SUBMITTAL REGISTER

CONTRACT NO.
N40085-10-D-5301

TITLE AND LOCATION
MARSOC CULTURAL ASSIMILATION FACILITY

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 33 29	SD-01 Preconstruction Submittals															
			Preliminary Sustainability	1.5.3.1	G													
			Notebook															
			Preliminary High Performance	1.5.3.1														
			and Sustainable Building Checklist															
			SD-11 Closeout Submittals															
			Final Sustainability Notebook	1.5.3.1	G													
			Final High Performance and	1.5.3.1	G													
			Sustainable Building Checklist															
			Amended Final Sustainability	1.5.3.1	G													
			Notebook															
		01 91 00.00 40	SD-01 Preconstruction Submittals															
			Commissioning Plan	2.1.1	G													
			Commissioning Schedule	2.1.1	G													
			SD-06 Test Reports															
			Functional Performance Testing	3.2.5	G													
			Results															
			Seasonal Testing	3.1	G													
			Short-Term Diagnostic Testing	3.3	G													
			Deficiency Report and Resolution	3.1	G													
			Record															
			SD-10 Operation and Maintenance															
			Data															
			Operations and Maintenance	3.5	G													
			Manuals															
			Training Plan	3.5	G													

SUBMITTAL REGISTER

CONTRACT NO.
N40085-10-D-5301

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							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 91 00.00 40	Operations and Maintenance	3.5	G													
			Database															
			SD-11 Closeout Submittals															
			Final Commissioning Report	3.1	G													
			Warranty	3.1	G													
		22 08 00.00 22	SD-01 Preconstruction Submittals															
			Commissioning Plan	1.5	G													
			Prefunctional Checklists	1.5	G													
			Functional Performance Test	1.5	G													
			(FPT) procedures															
			Narrative descriptions	1.5	G													
			SD-06 Test Reports															
			Commissioning Report	1.5	G													
		23 08 00.00 22	SD-01 Preconstruction Submittals															
			Commissioning Plan	1.5	G													
			Prefunctional Checklists	1.5	G													
			Functional Performance Test	1.5	G													
			(FPT) procedures															
			Narrative descriptions	1.5	G													
			SD-06 Test Reports															
			Commissioning Report	1.5	G													
			Commissioning Report	1.5	G													
			Commissioning Plan	1.5														
			Prefunctional Checklists	1.5														
			Functional Performance Test	1.5														
			(FPT) procedures															

SUBMITTAL REGISTER

CONTRACT NO.
N40085-10-D-5301

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MARSOC CULTURAL ASSIMILATION FACILITY

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 08 00.00 22	narrative descriptions	1.5														
		26 08 10.00 22	SD-01 Preconstruction Submittals															
			Commissioning Plan	1.5	G													
			Prefunctional Checklists	1.5	G													
			Functional Performance Test	1.5	G													
			(FPT) procedures															
			Narrative descriptions	1.5	G													
			SD-06 Test Reports															
			Commissioning Report	1.5	G													

SECTION 01 33 29

SUSTAINABILITY REPORTING
02/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014; Errata 1-2 2015) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

ANSI/SMACNA 008	(2007) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition

U.S. DEPARTMENT OF ENERGY (DOE)

ISWG Guiding Principles	(2008) High Performance and Sustainable Buildings Guidance

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.2 SUMMARY

This specification includes general requirements and procedures for this project to be constructed and documented per the federally mandated "Guiding Principles" (GP), UFC 1-200-02, High Performance and Sustainable Building Requirements, and other requirements identified in this specification.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor QC approval. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to this section. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preliminary Sustainability Notebook; G

Preliminary High Performance and Sustainable Building Checklist

SD-11 Closeout Submittals

Final Sustainability Notebook; G

Final High Performance and Sustainable Building Checklist; G

Amended Final Sustainability Notebook; G

1.4 GUIDING PRINCIPLES VALIDATION (GPV)

Provide construction related sustainability documentation to verify achievement of ISWG Guiding Principles Validation (GPV). Provide the following for GPV:

a. Refer to Attachment 1, HPSB Checklist at the end of this specification section.

b. Obtain approval of any changes to the HPSB Checklist from the Contracting Officer at the Preconstruction Conference. Contracting Officer's approval establishes identified ISWG Guiding Principles Requirements as the project's sustainability goals.

