controls should be commissioned. Consulting with other project managers, your own experience and budget considerations will help you decide on the others.

Next, under Task 1 of Section 5, Overall Coordination, decide whether the architect or the commissioning authority will coordinate the commissioning during design. The commissioning authority is generally a good choice to start with, but in some design teams the architect may be the better party, especially where the architect is more than just casually interested in commissioning, or where, with the commissioning authority as the coordinator, not enough support will be given to the commissioning authority from the other members of the team. Your decision can always be changed after the award of the contract.

Generally the formal commissioning should start at the beginning of the Design Development Phase. For smaller, less complex projects, the commissioning effort could wait until the beginning of the Construction Documents Phase.

Next, under Task 3 of Section 5, Design Development Review, decide how much, if any, the commissioning authority will review the design at the end of Design Development. This is highly recommended. The number of design areas the commissioning authority reviews is dependent on the commissioning authority’s skills and the emphasis and interest by the owner and the tenants in particular areas. At a minimum, the commissioning authority should review the energy-efficiency, operations and maintenance and the indoor environmental quality issues. Desired areas for review should be checked in Table 5-1.

Under Task 4 of Section 5, Develop Design Documentation, decide for which systems the designers will provide documented detailed design intent and operational parameters. Generally, all of the listed areas are highly recommended. Also under Task 4, who will coordinate the development of the design intent

documentation—the commissioning authority or the architect— must be determined. Either party should work well. The desired areas for documentation should be checked.

Task 5 of Section 5, Develop Construction Phase Commissioning Plan, requires no input, unless there are areas in the as-is *Model Commissioning Plan—Construction Phase* (Part IV) that the owner does not want to include. If so, the exclusions should be footnoted under this task.

Task 6 of Section 5, Develop Commissioning Specifications, requires no input at this time, unless there are large significant areas of the *Guide Specifications* (Part III) that the owner wants changed or clarified now, rather than during the normal adaptation process. If so, these exclusions or clarifications should be given under Task 6. It is noted that the *Guide Specifications* are not intended to be totally applicable to the project at hand and that the job of the design team is to adapt them. Thus, most or all of the changes needed will be made during the design process with guidance and approval of the owner.

Task 7 of Section 5, Conduct a Final Design Review, requires similar input as Task 3, using Table 5-3.

The Commissioning Schedule in Section 6 is fairly universal and will generally require no input. The only change that might be needed is if the commissioning starts later than the beginning of Design Development.

Finally, go to Table 4-1 in Section 4. This is a one-page view of the commissioning roles and responsibilities of the design team. In Table 4-1, there are two areas requiring input: 1) Who the overall commissioning coordinator during *design* will be, and 2) Who the lead on Task 4 will be. Check the appropriate party for these tasks and verify the other checks.

## Commissioning Plan—Design Phase

Project: \_\_\_\_\_

Owner Contact: \_\_\_\_\_

Date: \_\_\_\_\_

### 1. Overview of Commissioning During Design

Commissioning (Cx) is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner’s operational needs. This is achieved by beginning at the design phase with documented design and operating intent and continuing through construction and acceptance with actual verification of performance.

Commissioning during design is intended to achieve the following specific objectives:

- Provide commissioning focused design review.
- Ensure that the design and operational intent are clearly documented.
- Ensure that commissioning for the construction phase is adequately reflected in the bid documents.

The commissioning process during design is illustrated in Figure 1-1.

For reference, a brief description of the Owner design phases follows. Refer to the *Part I, Commissioning Requirements–Design Phase* for a listing of party definitions.

**Programming**—Design team and the Owner Project Manager meet with representatives of the occupying agency or client and determine the square footage and occupancy requirements of the building.

**Conceptual Design Phase**—Architect develops block diagrams, building sizing, rough space planning and sketches of exterior types. Multiple choices are provided. Mechanical and electrical designers generally have no input in this phase.

**Design Development Phase**—Additional detail is applied to the block diagrams and layouts. Interior and exterior features and finishes and *general* HVAC system types are determined and a rough floor plan is approved. Value engineering, if any, is completed.

**Construction Documents Phase**—Drawings are completed. Specifications are completed, generally using the Owner’s Master Spec. Bid documents are prepared.

