APPENDIX H

Energy Cost Budget (ECB) Compliance Report — Page 1

Project Name:	Inland Empire Utility Headquarters (Buildings A & B)		
Project Address:	S.E. Corner of Kimball & El Prado	Date:	June 27, 2003
City:	Chino, CA	Principal Heating Source:	[ ] Fossil Fuel
Weather Data:	California CZ10	[ ] Electricity	[x] Site Recovered [ ] Other
Energy Code:	2001 Title-24 (New Construction)		

Space Summary

Building Use	Conditioned Area (ft^2)	Unconditioned (ft^2)	Total
Building A:			
1. Office	30,574	0	30,574
2. Auditorium	1,800	0	1,800
Total Building A:	32,374	0	32,374
Building B:			
1. Office	32,374	0	32,374
Total	64,748	0	64,748

Advisory Messages

	Proposed Building Design	Budget Building	Difference (Proposed - Budget)
Percent of hours sytem load out of throttling range	0.0%	0.0%	0.0%
Percent of hours plant load not met	0.0%	0.0%	0.0%
Number of warnings	2	2	0
Number of errors	0	0	0
Number of defaults overridden	0	0	0

Description of differences between the budget building and proposed design not documented on other forms:

[ ] Not Applicable [x] Attached

Compliance Result

The design detailed in the above referenced plans complies with the mandatory requirements of 2001 Title-24 and the design energy cost does not exceed the Energy Cost Budget. Therefore, this design DOES COMPLY with the 2001 Title-24 ECB Compliance Methodology.

Individual certifying authenticity of this data provided in this analysis:

Signature:	Ted Strudas	Title:	Energy Analyst, CTG Energetics

Project Name:	Inland Empire Utility Headquarters - Buildings A & B	19-Dec-03

Energy Summary by End Use

End Use	Energy Type	Proposed Building		Budget Building		Proposed / Budget Energy (%)
		Energy (10^3 Btu)	Peak (10^3 Btu/h)	Energy (10^3 Btu)	Peak (10^3 Btu/h)	
Lighting - conditioned	Electricity	1,266,656	132	2,357,468	246	53.7
Space heating (1)	Natural Gas	256,600	908	831,900	2,115	30.8
Space heating (2)						
Space cooling (1)	Electricity	7,134	2	2,529,950	701	79.2
Space cooling (2)	Natural Gas	1,996,000	1,613			
Pumps	Electricity	382,068	80	37,249	5	1025.7
Heat rejection	Electricity	1,131,809	146			
Fans - interior ventilation	Electricity	500,779	64	570,312	155	87.8
Service water heating (1)						
Service water heating (2)						
Office equipment	Electricity	1,249,496	120	1,249,496	120	100.0
Total Building Consumption		6,790,543	3,065	7,576,376	3,341	89.6
Total Building Consumption (regulated loads only)		5,541,047	2,945	6,326,880	3,221	87.6

Energy and Cost Summary by Fuel Type

	Proposed Building		Budget Building		Proposed/Budget	
	Energy (10^3 Btu)	Energy Cost ($/yr)	Energy (10^3 Btu)	Energy Cost ($/yr)	Energy (%)	Cost (%)
All Building Energy (includes unregulated energy						
Electricity	4,537,943	$40,331	6,744,476	$59,948	67.3	67.3
Natural gas	2,252,600	$14,462	831,900	$5,341	270.8	270.8
Total - (all loads regulated + unregulated)	6,790,543	$54,793	7,576,376	$65,289	89.6	83.9
Unregulated Energy Subtracted Out	Energy that is unregulated (10^3 Btu)	(cost offset)	Energy that is unregulated (10^3 Btu)	(cost offset)		
Electricity	1,249,496	$11,105	1,249,496	$11,106		
Natural gas		$0		$0		
Total (regulated loads only)	5,541,047	$43,688	6,326,880	$54,183	87.6	80.6
Solar/Renewable Energy Subtracted Out	Energy generated by solar (10^3 Btu)	(cost offset)	Energy generated by solar (10^3 Btu)	(cost offset)		
Electricity (Photovoltaics)	1,198,895	$10,655				
Natural gas (Waste heat from electric generation process)	2,252,600	$14,462				
	Proposed Building		Budget Building		Proposed/Budget	
	Energy (10^3 Btu)	Energy Cost ($/yr)	Energy (10^3 Btu)	Energy Cost ($/yr)	Energy (%)	Cost (%)
Total - (regulated loads only, solar energy is free)	5,541,047	$18,571	6,326,880	$54,183	87.6	34.3

LEED Points

Energy Cost Budget - Percent Below Code:	65.7%	LEED Points:	10

* These results use assumptions for showing compliance during a typical year, actual energy costs may be substantially different

APPENDIX I

CTG Energetics, Inc.
Consulting Engineering for Energy Efficiency & Sustainability in Buildings

Dr. Malcolm Lewis, PE
President

December 23, 2003

JN: **60177B**

Re: Inland Empire Utilities Agency's New Headquarters

To: LEED™ Certification Committee

This letter verifies that CTG Energetics, Inc. was engaged by TG Construction Inc. as the commissioning authority for the Inland Empire Utilities Agency's New Headquarters. CTG developed and carried out a Commissioning Plan; the complete language of the commissioning plan is included in the documentation for the Fundamental Building Systems Commissioning prerequisite. The Fundamental Building Systems Commissioning tasks were successfully completed on December 22, 2003.