   No variations or substitutions to the HPSB Checklist are allowed without written consent from the Contracting Officer. Immediately bring to the attention of the Contracting Officer any changes that impact meeting the approved ISWG Guiding Principles Requirements for this project and demonstrate that change will not incur additional construction cost or increase the life cycle cost.

c. Include all work required to incorporate the applicable ISWG Guiding Principles Requirements indicated on the HPSB Checklist and in this contract.

d. Include construction related documentation to maintain an up-to-date Sustainability Notebook. Supplement construction related documentation containing the following components;

   (1) HPSB Checklist

   (2) Sustainability Action Plan

   (3) Documentation illustrating Guiding Principle (GP) Requirements compliance

   (4) Commissioning Plan and Reports

1.4.1 Sustainability Action Plan

Include the following information in the Sustainability Action Plan:

a. Contractor's planned method to achieve each construction related GP requirement.

b. For each designated construction related ISWG Guiding Principles Requirements that is not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.

c. Name and contact information for: Contractor's POC responsible for ensuring sustainability goals are accomplished and documentation is assembled.

1.4.2 Costs

Contractor is responsible for all costs associated with constructing and demonstrating that project complies with approved ISWG Guiding Principles Requirements.

1.5 SUSTAINABILITY SUBMITTALS

Provide HPSB Checklist and other documentation in the Sustainability Notebook to indicate compliance with the sustainability requirements of the project.

1.5.1 High Performance Sustainable Building (HPSB) Checklist

Provide construction documentation that provides proof of and supports compliance with the completed HBSP Checklist.

1.5.1.1 HPSB Checklist Submittals

Submit updated HPSB Checklist with each Sustainability Notebook submittal. Attach final HPSB Checklist to DD1354 Real Property Record Submittal.

1.5.1.2 HPSB Checklist Public Access

Where not included as attachment to this specification section, use the following as HPSB Checklist for respective service branch. Where Internet address appears on two lines, copy full address into Internet browser.

a. Air Force - Air Force MILCON Sustainability Requirements Scoresheet, Attachment 3 of "AF Sustainable Design Development Implementing Guidance Memo" http://www.wbdg.org/ccb/browse_cat.php?c=265

b. Army - Energy & Sustainability Record Card http://wbdg.org/ccb/ARMYCOE/COEECB/ecb_2013_25.pdf

c. Navy - NAVFAC Sustainability & Energy Data Record Card/High Performance and Sustainable Building Checklist http://www.wbdg.org/pdfs/navfac_sustainable_energy_data_record_card.pdf

1.5.2 "S" Submittals for Sustainability Documentation

Submit the GPV sustainability documentation required in this specification as "S" submittals. Highlight GPV compliance data in "S" submittal.

1.5.3 SUSTAINABILITY NOTEBOOK

Provide and maintain a comprehensive Sustainability Notebook to document compliance with the sustainability requirements identified in the approved HPSB Checklist. Sustainability Notebook must contain all required data to support full compliance with the ISWG Guiding Principles Requirements. Sustainability Notebook is in the form of an Adobe PDF file; bookmarked at each ISWG Guiding Principles Requirement and sub-bookmarked at each document. Match format to ISWG Guiding Principles numbering system

indicated herein. Maintain up to date information, spreadsheets, templates, and other required documentation with each current submittal.

Contracting Officer may deduct from the monthly progress payment accordingly if Sustainability Notebook information is not current, until information is updated and on track per project goals.

1.5.3.1 Sustainability Notebook Submittal Schedule

Provide Sustainability Notebook Submittals at the following milestones of the project:

a. Preliminary Sustainability Notebook

Submit preliminary Sustainability Notebook for approval at the Pre-construction conference. Include Preliminary High Performance and Sustainable Building Checklist.

b. Construction Progress Meetings. Update GP documentation in the Sustainability Notebook for each meeting.

c. Final Sustainability Notebook

Submit updated Sustainability Notebook within 60 days after the Beneficial Occupancy Date (BOD). Final progress payment retainage may be held by Contracting Officer until final sustainability documentation is complete. Submit three (3) electronic copies of the Final Sustainability Notebook on DVDs to the Government. Include Final High Performance and Sustainable Building Checklist.

d. Amended Final Sustainability Notebook

Amend and resubmit the Final Sustainability Notebook to include commissioning, testing and balancing, and collection of performance requirements. Submit three (3) final electronic copies of the Amended Final Sustainability Notebook Submittal on DVDs to the Government no longer than 30 days after the GP, and Cx designated data collection period.