### 2. Building Information

Project Name: \_\_\_\_\_

Location: \_\_\_\_\_

Building Type (office, court, etc.): \_\_\_\_\_

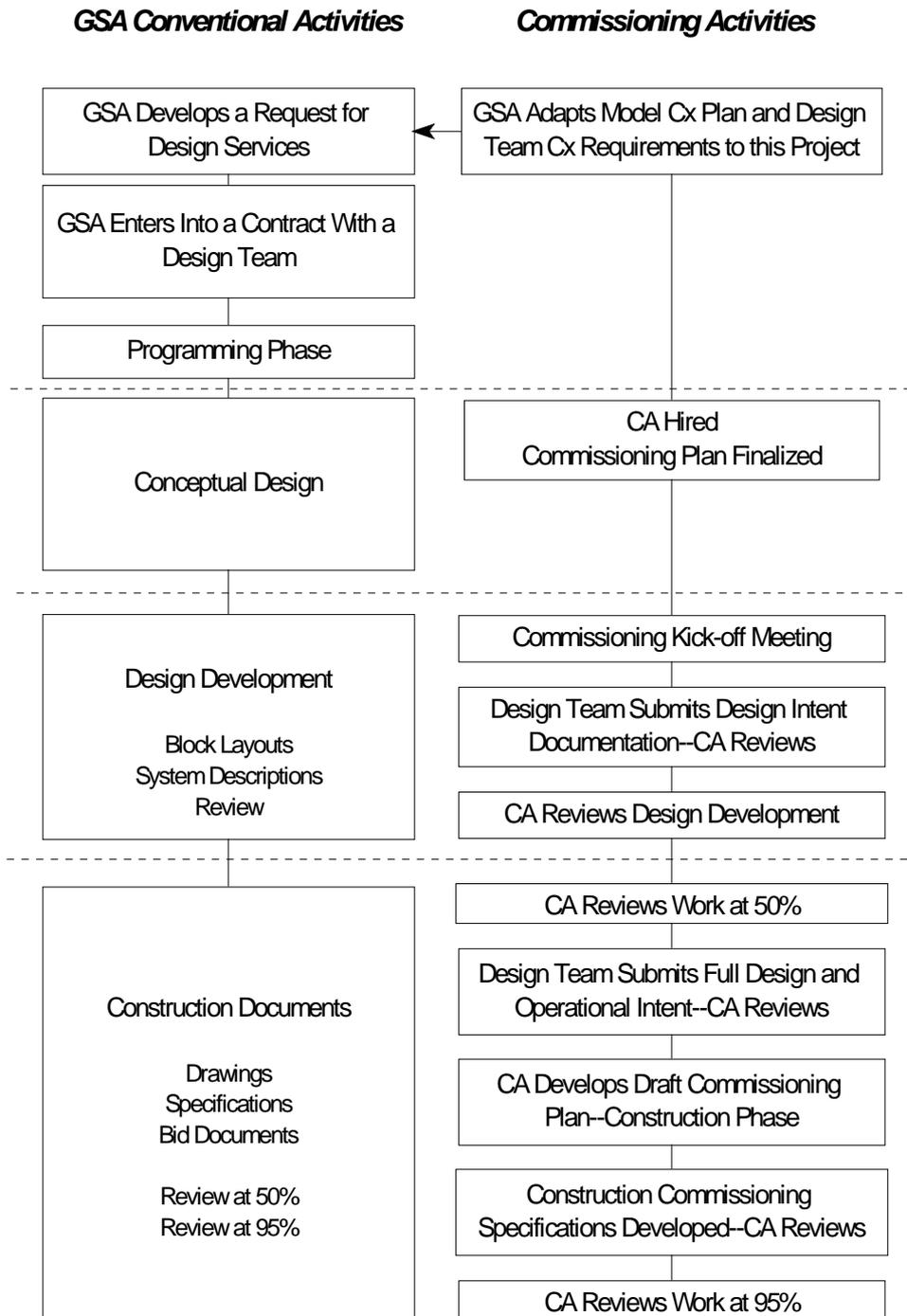
Square Footage: \_\_\_\_\_ Expected number of stories: \_\_\_\_\_

Agency: \_\_\_\_\_ Tenants: \_\_\_\_\_

Part II. Model Commissioning Plan–Design Phase

Design Period: \_\_\_\_\_ Const. Period: \_\_\_\_\_

**Figure 1-1. Commissioning During Design**





**3. Design Project Team Data**

|                              |                    |                                |                 |
|------------------------------|--------------------|--------------------------------|-----------------|
| Project Manager              | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
| Commissioning Authority (CA) | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
| Architect                    | Names:<br>Company: | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
| HVAC Mechanical Designer     | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
| Electrical Designer          | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
| Construction Manager         | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
| Tenant Representative        | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |
|                              | Name:<br>Company:  | Voice Ofc:<br>Fax:<br>Address: | Cell:<br>Email: |

|  |  |  |
|--|--|--|
|  |  |  |
|--|--|--|

#### **4. Responsibilities**

##### **Tasks**

A list of the responsibilities and tasks for each party of the design team are presented in Table 4-1. The member assigned as the lead for a given task is shown. The lead will coordinate the completion of the task. Under each task listing are subtasks with an “X” marked by the participating team members. The tenant representative(s) are considered members of the design team and will contribute in their normal fashion. They have no new role in the commissioning effort and so are not listed in the table.