This letter certifies that CTG Energetics, Inc. completed the following activities required to achieve the Additional Commissioning requirements:

1. A review of the design prior to the construction documents phase
2. A review of the design near the end of the construction documents phase
3. Reviews of several contractor submittals of commissioned equipment

After completing the reviews listed above, CTG reported their findings to the ownership, design, and construction team.

Sincerely,

Jared Ingwalson
Project Manager

16 Technology Drive · Suite 109 · Irvine · CA · 92618-2323 949-790-0010 Fax: 949-790-0020 www.CTG-net.com

CTG Energetics, Inc.
Consulting Engineering for Energy Efficiency & Sustainability in Buildings

Dr. Malcolm Lewis, PE
President

December 23, 2003

JN: **60177B**

Re: Inland Empire Utilities Agency's New Headquarters

To: LEED™ Certification Committee

This letter verifies that CTG Energetics, Inc. was engaged by TG Construction Inc. as the commissioning authority for Inland Empire Utilities Agency's New Headquarters. CTG developed and carried out a Commissioning Plan; the complete language of the commissioning plan is included in the documentation for the Fundamental Building Systems Commissioning prerequisite. The Fundamental Building Systems Commissioning tasks were successfully completed on December 22, 2003.

CTG's tasks included completing the activities in the Additional Commissioning point. CTG Energetics, Inc. completed a re-commissioning manual. The re-commissioning manual will be included with the commissioning record for the project.

CTG Energetics, Inc. is contracted to complete a near-warranty end review. This review will take place in September of 2004. During this review, the following activities will be carried out:

- Review current building operation of commissioned systems
- Interview facility staff regarding operation of commissioned systems
- Address outstanding issues related to the original and seasonal commissioning
- Provide suggestions for improvement of the operation of commissioned systems
- Assist facility staff is developing service requests to remedy outstanding problems
- Record results (including operational changes) in O&M & re-commissioning manual

Sincerely,

Jared Ingwalson
Project Manager

16 Technology Drive · Suite 109 · Irvine · CA · 92618-2323 949-790-0010 Fax: 949-790-0020 www.CTG-net.com

LEED™ Commissioning Plan

Inland Empire Utilities Agency

New Headquarters (Buildings A & B)

Report prepared for:

Inland Empire Utilities Agency

9400 Cherry Avenue, Building A

Fontana, CA 92335

Report prepared by:

CTG Energetics, Inc.

16 Technology Drive, Suite 109

Irvine, CA 92618

(949) 790-0010; (949) 790-0020 fax

Final Revision - December, 2003

CTG Job No. 60177B

Table of Contents

1. Introduction

This *Commissioning Plan* was developed by CTG Energetics for the for Inland Empire Utilities Agency. The initial construction phase for the Inland Empire Utilities Agency complex will consist of two buildings, A & B with a combined total of over 66,000 sq. ft. of enclosed office space. The project has been designed to achieve the LEED™ 'Platinum' level of sustainability (the possible ratings are Certified, Silver, Gold, and Platinum) under the US Green Building Council's Leadership in Energy and Environmental Design Green Building Rating System™[1]. The commissioning process is being undertaken, in part, to fulfill the requirements of the LEED rating's Commissioning Prerequisite. CTG Energetics, Inc. will provide Commissioning Authority (CA) services for this project.

1.1 Commissioning Overview and Scope

Commissioning is a systematic process of verifying that 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. In this LEED commissioning process, commissioning is intended to achieve the following specific objectives:

- Develop and utilize a commissioning plan
- Collect and review design intent and basis of design documentation
- Conduct a focused review of the design prior to the construction documents phase
- Conduct a focused review of the construction documents when close to completion
- Include commissioning requirements in the construction documents
- Conduct a selective review of contractor submittals of commissioned equipment
- Verify installation, functional performance, training and documentation
- Complete a post-occupancy review of the commissioned systems

In addition, the commissioning authority will complete two major deliverables, as follow:

- Complete a commissioning report
- Complete a re-commissioning management manual

These activities are described in Sections 4 and 5 of this document as well as in the Project Specifications.

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[1] LEED Green Building Rating System™ (LEED™) is a registered trademark of the U.S. Green Building Council.

1.2 Commissioned Systems

The following equipment and systems will be commissioned. General references to equipment in this document and the project specifications refer to equipment in this list.