1.6 DOCUMENTATION REQUIREMENTS

Incorporate each of the following ISWG Guiding Principles Requirements into project construction; and provide documentation that proves compliance with each listed requirement. Items below are organized according to the ISWG Guiding Principles. For projects that require TPC, refer to Third Party Certifier's reference manuals for TPC requirements.

1.6.1 Commissioning

Work with the Commissioning Authority (CxA) to achieve requirements of the Commissioning plan and other contract document requirements at each stage of commissioning. Maintain up-to-date records of commissioning activities in the Sustainability Notebook, to include commissioning plan and summary commissioning report.

1.6.2 Energy Efficient Equipment

Provide only energy-using equipment that is Energy Star rated, or has the Federal Energy Management Program (FEMP) recommended efficiency. Where

Energy Star or FEMP recommendations have not been established, provide most efficient equipment available. Provide only energy using equipment that meets FEMP requirements for low standby power consumption. Energy efficient equipment can be found at: http://www1.eere.energy.gov/femp/ and http://www.energystar.gov/. Provide the following documentation:

Proof that equipment is labeled energy efficient and complies with the cited requirements.

1.6.3 Benchmarking

Provide report of initial actual energy performance with the energy design targets. Provide the following documentation:

Prefinal Performance Report with data collected from the first 60 days of operation of the facility after Beneficial Occupancy Date (BOD). Submit this information with the Final Sustainability Notebook Submittal.

1.6.4 Water Conserving Fixtures

Provide only water-consuming products that are EPA WaterSense labeled, or the most efficient water fixtures available when EPA Watersense products are not available. Provide the following documentation:

Proof that water fixtures are efficient and comply with the cited requirements.

1.6.5 Reduce Volatile Organic Compounds (VOC) (Low Emitting Materials)

Provide materials and products with low pollutant emissions, including composite wood products, adhesives, sealants, interior paints and finishes, carpet systems, and furnishings. Meeting the requirements of ASHRAE 189.1 Sections 8.4.2 (Prescriptive Option: Materials) or Section 8.5.2 (Performance Option: Materials) demonstrates compliance. Insulation products must meet the requirements of Section 8.5.2 (Performance Option: Materials). Provide the following documentation:

a. Demonstrate that materials do not exceed maximum VOC emissions of cited standards. VOC averaging is allowed where coatings are subject to human contact or harsh environmental conditions.

b. Demonstrate that flooring materials comply with VOC emissions of cited standards.

c. Demonstrate that composite wood and agrifiber products and associated laminating adhesives contain no added urea-formaldehyde.

d. Demonstrate that furniture and seating complies with low emissions requirements.

e. Create and maintain a list of above listed products used on the project within the building vapor barrier. Demonstrate how product meets cited standards.

1.6.6 Indoor Air Quality During Construction

Prior to construction, create indoor air quality plan. Implement IAQ plan during construction and flush building air before occupancy.

a. Construction submittal documentation required:

(1) For new construction and for renovation of unoccupied existing buildings, comply with ASHRAE 189.1 Section 10.3.1.4. (Indoor Air Quality (IAQ) Construction Management), with maximum outdoor air consistent with achieving relative humidity no greater than 60 percent. For renovation of occupied existing buildings, comply with ANSI/SMACNA 008 IAQ Guidelines for Occupied Buildings Under Construction.

(2) Provide required documentation showing that after construction ends and prior to occupancy, new HVAC filters were installed, and building air was flushed out in accordance with UFC 1-200-02.

1.6.7 Environmentally Preferred Products

Use products designated for Federal procurement to meet environmentally preferred requirements. Provide the following documentation:

Provide list of environmentally preferable products used on this project that meet the requirements of UFC 1-200-02.

1.6.8 Recycled Content

Provide materials on this project with aggregated total recycled content equal to or greater than 10 percent. In addition, comply with 40 CFR 247. Refer to for assistance identifying products cited in 40 CFR 247. Provide the following documentation:

a. Total amount of recycled content contained in building materials as a percentage of total cost of all building materials on the project (mechanical, electrical, and plumbing components, fire protection equipment and transportation are excluded).

b. Manufacturers documents stating the recycled content by material, or written justification for claiming one of the exceptions allowed under RCRA 6002.

c. Substitutions: Contractor may submit for Government approval, proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. For all such proposed substitutions, submit with the Sustainability Action Plan accompanied by product data demonstrating equivalence.