##### **Scope**

Section 5 provides additional detail regarding scope of the tasks.

##### **Reporting**

Members completing subtasks report to the lead for that task, per Table 4-1. The task lead reports to the Coordinator lead (the lead in Task 1).

**Table 4-1. Commissioning Roles and Responsibilities During Design**

| Task  | Design Phase<br>Commissioning Responsibilities and Tasks | Parties Involved    |           |                            |                     |                     |                    |
|---|--|---------------------|-----------|----------------------------|---------------------|---------------------|--------------------|
|   |  | Commissioning Agent | Architect | Mechanical Designer (HVAC) | Electrical Designer | GSA Project Manager | GSA Const. Manager |
| <b>1 Overall coordination of the Cx work during Design</b>  | <i>Lead--&gt;</i>  |                     |           |                            |                     |                     |                    |
| a. Plan and schedule meetings   |  | X                   | X         |                            |                     | X                   |                    |
| b. See that all tasks are carried out   |  | X                   | X         |                            |                     | X                   |                    |
| c.  |  |                     |           |                            |                     |                     |                    |
| <b>2 Finalize the Cx plan for Design Phase</b>  | <i>Lead--&gt;</i>  | <b>X</b>            |           |                            |                     |                     |                    |
| a. Edit the original Cx Plan as necessary   |  | X                   |           |                            |                     |                     |                    |
| b. Review and comment on Cx plan  |  |                     | X         |                            |                     | X                   |                    |
| c.  |  |                     |           |                            |                     |                     |                    |
| <b>3 Perform design development review [1]</b>  | <i>Lead--&gt;</i>  | <b>X</b>            |           |                            |                     |                     |                    |
| a. After completion of Design Development, review design concepts of the areas checked in Table 5-1.                      |  | X                   | --        | --                         | --                  | --                  |                    |
| b.  |  |                     |           |                            |                     |                     |                    |
| <b>4 Develop design &amp; operating intent documentation</b>  | <i>Lead--&gt;</i>  |                     |           |                            |                     |                     |                    |
| a. Provide design intent format and assistance  |  | X                   |           |                            |                     |                     |                    |
| b. Write design intent for systems checked under Task 4 in Section 5.   |  |                     | X         | X                          | X                   | X                   |                    |
| c. Review and approve design intent for clarity and completeness  |  | X                   |           |                            |                     | X                   |                    |
| d.  |  |                     |           |                            |                     |                     |                    |
| <b>5 Develop draft Cx plan for Construction Phase</b>   | <i>Lead--&gt;</i>  | <b>X</b>            |           |                            |                     |                     |                    |
| a. Adapt and edit the Model Cx Plan--Const. Phase, Draft 1 and 2  |  | X                   |           |                            |                     |                     |                    |
| b. Review Cx plan   |  |                     |           |                            |                     | X                   | X                  |
| c.  |  |                     |           |                            |                     |                     |                    |
| <b>6 Develop Cx specifications for construction</b>   | <i>Lead--&gt;</i>  | <b>X</b>            |           |                            |                     |                     |                    |
| a. Assist in, review & approve all sections   |  | X                   |           |                            |                     |                     | X                  |
| b. Adapt Cx guide specs & include in Division 1   |  | X                   | X         |                            |                     |                     |                    |
| c. Adapt Cx guide specs & include in Division 15 (HVAC)   |  |                     |           | X                          |                     |                     |                    |
| d. Adapt Cx guide specs & include in Division 16 (electrical)   |  |                     |           |                            | X                   |                     |                    |
| e. Adapt Cx guide specs in special Cx Division _____  |  | X                   |           |                            |                     |                     |                    |
| f. Adapt Cx guide specs & include in Division _____   |  |                     |           |                            |                     |                     |                    |
| g.  |  |                     |           |                            |                     |                     |                    |
| <b>7 Review final drawings and specifications [1]</b>   | <i>Lead--&gt;</i>  | <b>X</b>            |           |                            |                     |                     |                    |
| a. Review full drawings & specifications at ~50% & ~95% complete to ensure that the design intent is met (see Table 5-3). |  | X                   | --        | --                         | --                  | --                  | --                 |

[1] This does not preclude the normal reviews by all parties, denoted by a dash —, but is intended to show the added review by the commissioning authority.