Division 15 – Mechanical Systems

- Central HVAC plant including four absorption chillers, variable speed chilled water pump, variable speed heat medium pump, variable speed cooling water pump, constant speed space heating hot water pump and heat exchangers for the heating medium, cooling water and space heating hot water,
- Direct Digital Control System,
- Variable-Air-Volume Air-Handling units,
- General occupancy exhaust fans greater than five horsepower,
- Air Distribution Systems for 2 buildings with a combined total of over 66,000 SF.

Division 16 – Electrical Systems

- Daylighting system including fenestration, daylighting controls and central control system,
- High efficiency electric lighting design with local controls
- Lighting Levels

2. Design Project Team Directory (primary parties)

Team Member	Co. & Contact Names	Phone, fax, email address
Owner Project Manager	Neil Clifton Inland Empire Utilities Agency	Phone: (909) 357-0241 Fax: (909) 357-3870 Address: 9400 Cherry Avenue, Bldg. A Fontana, CA 92335 Email: nclifton@ieua.org
Construction Manager General Site Contact	Dave Wall Inland Empire Utilities Agency	Phone: (909) 357-0241 Address: 9400 Cherry Avenue, Bldg. A Fontana, CA 92335 Email: dwall@ieua.org
Commissioning Authority (CA)	Tom Lunneberg CTG Energetics, Inc.	Phone: (949) 790-0010 Fax: (949) 790-0020 Address: 16 Technology Drive, Suite 109 Irvine, CA 92618 Email: tlunneberg@ctg-net.com
Architect Project Architect	Michael Shea La Cañada Design Group	Phone: (626) 795-6474 Fax: (626) 795-2274 Address: 200 E. Del Mar Boulevard, Ste. 108 Pasadena, CA 91105 Email: micshea@lcdg.com
Mechanical Engineer	Robert Banbury Xcel Mechanical Systems, Inc.	Phone: (310) 660-0090 Fax: (310) 660-0095 Address: 1614 139th Street Gardena, CA 90249 Email: rbanbury@xcelmech.com
Controls Contractor	Dave Brown Xcel Mechanical Systems, Inc.	Phone: (310) 660-0090 Fax: (310) 660-0095 Address: 1614 139th Street Gardena, CA 90249 Email: dbrown@xcelmech.com
Electrical Engineer	Terry Smith Dyna Electric	Phone: (714) 484-2326 Fax: (714) 484-2394 Address: 4462 Corporate Center Drive Los Alamitos, CA 90720 Email: tsmith@dyna-la.com
General Contractor Project Manager	Steve Pavone TG Construction Inc.	Phone: (310) 640-0220 Fax: (310) 640-2907 Address: 119 Standard Street

		El Segundo, CA 90245 spavone@tgconst.com
Project Engineer	Brian Schiltz TG Construction Inc.	Phone: (310) 640-0220 Pager: (310) 585-0059 Fax: (310) 640-2907 Address: 119 Standard Street El Segundo, CA 90245 Email: bschiltz@tgconst.com

3. Roles and Responsibilities

3.1 Locations of Role Descriptions

Descriptions and explanations of the roles and responsibilities of commissioning team members are found in the following places in the Contract Documents:

List of team members:	Commissioning Plan (Cx Plan) Section 2
Management plan outline:	Cx Plan Section 4, Task D
General roles:	Cx Plan 3.2; Specifications 01810
Specific responsibilities:	Cx Plan Section 4, Specifications 01810 and related sections

3.2 Commissioning Team Roles and Responsibilities

A list of the responsibilities and tasks for each party of the commissioning team is presented in Table 3-1. The member assigned as the leader for a given task is shown. The leader will coordinate the completion of the task. Under each task listing are subtasks with an "X" marked by the participating team members. Section 4 provides additional detail regarding scope of the tasks.

Table 3-1. Commissioning Roles and Responsibilities

Task	Commissioning Responsibilities and Tasks	Commissioning Authority	IEUA Project Manager	Architect	Design Engineers	General Contractor	Mechanical Contractor	Electrical Contractor
A	**Overall coordination of the Cx work** Lead-->	X						
	a. Develop and edit the Commissioning Plan	X						
	b. Plan and schedule meetings	X		X		X		
	c. Review and comment on the Commissioning Plan		X	X	X			
	d. Meeting Minutes					X		
	e. See that commissioning tasks are carried out	X		X		X		
B	**Develop Design Intent and Basis of Design** Lead-->			X				
	a. Provide design intent format and assistance (sample formatting included in Commissioning Plan)	X						
	b. Write Design Intent Document and Basis of Design.			X	X			
	c. Review and approve Design Intent and Basis of Design based on criteria in Commissioning Plan	X	X					
	d. Update Design Intent Document and provide an "As-built" copy at the end of construction	X						
C	**Design Development Review** Lead-->	X						
	a. Review the project documents near the end of Design Development and provide written comments	X						
	b. Incorporate review comments into the design			X	X			
D	**Develop Cx specifications for construction** Lead-->	X						
	a. Provide specification review, coordination, and support			X	X			
	b. Provide commissioning related specification language for Division 1, 13, 15, and 16	X						
	c. Integrate commissioning specifications into Divisions 1, 13, 15 & 16			X	X			
E	**Construction Documents Review** Lead-->	X						
	a. Review the construction documents near their completion (95% CDs) and provide written comments	X						
	b. Incorporate review comments into the design			X	X			