1.6.9 Bio-Based Products

Utilize products and material made from biobased materials to the maximum extent possible without jeopardizing the intended end use or detracting from the overall quality delivered to the end user. Use only supplies and materials of a type and quality that conform to applicable specifications and standards.

Biobased products that are designated for preferred procurement under the USDA BioPreferred Program must meet the required minimum biobased content. Refer to http://www.biopreferred.gov for the product categories and BioPreferred Catalog. Provide the following documentation:

a. For biobased products used on this project, provide biobased product

content percentage and biobased source of material. Indicate name of the manufacturer, cost of each product and the use of each product on this project.

b. For products that meet USDA Biopreferred Program, provide documentation of USDA Biopreferred label.

1.6.10 Waste Material Management (Recycling - Construction)

Divert construction debris from landfill disposal where markets or on-site recycling exists in accordance with Section 01 74 19 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT. Provide the following documentation:

a. Documentation showing total amount of construction debris diverted from landfill as a percentage of all construction debris on the project.

b. Include project's Construction Waste Management Plan and all dumpster haul tickets.

1.6.11 Ozone Depleting Substances

The use of CFC-based refrigerants in HVAC&R systems is prohibited. Eliminate the use of ozone depleting substances (CFC's, HCFCs, or Halons) during and after construction where alternative environmentally preferable products are available, taking into account lifecycle impacts. Meet the requirements of ASHRAE 189.1 Section 9.3.3 Refrigerants for no CFC-based refrigerants in heating ventilation, air conditioning and refrigeration systems (except for fire suppression system requirements, covered elsewhere in this specification). Provide the following documentation:

a. MSDS sheets for all refrigerants provided

b. Products that meet the criteria of U.S. EPA Significant New Alternatives Policy, available at http://www.epa.gov/ozone/snap/index.html.

1.6.12 Validation and Certification Restrictions

The Contractor's purchase of renewable energy certificates (RECs) specifically to meet project sustainability goals is prohibited.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 SUSTAINABILITY COORDINATION

3.1.1 Coordinating Sustainability Documentation Progress

Provide sustainability focus and coordination at the following meetings to achieve sustainability goals. Contractor's designated sustainability professional responsible for GP documentation must participate in the following meetings to coordinate documentation completion.

a. Pre-Construction Conference: Discuss the following: HPSB Checklist, Sustainability Action Plan, Construction submittal requirements and

schedule, individuals responsible for achieving each Guiding Principle Requirement.

b. Construction Progress Meetings: Review GP sustainability requirements with project team including contractor and sub-contractor representatives. Demonstrate GP documentation is being collected and updated to the Sustainability Notebook.

(1) Facility Turnover Meetings: Review Sustainability Notebook for completeness and identify any outstanding issues relating to final documentation requirements.

(2) Final Sustainability Notebook Review

-- End of Section --

NAVFAC SUSTAINABILITY AND ENERGY DATA --- *NEW CONSTRUCTION & MAJOR RENOVATION*

PROJECT INFORMATION

Work Order No.: 1386337 FY 15 MILCON P No. / Customer Reference No.: P1475
Project Title: MARSOC Cultural Assimilation Facility
Location/UIC: Marine Corps Base Camp Lejuene, North Carolina
NAVFAC Project Manager: Scott Littlefield Project Dollar Amount $: 1,741,686
Project Type: New Construction Project Design Level: Final
Facility Area: 11,240 U/M: SF Category Code: 171 Facility #:
AE Contract # & T.O. N40085-10-D-5301 AE Firm Sustainability Coordinator: Macklin Smith, AIA
AE Firm Name: HBA Architecture & Interior Design
Project Phase: ☑ Solicitation Documents Complete (Draft) ☐ Construction Complete (Final)
Construction Contract & T.O. TBD Award Date (P/A): BOD (P/A):
Construction Contractor: TBD
Contractor's Sustainability Coordinator: TBD

SUSTAINABILITY DATA - GUIDING PRINCIPLES for SUSTAINABLE NEW CONSTRUCTION and MAJOR RENOVATION

Use this form to collect design and as-constructed project information to be recorded on the Sustainable and Energy Tab in eProjects

Provide justification for each target missed:

On-site renewable energy not included due to severe budget constraints.