### 5. Commissioning Scope of Work

The following checked systems will be commissioned in this project:

- \_\_\_ HVAC system (virtually all equipment)
- \_\_\_ HVAC system (primary equipment only)
- \_\_\_ HVAC energy management control system
- \_\_\_ Indoor air quality (moderate level of effort)
- \_\_\_ Indoor air quality (rigorous level of effort)
- \_\_\_ Automatic Lighting controls
- \_\_\_ Electrical system power quality, grounding, etc.
- \_\_\_ Emergency power system
- \_\_\_ Communications system, e.g.,  
00000
- \_\_\_\_\_
- \_\_\_ Security system
- \_\_\_ Fire/smoke alarm and control system
- \_\_\_ Plumbing systems
- \_\_\_ Telecommunications and data systems
- \_\_\_ \_\_\_\_\_
- \_\_\_ \_\_\_\_\_

The following tasks comprise the commissioning work during design:

1. Coordinate the commissioning activities
2. Finalize design phase commissioning plan
3. Perform a review of Design Development
4. Develop design intent documentation
5. Develop the draft commissioning plan for the construction phase
6. Develop commissioning specifications for the construction bid documents
7. Perform a final review of the drawings and specifications

A listing of these tasks with the parties involved with them is included in Table 4-1. Each of the tasks in Table 4-1 will be executed unless specifically noted otherwise.

### 5.1 Task 1. Coordination of Commissioning During Design

The \_\_\_ *commissioning authority*, \_\_\_ *architect* will be the coordinator of the commissioning activities during design, per the designations in Table 4-1. The beginning of this task consists of holding a kick-off meeting with the design team at the beginning of \_\_\_ *Conceptual Design Phase*, \_\_\_ *Design Development Phase*, \_\_\_ *Construction Documents Phase*. This meeting is held after the Cx Plan has been finalized (Task 2). The meeting includes reviewing the process and outlining each party’s responsibilities.

The coordinator will ensure that commissioning issues are part of design team meeting agendas and will ensure that the Leads for each task understand their responsibilities and execute them. The coordinator makes any necessary changes to the design phase Commissioning Plan provided by the to the A/E team during the proposal process (Task 2). The coordinator reports to the architect and to the Project Manager.

**5.2 Task 2. Design Phase Commissioning Plan**

The commissioning coordinator for the design phase (Task 1) makes any necessary clarifications and changes to the original design phase Commissioning Plan provided by the Owner at the RFP stage and submits it to the architect and Project Manager for approval. This final plan guides the commissioning work during design. Necessary adjustments to the design team’s fees relative to Commissioning Plan changes are negotiated. All design team members receive a copy of the plan from the coordinator.

**5.3 Task 3. Design Development Review**

At the end of Design Development, the commissioning authority     reviews,     does not review the design along with the other design team members. If the commissioning authority does not perform this review, the rest of this section does not apply, otherwise:

The commissioning authority compares the design with the interests and needs of the Owner as identified in the programming report of the Programming and Conceptual Design Phases. The commissioning authority also compares the proposed design against the GSA design guide (PBS-PQ100.1, *Facilities Standards for the Public Buildings Service*) for the design areas checked below. The commissioning authority also identifies any improvements that can be made in areas checked below. Though the commissioning authority may review the areas checked below, they are not *responsible* for design concept, design criteria or compliance with codes.

**Table 5-1. Commissioning Authority Design Development Review**

| Design Area                                    | Review Description  |
|--|---|
| <u>    </u> Commissioning facilitation         | Input regarding making the building easier to commission (see Commissioning Facilitation under Section 5.7) |
| <u>    </u> Energy Efficiency                  | General efficiency of building shell, building layout, HVAC system types, lighting system type, etc.        |
| <u>    </u> Operation and Maintenance (O&M).   | How building O&M can be made easier (accessibility and system control, etc.)                                |
| <u>    </u> Indoor Environmental Quality (IEQ) | How thermal, visual, acoustical comfort or air quality <sup>1</sup> can be improved                         |
| <u>    </u> Functionality for Tenants          | How the design can be changed to improve functionality for the occupants                                    |
| <u>    </u> Environmental Sustainability       | How the building materials and systems and landscaping can create less of an impact on the environment      |
| <u>    </u> Life Cycle Costs                   | Life cycle assessment of options relative to energy efficiency, O&M, IEQ or functionality                   |

<sup>1</sup> To perform this review, the commissioning authority, in consultation with the owner to establish scope, shall use the checklists provided in Appendix 3. Indoor air quality (IAQ) commissioning does not ensure that indoor air quality will be adequate or without deficiency at building turnover or during occupancy,

unless the owner has specifically specified that actual air quality testing is performed. Commissioning indoor air quality entails performing tasks that minimize the potential for IAQ problems, but it does not eliminate their possibility.

This review is documented in writing and submitted to the design phase commissioning coordinator and forwarded to the architect and Project Manager. The architect distributes the comments to the design team members. The team members respond to the architect who provides a written response to the commissioning authority and to the Project Manager describing the team’s response and any changes or considerations made in the design.

#### **5.4 Task 4. Design Intent and Basis of Design Documentation**

Specifically identifying and developing the design intent and basis of design provides each party involved, at each respective stage, an understanding of the building systems. This allows team members to perform their respective responsibilities regarding the design, construction or operation of the building.