Table 3-1. Commissioning Roles and Responsibilities (continued)

Task	Commissioning Responsibilities and Tasks	Commissioning Authority	IEUA Project Manager	Architect	Design Engineers	General Contractor	Mechanical Contractor	Electrical Contractor
F	**Pre-Construction Meeting** Lead-->	X						
	a. Attend Pre-Construction Commissioning Meeting	X	X			X	X	X
	b. Review and comment on the Commissioning Plan at the Pre-Construction Meeting		X			X	X	X
	c. Meeting Minutes					X		
G	**Contractor Submittals of Commissioned Equipment** Lead-->					X		
	a. Provide submittal, operations & maintenance data according to the project specifications to CA					X	X	X
	b. Review selected submittals for commissioned systems	X						
	c. Re-submit equipment as necessary					X	X	X
H	**Start-up and Prefunctional Checklists (See Appendix 2 charts 1, 3, & 5)** Lead-->	X						
	a. Develop prefunctional checklists and plans	X					X	X
	b. Review and approve checklists			X	X	X	X	X
	c. Execute Checklists					X	X	X
I	**Functional Performance Testing (See Appendix 2 charts 2, 4, & 5)** Lead-->	X						
	a. Develop functional test procedures in accordance with the project specifications.	X						
	b. Review and approve test procedures.	X			X			
	c. Complete testing	X				X	X	X
J	**O&M Manuals & Operator Training** Lead-->					X		
	a. Develop O&M Manuals according to the project specifications					X	X	X
	b. Develop Commissioning Record and re-commissioning manual to be inserted into the O&M Manual	X						
	c. Review O&M manual for compliance with the project specifications and the *Commissioning Plan*	X	X	X				
	d. Re-submit O&M manual sections based on Commissioning review, as necessary.					X	X	X
K	**Warranty Period** Lead-->	X						
	a. Complete deferred testing according to the project specifications	X				X	X	X
	b. Complete a post-occupancy review of the commissioning systems	X						
L	**Final Commissioning Report** Lead-->	X						
	a. Complete Commissioning report	X						

4. Commissioning Scope of Work

The tasks listed in Section 3.2 comprise the commissioning process for this project. This section discusses each task in detail.

Task A. Overall Coordinating of the Commissioning Process

The commissioning authority (CA) will coordinate the commissioning activities as shown in Table 3-1. The beginning of the commissioning process consists of developing this Commissioning Plan. The CA meets with the design team to discuss the Commissioning Plan and get feedback from the design team. This Commissioning Plan will guide the commissioning process.

Other CA duties under Task A include monitoring the commissioning process, attending select design and construction meetings, planning and coordinating commissioning team meetings. The CA reports to the TG Construction Project Manager (Brian Schiltz), but may also provide information to the Owner.

Task B. Develop Design Intent and Basis of Design

Purpose and Scope

Specifically identifying and developing the design intent and basis of design provides each party involved an understanding of the building systems as well as the design goals for the project. This allows team members to perform their respective responsibilities regarding the design, construction and/or operation of the building. This project will include a Design Intent and Basis of Design (BOD) document. The Design Intent and Basis of Design differ from traditional drawings and specifications in that they provide a more narrative description of the various systems or issues and "frame" the issue or building component with clear and useful background information. The primary difference between these two documents is that the DID spells out what is required by the owner, and the BOD indicates how the designers will achieve these goals.

The sample Basis of Design format CTG provides for this information is in a narrative format.

Design Intent Document

The Design Intent is a dynamic document that provides the explanation of the ideas, development concepts and systems criteria that are considered important to the owner. This document is drafted from the programming phase submittals but will require gaining additional information from the Owner, Architect and Engineers. The Design Intent Document covers the following, for each system, major component, and/or area, as applicable:

- General area or system description
- Occupancy requirements
- Objectives and functional use of the area, system, or equipment
- Indoor environmental quality (IEQ): space temperature, relative humidity, indoor air quality, noise level, and illumination level

- Performance criteria: applicable codes and standards, general efficiency, energy goals, and tolerances of the IEQ objectives
- Budget considerations and limitations
- System restrictions and limitations

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 made in order to meet the Design Intent. The Basis of Design describes the systems, components, conditions and methods chosen to meet the intent. The Basis of Design narrative should include technical information about the project as well as specific design information about the systems and components in the design. The general project information in the Basis of Design includes the following:

- Primary load and design assumptions
- Diversity factors used in sizing equipment
- Occupant density and space function requirements
- Indoor conditions (by area): space temperature, relative humidity, lighting power density, ventilation rates, and infiltration rates, glazing fraction, glazing U-value & solar heat gain coefficient
- Outdoor weather conditions for seasons.
- General ventilation strategies required and methods of accomplishing (by area)
- General operating schedules, either provided by the owner or assumed by the design team
- Complete control system point list. Each point is described as an adjustable control point, a non-adjustable control point, or a monitoring point.
- Detailed Sequence of Operations

To compile this general information, the design team integrates assumptions from various disciplines. If this information is shown on other contract documents, it may be included in the Basis of Design by reference.

In addition, the Basis of Design provides specific design information for the commissioned systems. For example, the Basis of Design for a rooftop air conditioning unit includes:

- Areas served
- Interactions and interlocks with other systems
- Sizing assumptions and calculations
- Efficiency and energy performance including a description of equipment's capacity control features.
- Control type (Carrier DDC) including delineation of interfacing requirements between packaged controls and the building automation system (BAS)
- Special equipment maintenance requirements

- Complete sequences of operation for equipment and system as intended to be programmed into BAS or as it comes with packaged equipment.
- Description of how the sequences and equipment meet design goals included in the Design Intent Document. Include an explanation of why this component was chosen above others.

If this information is shown on other contract documents, it may be included in the Basis of Design by reference. See the next section and Appendix 2 for more information on developing the Basis of Design.

Design Intent and Basis of Design Development

As shown in Table 3-1, the architect has primary responsibility for and coordinates the creation of the Design Intent and the Basis of Design documents. The design team develops these documents and the CA assists the design team on an as-needed basis. The detail of both the Design Intent and Basis of Design increase as the design process progresses, as described in Table 4-2. The CA reviews the Design Intent and Basis of Design according to the criteria in the Commissioning Plan during the commissioning document reviews (Task C & Task D).

Table 4-2. Progression of Design Intent Document and Basis of Design

Stage	Timing	DID Issues Addressed	BOD Issues Addressed	Responsible Parties
Programming	SD	The owner's and tenant's needs are identified in detail.	None	Owner Architect
Schematic Design & Design Development	100 % DDs	The applicable parts of the programming report become the Design Intent Document and Design Intent clarified.	Basis of Design begun: overall system descriptions, objectives of systems, and general methods of achieving objectives	Owner Architect M/E/P Engineers
Construction Documents & Specification Development	100% CDs	Same as Schematic Design and Design Development above, but DID is updated if owner's requirements change.	Same as Schematic Design and Design Development above, but in more detail, including a complete Basis of Design.	Architect M/E/P Engineer
As-Built Documentation	Substantial Completion	Complete DID, clarifying any issues raised during construction.	Complete BOD, including adjusted sequences with final control parameters.	Contractors Building Operator Architect M/E/P Engineers CA

The architect and engineers draft the Design Intent Document and the Basis of Design. The documents are submitted by the architect with the 100% drawings and are reviewed by the CA in conjunction with Task C (see the schedule in Section 6 for more information). The design team incorporates the CA's review comments.

The architect then submits the updated Design Intent and Basis of Design document. The CA reviews this information in conjunction with Task D. The design team incorporates the CA's review comments.

The CA will update the Design Intent Document and Basis of Design during construction and provide a final as-built copy of the documents for inclusion in the O&M manuals at the end of construction.

Task C. Design Development Review

Near the end of Design Development, the CA provides a focused commissioning review of the design documents. The CA compares the design with the interests and needs of the Owner as identified in the Design Intent Document. The commissioning authority also identifies improvements that can be made on commissioned equipment in areas described in the table below. Though the commissioning authority may review this information, they are not *responsible* for design concept, design criteria or compliance with codes.

Table 4-3. CA Design Development Review

Design Area	Review Description
Commissioning facilitation	Input regarding making the building easier to commission
Energy Efficiency	General efficiency of building shell, building layout, HVAC system types, lighting system type, tenant standards and the like.
Operation and Maintenance (O&M)	How building O&M can be made easier (i.e. accessibility and system control)
Indoor Environmental Quality (IEQ)	How thermal, visual, or acoustical comfort can be improved
Functionality for Tenants	How the design can be changed to improve functionality for the occupants
Environmental Sustainability	How the building materials, systems and landscaping can create less of an impact on the environment - this is not the formal LEED review.
Life Cycle Costs	Qualitative assessment of options relative to energy efficiency, O&M, IEQ or functionality

This review is documented in writing. The CA will alert the commissioning team members that the document is available (see Section 2 for Cx team members). The team members respond to the comments in writing and incorporate the comments into their design, as necessary. The CA attends a design review meeting, if necessary.