Sustainability Third Party Rating System: ☐ USGBC LEED ☐ GBI Green Globes ☑ Not Applicable ☐ Other

A Sustainability Certification Level - Target
☐ LEED Silver ☐ 2 Globes ☑ Other

Identify "Other" certification system and target level: Guiding Principles Validation (GPV)

B Sustainability Certification Level - Achieved
☐ LEED Certified ☐ LEED Silver ☐ LEED Gold ☐ LEED Platinum ☐ Not Met
☐ 1 Globe ☐ 2 Globes ☐ 3 Globes ☐ 4 Globes ☑ Other

Identify "Other" certification system and level achieved: GPV

I. Employ Integrated Design Principles
I.a Integrated Assessment, Operation, and Management ☑ Included ☐ Not Included
I.b Commissioning (Select one)
☑ Commissioning ☐ No Commissioning

Systems Commissioned: Plumbing, HVAC and Electrical

II. Optimize Energy Performance
II.a Energy Efficiency
i Energy Reduction 30% target 50.90
ii Efficiency Standard
☐ 90.1 - 2004 ☑ 90.1 - 2007 ☐ 90.1 - 2010
a. Total Design Energy Use Intensity (EUI): kBTU/Sq Ft/Year 54
iii New Technology: Provide description: LED lighting, VAV controls, Energy recovery

II.b On-Site Renewable Energy
i. Solar Hot Water 30% target 0.00
ii. Renewable energy technology types (select all that apply)
☐ Daylighting ☐ Ground Source Heat Pumps ☐ Solar Photovoltaic
☐ Geothermal ☐ Mechanical (i.e., direct water pumping) ☐ Solar Thermal -domestic hot water
☐ Wind ☐ Solar Thermal -space conditioning
iii. Sustainable Roof Attribute (Select all that apply)
☑ Cool - white ☐ Cool - reflective ☐ Solar PV ☐ Solar Thermal ☐ Vegetated
II.c Building-level Metering (Measurement) ☑ Included ☐ Not Included

III. Protect and Conserve Water
III.a Indoor Water
i Reduce potable water 49.30
ii Building-level Metering (Measurement) ☑ Included ☐ Not Included
a. Total Design Indoor Water Use Intensity (WUI): Gallons/Sq Ft/Year 8

III.b Outdoor Water
i Reduce landscape water ☐ 50% below conventional ☑ 100% ☐ Not Met

IV. Enhance Indoor Environmental Quality
IV.a Ventilation and Thermal Comfort
i Thermal Environmental Conditions ☑ Met ☐ Not Met
ii Ventilation ☑ Met ☐ Not Met
IV.b Moisture Control Plan ☑ Included ☐ Not Included
IV.c Daylighting
i Minimum Daylight ☑ Met ☐ Not Met
ii Automatic dimming controls ☑ Included ☐ Not Included
IV.d Low-Emitting Materials ☑ Met ☐ Not Met

NAVFAC SUSTAINABILITY AND ENERGY DATA --- *NEW CONSTRUCTION & MAJOR RENOVATION*

IV.e Protect Indoor Air Quality during Construction ☑ Met ☐ Not Met

V. Reduce Environmental Impact of Materials

V.a Recycled Content: www.epa/gov/cpg ☑ Met ☐ Not Met

V.b Biobased Products ☑ Met ☐ Not Met

V.c Waste and Materials Management

i. Waste Diversion (50% targett) 0%

ii. Waste Management ☑ Included ☐ Not Included

V.d Ozone Depleting Compounds ☑ Met ☐ Not Met

To maintain prior project sustainability information, print and upload a copy of the completed worksheet to the Notes tab as Design & Criteria note BEFORE updating the tab.

GUIDANCE ON CALCULATION FOR EUI & WUI

1 The EUI must be calculated as the total Design Energy Consumption per year (including savings from renewables) divided by the total Building Area (including unconditioned indoor space).

a. The total Design Energy Consumption can be found in the Energy Cost Budget (ECB) Compliance Report. The Design Energy Consumption is in the Energy Summary by End Use Table at the bottom of page 2 of the ECB Report. The value is listed as Total Including Solar for the Proposed Building. It is the first field on the bottom row. (Units in the ECB Report are 10^6 Btu/yr, so multiply by 1000 to yield kBtu/yr

b. The total Building Area (including unconditioned indoor spaces) can be found in the Energy Cost Budget (ECB) Compliance Report in the Space Summary Table on page 1 of the ECB Report. The value is listed as Total (area) including Conditioned area and Unconditioned area. Insure the units are in square feet

2 The WUI must be calculated as the total Design Indoor Potable Water Consumption per year divided by the total Building Area (including unconditioned space).