The design documentation differs from traditional specifications in that it provides a more narrative description of the system or issue and “frames” the issue or building component with clear and useful background information. However, design documentation often includes parts of specifications. In general, specifications detail what is to be done on a component level, while design documentation explains why something is done and, in general terms, how design and operating objectives will be accomplished. Sections of the design documentation can look like specifications, especially where tasks depart from conventional practice, e.g., energy-efficient design and construction.

Design documentation includes the salient information from the programming report, the conceptual design phase and from the design and construction process necessary to guide the design, verify compliance during construction and aid building operations. Design documentation consists of two dynamic components: design intent and the basis of design.

##### ***Design Intent***

The design intent is a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases. The design intent narrative should cover the following, for each system, major component, facility and area:

- General system description
- Objectives and functional use of the system, equipment or facility
- General quality of materials and construction
- Occupancy requirements
- Indoor environmental quality, IEQ (space temperature, relative humidity, indoor air quality, noise level, illumination level, etc.)
- Performance criteria (general efficiency, energy and tolerances of the IEQ objectives, etc.)
- Budget considerations and limitations
- Restrictions and limitations of system or facility

Many of the above topics may not be necessary for smaller components, such as VAV terminal units.

### ***Basis of Design***

The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included. The following should be included in the basis of design for major equipment:

- Specific description of systems, components and methods for achieving the design intent objectives. (For example, for a rooftop air conditioning unit include: why this system was chosen above others, details of size, efficiencies, areas served, capacity control details, compressors, coils, dampers, setpoints, filters, economizers, minimum ventilation control, control type, noise and vibration criteria, tie-in to other systems, sequences of operation under all modes of operation, control strategies, etc.)
- Equipment maintainability
- Fire, life, safety: criteria, general strategy narrative and detailed sequences
- Emergency power control and function
- Energy performance
- Ventilation strategies and methods
- Complete sequences of operation, including setpoints and control parameters
- Schedules
- Applicable codes and standards
- Primary load and design assumptions
  - Diversity used in sizing
  - Occupant density and function
  - Indoor conditions (space temperature, relative humidity, lighting power density, ventilation and infiltration rates, etc.)
  - Outdoor conditions
  - Glazing fraction, U-value and shading coefficient

Information of secondary importance to the commissioning and operation of the building should be documented by the design team, but is not included in the design documentation described here or included in the O&M manuals (e.g., wall R-values, mass, etc.)

The detail of both the design intent and basis of design increase as the design process progresses, as described in Table 5-2. In the beginning, the design documentation required is primarily a narrative of the building system descriptions, the purpose of the systems, how the systems will meet those objectives and why this system or method was chosen above others. As the design process progresses, the design documentation includes the basis of design, a specific description of the system and components, its function, how it relates to other systems, sequences of operation, and operating control parameters.

Each contributing designer clearly documents in writing the intent behind the chosen design and the operating parameters of the system. The design intent required here is not a substitute for what may be required in the specifications or contract for other systems.

**Table 5-2. Progression of Design Documentation**

| Stage  | Issues Addressed   | Responsible Parties  |
|--|--|--|
| Programming  | The owner’s and tenant’s needs are identified in detail. The applicable parts of the programming report become the initial design intent.  | Owner<br>Architect   |
| Conceptual Design and Design Dev.                    | Design intent clarified. Basis of design begun: overall system descriptions, objectives of systems, general methods of achieving objectives, etc.  | Owner<br>Architect   |
| Construction Documents and Specification Development | Same as Conceptual Design and Design Dev. above, but in more detail, including complete basis of design: complete system & component description, specific methods of achieving system objectives, design & load assumptions, applicable codes and standards, complete sequences of operation and control strategies | Architect<br>Design Engineers  |
| As-Built Documentation                               | Same as Construction Documents and Specification Development, plus:<br>Adjusted sequences with final control parameters  | Design Engineers<br>Installing Contractors<br>Building Operator<br>Architect |

The initial design intent from the programming phase is developed by the architect with review by the design team and commissioning authority. The architect, or other assigned party, acts as the design documentation task lead and coordinates the creation of the full design documentation by the design team. Each member of the team provides the system description, the written basis of design and detailed sequences of operation for the areas of design that are their responsibility. They submit the documentation in parts to the task lead at the pre-determined phases of design. The architect, task lead and commissioning authority review, comment on and approve the submissions. Design intent documentation for other components and systems such as structural, interior design, furnishings, plumbing, etc. may be required, but are not a part of the commissioning work unless listed and checked herein.