Task D. Develop Commissioning Specifications for the 100% CDs

Purpose

The CA develops commissioning language for the project specifications. The commissioning specifications provide detail for the construction-phase commissioning work including specific contractor role. They provide the requirements and process for properly executing the commissioning work.

Specification Content

The commissioning specifications provide the construction team a clear description of the extent of the verification testing required, including the following:

- Commissioned components and systems (reference to *Cx Plan*, Section 1.2)
- Relationship between and requirements for Start-up Plan, Prefunctional Checklists, Functional Tests
- Contractors responsibilities for writing tests, executing tests, witnessing and signing-off on tests (reference to *Cx Plan*, Section 4)
- Examples of Prefunctional Checklists
- Scope of Functional Testing
- Operator training requirements
- Operations and Maintenance requirements

Coordination, Reporting and Review

The CA issues draft commissioning language, including a list of sections that the CA needs to review to develop recommended language. The design team reviews the specifications that apply to their systems and notifies the CA of changes.

Following the draft stage, the CA issues final commissioning language. These specifications include sections not submitted during 50% CDs as well as refinements to specifications based on updates in the project drawings. The design team members review the specifications that apply to their systems and notify the CA of changes. The design team includes the updated documents in the final specifications. Though the CA provides language for the commissioning specifications, the ultimate responsibility for their content and preparation lies with the A/E.

Task E. Construction Document Review

The CA reviews the full set of Construction Documents and specifications when approximately 90% complete. The CA compares the design with the interests and needs of the Owner as identified in the Design Intent Document. The CA also identifies improvements that can be made on commissioning equipment in areas described in Table 4-3.[2]

For the non-commissioning specifications and all the drawings, the commissioning authority issues written comment after receiving the documents. The architect provides a written response to the CA and Project Manager as to how the comments will be reflected in the final bid documents.

Table 4-4. CA Construction Document Review

Design Area	Review Description
Commissioning facilitation	Input regarding making the building easier to commission
Component energy efficiency	Review for adequacy of the efficiency of bldg. shell components, HVAC systems and lighting systems.
Control system & control strategies	Review HVAC and lighting strategies and sequences of operation for completeness and efficiency.
Operation and maintenance	Review for effects of specified systems and layout toward facilitating O&M (i.e. equipment accessibility, system control).
Indoor environmental quality	Review to verify that systems relating to thermal, visual, acoustical, and air distribution are in accordance with the design intent.
Facility performance & design intent	Identify flaws, oversights, or insufficient detail in the design, relevant to being able to reasonably meet the design intent
O&M documentation	Verify that building O&M documentation requirements specified are complete and adequate
Training	Verify that operator training requirements specified are adequate.
Commissioning specifications	Verify that the bid documents adequately specify building commissioning and that there are adequate monitoring and control points specified to facilitate commissioning and O&M (trending/graphing capabilities, test ports, control points, gages, thermometers and the like).
Review of engineering assumptions	Review the engineering assumptions relating to equipment sizing, energy efficiency decisions and HVAC cost-benefit calculations

[2] Though the CA may review the areas in Table 4-4, they are not *responsible* for design concept, design criteria, compliance with codes or other design related items belonging in the contract documents. The CA does not *verify* the designers' calculations or proof schematics or layouts in detail. For example, the CA 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 and so on.

Task F. Pre-Construction Meeting

The CA meets with the construction commissioning team prior to the beginning of construction (See Section 2). During the Pre-Construction Meeting, commissioning parties are introduced, the Commissioning process is reviewed, management and reporting lines are determined (see Table below), the flow of documents is discussed, and each party's responsibilities are outlined. The GC keeps notes from the meeting and distributes them to each team member.

Table 4-5. Construction Protocol

Issue	Protocol
For requests for information (RFI) or formal documentation requests:	The CA goes first through the GC Project Manager, then direct to Sub or A/E.
For minor or verbal information and clarifications:	The CA goes direct to the informed party.
For notifying contractors of deficiencies:	The CA documents deficiencies through the GC PM.
For scheduling functional tests:	The CA may provide input for and do some coordination of testing, but does not do any scheduling.
For scheduling commissioning meetings:	The CA selects the date and schedules through the GC PM.
For making a request for significant changes:	The CA has no authority to issue change orders.
For making small changes in specified sequences of operations:	The CA may suggest changes to the specified sequences with approval from the engineer of record.
Subcontractors disagreeing with requests or interpretations by the CA shall:	Try and resolve with the CA first. Then work through GC who will work with CA directly.

Task G. Contractor Submittals of Commissioned Equipment

The CA reviews and approves contractor submittals relative to commissioning issues expressed in the contract documents, not for general contract compliance (which is the A/E's responsibility). The CA receives the submittals at the same time as the design team and follows the same schedule for returning submittals. When the CA is concerned with a submittal, they will contact the design engineer or architect regarding that submittal. If the design team member agrees with the CA, the contractor will revise and/or re-submit based on commissioning review comments.