**Design Documentation Submitted:**

**By the Architect**

- general building design and function
- interior lighting
- building shell efficiency
- environmental sustainable construction
- landscaping / irrigation
- \_\_\_\_\_
- \_\_\_\_\_

***By the HVAC Mechanical Designer/Engineer***

- HVAC systems (air and water)
- automatic controls
- fire/smoke protection systems
- thermal comfort
- air quality
- acoustical quality
- one-line CAD drawings of the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems, medical gas system, and \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

***By the Electrical Designer/Engineer***

- interior lighting
- automatic lighting controls (exterior and interior)
- security system
- communications system
- fire and smoke alarm system
- power quality
- emergency power
- one-line CAD drawings of the emergency power system

\_\_\_\_\_

***Documentation Format and Detail***

The format and rigor of the design intent documentation will be similar to the example documentation format found in the Design Documentation Format Form in Appendix 1 of this plan. The design team follows the example format and level of detail for, at a minimum, the systems checked above. The general outline of the full documentation is:

- A design narrative describing the system in general
- The objectives of each system and its functional use
- The full sequence of operations under all modes and conditions
- The setpoints and operating parameters
- Performance criteria and applicable codes and standards

One-line CAD drawings of the above named systems shall be developed to augment the design narratives.

***Reporting and Review***

Each team member submits his or her design documentation to the architect at the end of the phase listed in the example design documentation format in Appendix 1 (Design Development Phase, Construction Documents for Specification Development). The architect provides a copy of the design intent to the Project Manager and to the commissioning authority. Documentation listed to be completed in the As-Built stage is not provided during design. The commissioning authority reviews the documentation and provides written comments, through the architect, to

each designer. Each designer makes necessary changes according to the commissioning authority request and resubmits the documentation to the commissioning authority, through the architect.

At the end of Design, the architect compiles and submits the full design intent documentation to the commissioning authority and to the Project Manager. These three parties decide how much of the design documentation should be included in the bid specifications. Minimally, the design team members include their full sequences of operation as well as a brief system narrative (what the system is, what it is used for, general areas served, etc.) in their bid document specifications for each system they designed. Additionally, selected portions of the design intent and basis of design may be incorporated into the specifications before Division 1 in the CSI Systems and Assemblies section.

A draft copy of the full design intent and basis of design are provided to the commissioning authority at the beginning of construction. A final as-built copy is prepared and is included in the O&M manuals at the end of construction.

### ***Sequences of Operation***

Detailed written sequences of operation shall be developed with the following components clearly and completely described for each piece of dynamic equipment:

- An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function
- All interactions and interlocks with other systems
- Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable
- Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative.)
- Startup sequences
- Warm-up mode sequences
- Normal operating mode sequences
- Unoccupied mode sequences
- Shutdown sequences
- Capacity control sequences and equipment staging
- Temperature and pressure control: setbacks, setups, resets, etc.
- Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
- Effects of power or equipment failure with all standby component functions
- Sequences for all alarms and emergency shut downs
- Seasonal operational differences and recommendations
- Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment
- Schedules, if known

- All sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

#### ***Fire and Emergency Power Response Matrix***

An HVAC fire and emergency power response matrix that lists all equipment and components (air handlers, dampers, valves, etc.) with their status and action during a fire alarm and under emergency power shall be developed. An example of a fire and power response matrix and flow chart are found in Appendix 2.

### **5.5 Task 5. Draft Commissioning Plan for Construction**

When the drawings, traditional specifications (non-commissioning) and design intent documentation are partially complete, prior to developing commissioning specifications, the commissioning authority uses the *Model Commissioning Plan—Construction Phase* (Part IV of the *Model Commissioning Plan and Guide Specifications*) to develop the draft construction phase commissioning plan for this project. The plan contains a list of the systems and specific equipment and components to be commissioned and the general modes to be tested with the probable testing method. In addition, sections of standard language regarding process, responsibilities, O&M documentation, training and scheduling are included.

The parts in the construction phase commissioning plan with blanks that need to be filled in **prior** to construction bidding are noted to the right of the section heading with “[Bid Docs].” Other fill-in blanks are not filled in until after construction begins.

When completed, this draft (Draft 1) of the construction phase plan, provides the general scope for the construction commissioning specification development (Task 7). Then, after all drawings and specifications are complete, the commissioning authority updates the construction-phase Commissioning Plan (which becomes Draft 2). Draft 2 of the commissioning plan is included as part of the construction bid documents.

The project manager and construction manager review both drafts of the plan and the commissioning authority makes recommended changes.

### **5.6 Task 6. Commissioning Specification Development**

Commissioning specifications for inclusion in the construction bid documents are developed by members of the design team as part of the commissioning process during design.

#### ***Purpose***

The specifications provide detail so that those bidding on the project can clearly understand how the commissioning process works and specifically what role they have in the process. They provide the requirements and process for properly executing the commissioning work.

#### ***Specification Content***

The commissioning specifications shall provide the bidders a clear description of the extent of the verification testing required, including what components and systems will be tested and the documentation, reporting and scheduling requirements. Details of the extent of testing and who is responsible for writing tests, executing tests, witnessing and signing-off on tests shall be included. The relationship between and requirements for start-up, prefunctional checklists,

manual functional performance tests, control system trend logs and stand-alone data logging shall also be given. Example tests shall also be provided. The specifications shall also detail the operator training and the O&M documentation and any O&M plan requirements. Any specific program of tasks focusing on indoor air quality should be included in the specifications.

### ***Guide Specifications***

Each designer uses the *Guide Commissioning Specifications*, adapts them for this project and includes them in specifications. Draft 1 of the *Commissioning Plan—Construction Phase* as explained in Task 5 is used to guide the commissioning specification development. This plan was developed earlier in the design process.

### ***Coordination, Reporting and Review***

The responsibilities for developing the individual sections of the commissioning specifications are listed in Table 4-1. The Specification Overview section in Part III, Commissioning Guide Specifications, of the *Model Commissioning Plan and Guide Specifications* provides a listing of what needs to be addressed in each specification section. The commissioning authority coordinates the commissioning specification effort and provides assistance as needed to all team members. Each team member submits the full specification of any division that includes references to commissioning, in *\_\_\_electronic format, \_\_\_hard copy format* to the commissioning authority for review at least two weeks prior to the printing of final specifications. Each page contains the filename and date of the document. A list is provided of any areas where the commissioning specifications deviate significantly from the guide specifications and the rationale for the deviation. Each team member also provides an *\_\_\_electronic copy, \_\_\_hard copy* to the architect and to the Project Manager.

The commissioning authority reviews the specifications and provides written comments to each designer who edits the specifications according to the commissioning authority request and resubmits edited sections to the commissioning authority. The printed edited sections show the filename and date automatically printed on each page. The commissioning authority notifies each designer in writing of the approval of his or her commissioning specification. The commissioning authority provides to the architect in writing, the filenames and dates of the approved specification sections of each designer, which must precede printing of the final specifications. Though the commissioning authority coordinates and reviews the commissioning specifications, the ultimate responsibility for their content and preparation lies with the A/E.

## **5.7 Task 7. General Review of Drawings and Specifications**

The commissioning authority, along with the traditional design team members, reviews the full set of Construction Documents and specifications when approximately 50% and 95% complete. Parts of this review dealing with commissioning specifications will have been completed in Task 6—Commissioning Specification Development. The architect provides the necessary documents to the commissioning authority.

The commissioning authority compares the design with the interests and needs of the Owner as identified in the programming report of the Programming and Conceptual Design Phases. The commissioning authority also compares the proposed design against the Owner design guide (PBS-PQ100.1, *Facilities Standards for the Public Buildings Service*) for the design areas checked in Table 5-3. The commissioning authority also identifies any improvements that can

be made in areas that do comply with, or are not specifically mentioned in the design guide in areas checked in Table 5-3. The rigor of the review listed for the commissioning authority in Table 5-3 provides general guidance.

Though the commissioning authority may review the areas checked below, they are not *responsible* for design concept, design criteria or compliance with codes. The commissioning authority does not *verify* the designers’ calculations or proof schematics or layouts in detail. The constructibility review is performed by another party. The commissioning authority will use his or her expertise to provide input into the areas checked in Table 5-3. For example, the commissioning authority does not verify appropriate pipe or duct sizing, but may provide comments on unusually tight or restrictive duct layouts and bends or a poor location of a static pressure sensor.

For the non-commissioning specifications and all the drawings, the commissioning authority provides written comment to the architect within \_\_\_ *days* from receiving the documents. The commissioning specification review is detailed in Task 6. The commissioning authority also provides a copy of the comments to the Project Manager. The architect provides a written response to the commissioning authority and Project Manager as to how the comments will be reflected in the final bid documents.

**Table 5-3. Commissioning Authority Drawing and Specification Review (50% & 95%), Task 7**

| <b>Design Area</b>                           | <b>Review Description</b>   | <b>Rigor</b>             |
|--|---|--------------------------|
| ___ Commissioning facilitation               | Input regarding making the building easier to commission (see Commissioning Facilitation under Section 5.7)   | __moderate<br>__rigorous |
| ___Component energy efficiency               | Review for adequacy of the efficiency of bldg. shell components, HVAC systems and lighting systems.   | __moderate<br>__rigorous |
| ___Control system & control strategies       | Review ___HVAC, ___lighting, ___fire control, ___security control system, strategies and sequences of operation for adequacy and efficiency.                          | __moderate<br>__rigorous |
| ___Operation and maintenance                 | Review for effects of specified systems and layout toward facilitating O&M (equipment accessibility, system control, etc.).   | __moderate<br>__rigorous |
| ___Indoor environmental quality <sup>1</sup> | Review to ensure that systems relating to ___thermal, ___visual, ___acoustical, ___air quality comfort, ___air distribution are in accordance with the design intent. | __moderate<br>__rigorous |
| ___Environmental sustainability              | Review to ensure that the ___building materials, ___landscaping, ___use of water resources, ___waste management are in accordance with the design intent.             | __moderate<br>__rigorous |
| ___Facility performance and design intent    | Identify flaws, oversights, or insufficient detail in the design, relevant to being able to reasonably meet the design intent   | __moderate<br>__rigorous |
| ___Functionality for tenants                 | Review to ensure that the design meets the functionality needs of the tenants.  | __moderate<br>__rigorous |