Task H. Start-up Plans and Prefunctional Checklists

Coordinated Start-up Plans and Prefunctional Checklists are important to ensure that the equipment and systems are installed and operational and that functional performance testing can proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout by the Contractor and is certified by the contractor's signature that the equipment is ready operational and ready for functional testing.

Start-up Plan

Each commissioned system (Section 1.2) has an associated Start-up Plan. The party responsible for developing the Start-up is identified during the pre-construction meeting. In general, the mechanical sub-contractor will develop the Division 15 Start-up Plans and the electrical contractor will develop the Division 16 Start-up Plans. The CA may assist these parties. Refer to Appendix 2, Chart 1 for a graphic description of how the prefunctional checklist and start-up plans are developed.

Start-up Plans are developed after submittals are approved. Descriptions of the Start-up Plan content are provided in Specification Section 01810, Part 3. Start-up Plans are to be submitted to the CA four weeks after commissioned equipment submittals are approved.

Execution of Checklists and Startup

The Sub-contractors begin using the Start-up Plans as soon as they have received the approved plans from the GC. Throughout the equipment installation work, the CA visits the site periodically to review construction of the commissioned systems. The CA schedules these visits through the GC and may request to meet with the mechanical and/or electrical foreman for an update on commissioning of the equipment.

Deficiencies and Non-Conformance

More information is available in Specifications Section 01810 Part 3.

Task I. Functional Performance Testing

Prior to functional testing, the CA writes the functional testing procedures and submits them to the contractors and design team for review. The contractors will execute the functional tests while the CA witnesses and documents the results.

Requirements for these tests are included in Specification Sections 01811 and 01812. To write the procedures, the CA requires detailed installation information, product data, control sequences, and set points. Contractor submittal requirements are included in Section 01300. See specification Section 01810, Part 3 for further functional testing requirements.

Task J. O&M Manuals & Operator Training

Standard O&M Manuals

The CA reviews the O&M manuals for commissioned systems and verifies they are in accordance with the project specifications. The CA also reviews each equipment warranty and verifies that requirements to keep the warranty valid are clearly stated. The CA recommends approval and acceptance of these sections of the O&M manuals to the GC.

After substantial completion, the CA reviews the As-built drawings. The CA verifies that deficiencies found during commissioning are reflected in the drawings; the CA does not certify that the drawings are accurate.

Commissioning Data

The CA compiles, organizes and indexes the commissioning data by commissioned system (Section 1.2). The Commissioning Data section will include:

- As-built Design Intent
- A copy of the as-built control drawings and sequences of operation
- Completed Functional Tests
- A list of items included for re-commissioning purposes.

Training of Owner Personnel

The trainers conducting the training sessions complete submit training outlines to the CA. The building operators, the owner, and the CA review the *Plan*; make comments; approve the outlines subject to the comments; and submit back to the Contractor. The Contractor provides the approved plan to the trainer to use during the training session(s). The trainer provides a copy of the plan to each trainee.

Re-commissioning Manual

After the completion of functional testing, the CA delivers a re-commissioning manual to the Owner and operating staff. This manual incorporates portions of the commissioning documents, portions of the normal O&M manuals and other documents not normally included in either. The contents of this manual include:

- As-built Design Intent Document, including brief descriptions of the commissioned systems
- Updated Sequences of Operation
- Updated Control drawings
- List of time-of-day schedules
- Description of energy- and water-saving features included in the building and guidelines for maintaining these features
- List of routine and seasonal operational procedures including re-evaluation of operation
- Recalibration recommendations
- List of user-adjustable Building Automation System parameters

- Continuous commissioning recommendations
- List of diagnostic tools to be used by facility staff
- Final Commissioning Report

Task K. Warranty Period

During the warranty period any deferred testing is completed, as required. The CA coordinates this activity. Tests are executed and deficiencies corrected by the appropriate Subs, witnessed by the CA. Final adjustments to the O&M manuals and as-built drawings due to the testing are made. In addition the CA will return to the project approximately 10 months into the warranty period. During this visit, the CA will review the current building operation and the condition of outstanding issues related to the original commissioning. The CA will make suggestions for improvements. The CA will identify areas that may come under warranty or under the original construction contract. The CA will also assist facility staff in developing reports and documents and requests for services to remedy outstanding problems.

Task L. Final Commissioning Report

The CA will provide a final commissioning report to the owner after completion the functional tests. This summary report will include a list of each commissioned feature or system and the CA's disposition regarding the feature or system's compliance with the contract documents in the following ways:

- Meeting Design Intent
- Meeting Specifications
- Proper Installation
- Functional Performance & Efficiency
- O&M Documentation
- Operation Training

In addition, the final report will include a written list of outstanding commissioning issues, deferred testing, a schedule for deferred testing, and a list of outstanding deficiencies related to environmental responsiveness.