| Design Area                          | Review Description   | Rigor                    |
|--------------------------------------|--|--------------------------|
| ___ Life cycle costs                 | Perform a ___qualitative, ___quantitative lifecycle assessment of the primary competing systems relative to ___energy efficiency, ___O&M, ___IEQ, ___functionality.  | __moderate<br>__rigorous |
| ___O&M documentation                 | Verify that building O&M plan and documentation requirements specified are adequate  | __moderate<br>__rigorous |
| ___Training                          | Verify that operator training requirements specified are adequate.   | __moderate<br>__rigorous |
| ___Commissioning specifications      | Verify that bid documents adequately specify building commissioning and that there are adequate monitoring and control points specified to facilitate commissioning and O&M (trending capabilities, test ports, control points, gages and thermometers). | __moderate<br>__rigorous |
| ___Review of engineering assumptions | Review the engineering assumptions relating to equipment sizing, energy efficiency decisions and HVAC cost-benefit calculations  | __moderate<br>__rigorous |
| ___Owner’s design guide or standard  | Verify that the design complies with the Owner’s own design standard or guideline.   | __moderate<br>__rigorous |

<sup>1</sup> To perform this review, the commissioning authority, in consultation with the owner to establish scope, shall use the checklists provided in Appendix 3. See the disclaiming note at the bottom of Table 5-1.

## 5.8 Commissioning Facilitation

One of the primary tasks for the commissioning authority is reviewing the design documents to facilitate commissioning during construction. Many of the features that facilitate commissioning will also enhance ease of building operation. All items from the list below shall be considered for incorporation into the project. Some of the items in the list will be appropriate for the Design Development review, while the majority will apply to the 50% and 95% Construction Documents phase reviews. The commissioning authority will make recommendations to the design team as to which items are needed. The design team will respond in writing regarding their disposition on incorporating each item.

1. Clear and rigorous design documentation, including detailed and complete sequences of operation.
2. An HVAC fire and emergency power response matrix that lists all equipment and components (air handlers, dampers, valves, etc.) with their status and action during a fire alarm and under emergency power. See Appendix 2.
3. Access for reading gages, entering doors and panels, observing and replacing filters, coils, etc.
4. Required isolation valves, dampers, interlocks, piping, etc. to allow for manual overrides, simulating failures, seasons and other testing conditions.
5. Sufficient monitoring points in the building automation system (BAS), even beyond that necessary to control the systems, to facilitate performance verification and O&M.
6. Adequate trending and reporting features in the BAS.

7. Pressure and temperature (P/T) plugs close to controlling sensors for verifying their calibration.
8. Pressure gages, thermometers and flow meters in strategic areas for verifying system performance and ongoing O&M.
9. Pressure and temperature (P/T) plugs at less critical areas or on smaller equipment where gages and thermometers would be over-kill.
10. Specification of the location and criteria for the VAV duct static pressure sensor and chilled water differential pressure sensor.
11. Adequate balancing valves, flow metering and control stations and control system functions to facilitate and verify reliable test and balance.
12. Uniform inlet connection requirements to VAV terminal boxes.
13. Clear and complete commissioning specifications for the construction phase.
14. Complete O&M documentation requirements in the specifications.
15. Complete training requirements in the specifications.
16. Review entire document and building information management plan from design through construction and turnover to ensure adequacy and compliance with the owner’s program.

**6. General Schedule**

The commissioning activities are integrated into the typical design process without any real increase in the timetable of deliverables. Table 6-1 illustrates the location of the commissioning activities during design.

**Table 6-1. Commissioning Schedule—Design Phase**

| Tasks                     | Programming | Conceptual Development | Design Development | Construction Documents & Specifications |
|---------------------------|-------------|------------------------|--------------------|---|
| 1. Coordination           | ██████████  | ██████████             | ██████████         | ██████████                              |
| 2. Design Phase Cx Plan   |             | ████                   |                    |   |
| a. Kick-off Meeting       |             |                        | ██                 |   |
| 3. Design Dev. Review     |             |                        |                    | ████                                    |
| 4. Design Intent Doc.     | ████        | ████                   | ████               | ██████████                              |
| 5. Construction Cx Plan   |             |                        |                    | ████                                    |
| 6. Cx Specifications      |             |                        |                    | ████                                    |
| 7. Drawing & Spec Reviews |             |                        |                    | ████ █████                              |