5. Written Work Products

The written work products from parties are described in the table below. The table describes each product, general responsibilities and descriptions. The work products are generally listed in chronological order; see Section 4 & 6 for specific due dates.

Product	Created By	Product Description
Design Intent & Basis of Design	Design Team	Clarifies the Owner's project requirements and the design team's design assumptions
Other Design Phase deliverables	CA	Cx Plan, Cx Schedule design reviews, commissioning specifications
Pre-construction Meeting Minutes	GC	Minutes and notes of the meeting
Equipment submittals	Subs	Detailed data on all Commissioned equipment
Prefunctional checklists	Subs	Prefunctional checklists (see Appendix 2, Chart 1)
Start-up Plan	Subs	Specific listing of checklists to be completed. Combination of prefunctional checklists & Sub's startup and checkout.
Completed checklists and start-up	Subs	Filled out prefunctional checklists, tests, startup and initial checkout
Air balance report	TAB	TAB report in accordance with project specifications
Water balance reports	TAB	TAB report in accordance with project specifications
Change orders	GC	Change orders that affect commissioned equipment
Issues Log	CA	Record / track of all issues and deficiencies
Non-Compliance /Deficiency reports	CA	List of deficiencies and non-compliance with contract documents identified during commissioning
Functional test forms	CA	Full description of test procedures in "form" format
Completed functional test forms	CA	Recorded documentation of the test on the form
Functional test final approvals	CA	List of test number, and description, date of test, approval signatures of CA and A/E
O&M manuals (normal)	GC and Subs	Documentation of design, equipment, and O&M
As-built drawings (normal)	Subs	Documentation of as-built conditions
Training Plan	Owner PM, CA	Describes specific training topics requested. Clarifies training specification requirements but does not add to them.
Re-commissioning Manual	CA	Provides the owner with a plan for re-commissioning the building
Final Cx report	CA	Summary report with important findings, etc.

6. General Project Schedule

The initial commissioning schedule is summarized in the table below and assumes a Commissioning Meeting date of 10/02/02. Substantial Completion is assumed to be June 2003. This schedule is intended for overview purposes; it does not give every nuance of the commissioning process. This is the initial project schedule and subject to change.

Table 6-1. Commissioning Schedule

Associated Task	Activity	Start Date	End Date
B	Develop DID & BOD	05/03/02 through 06/15/03	
F	Commissioning meeting	10/02/02	
G	Submittals and O&M data obtained from subs	06/15/03	
H	Subs submits Start-up Plans for review	05/12/03	
H	Start-up Plans approved	05/26/03	
H	Cx team uses Start-up Plans. CTG construction site visits/inspections	06/02/03 through 06/27/03	
I	CTG requests O&M data	05/01/03	
I	CTG develops functional testing procedures	05/19/03 through 06/23/03	
I	Functional testing procedures approved	06/27/03	
H	Subs submit completed Start-up Plans to GC	06/23/03	
I	Conduct functional performance testing	06/30/03 through	
J	O&M manuals reviewed	07/11/03	
J	Operator training agendas approved	06/29/03	
J	Operator training conducted	07/01/03 through 07/31/03	
J / L	Commissioning documents completed: commissioning report, commissioning record, re-commissioning manual	09/01/03	
K	Complete Warranty Period testing and documentation, as necessary	07/01/04	

APPENDIX 1. Design Intent & Basis of Design Template

Electronic template available in Adobe Acrobat Format

APPENDIX 2: Flow Charts and Submittal Maps

Chart 1. Startup Plan Development

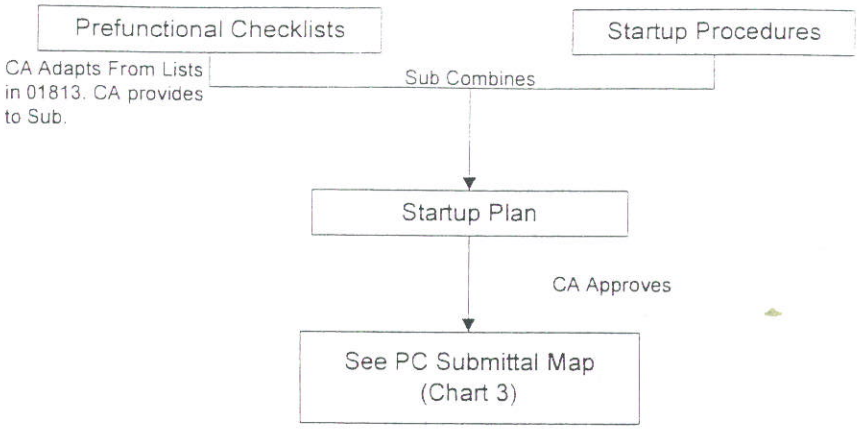

Chart 2. Functional Test Development