a. The total Design Water Consumption can be found in the LEED WE P1 water consumption calculation *or* Green Globes 3.4.1.1 Water Consumption calculation. The value is the Design Case – Annual Potable Water Consumption. It is listed in units of Gallons/year

b. The total Building Area (including unconditioned spaces) can be found in the Energy Cost Budget (ECB) Compliance Report in the Space Summary Table on page 1 of the ECB Report. The value is listed as Total (area) including Conditioned area and Unconditioned area. Insure the units are in square feet

01 91 00.00 40

COMMISSIONING
11/12

PART 1 GENERAL

The requirements of this Section apply to, and are a component part of, each section of the specifications.

This Section includes:

a. Building commissioning of the following systems:

(1) HVAC components and equipment

(2) HVAC system: interaction of cooling, heating, and comfort delivery systems

(3) Building Automation System (BAS): control hardware and software, sequence of operations, and integration of factory controls with BAS

(4) Lighting Control System and interface with daylighting

(5) Domestic hot water systems

(6) Renewable energy generation systems

b. Building commissioning activities and documentation in support of the Guiding Principles Validation requirements. Refer to Section 01 33 29 SUSTAINABILITY REPORTING.

The Government, Green Consultant, Architect/Engineer, or Commissioning Agent are not responsible for construction means, methods, job safety, or management function related to commissioning on the job site.

The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

The following Sections are an integral part of this project Commissioning:

a. Section 01 30 00 ADMINISTRATIVE REQUIREMENTS

b. Section 01 45 00.00 40 QUALITY CONTROL

c. Section 01 57 19.00 20 TEMPORARY ENVIRONMENTAL CONTROLS

d. Section 01 78 23 OPERATION AND MAINTENANCE DATA

e. Section 22 00 00 PLUMBING, GENERAL PURPOSE

f. Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

g. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS

h. Section 22 08 00.00 22 COMMISSIONING OF PLUMBING SYSTEMS

i. Section 23 08 00.00 22 COMMISSIONING OF HVAC SYSTEMS

j. Section 26 08 10.00 22 COMMISSIONING OF ELECTRICAL SYSTEMS

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D6245	(2012) Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation
ASTM D6345	(2010) Selection of Methods for Active, Integrative Sampling of Volatile Organic Compounds in Air

1.2 DEFINITIONS

a. 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 Project Requirements. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the Project Requirements may be included.

b. Commissioning - Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the requirements. Commissioning during the construction, acceptance, and warranty phases intends to achieve the following specific objectives:

(1) Verify and document that equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and the Contract Documents.

(2) Verify and document that equipment and systems receive complete operational checkout by the installing contractors.

(3) Verify and document equipment and system performance.

(4) Verify the completeness of Operations and Maintenance materials.

(5) Ensure that the operating personnel are adequately trained on the operation and maintenance of the building equipment.

c. Commissioning Agent - develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after pre-functional checklists and startup are complete.

d. Commissioning Plan - an overall plan that provides the structure, schedule and coordination planning for the commissioning process.

e. Deficiency - a condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly, or is not complying with the Project Requirements.

f. Project Requirements - a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the Government. It is initially the outcome of the programming and conceptual design phases.

g. Functional Performance Test - test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word.

h. Manual Test - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

i. Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.

j. Pre-functional Checklist - a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Commissioning Agent to the contractor. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word "pre-functional" refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's start-up checklist.

k. Seasonal Performance Tests - Functional Performance Test that are deferred until the system(s) will experience conditions closer to their design conditions.

l. Warranty Period - warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.3 ADMINISTRATIVE REQUIREMENTS

Perform commissioning services for the system. Expedite the testing process and minimize unnecessary delays, while not compromising the

integrity of the procedures. The commissioning requires cooperation of the Contractor, subcontractors, vendors, Architect/Engineer, Commissioning Agent, Green Consultant, and Contracting Officer.

1.3.1 Co-ordination

The Government will provide a Commissioning Agent for overall co-ordination and management of the commissioning program. The commissioning team comprises the following groups:

a. Contractors Project Manger and Test Engineer

b. Sub-contractor for the system being commissioned

c. Commissioning Agents Project Manager and Project Engineers

d. Contracting Officers Representative

e. Green Consultant

f. Architect/Engineer and Specialty Consultant

Coordinate with IAQ baseline evaluation in conformance with ASTM D6245, and ASTM D6345.

1.3.2 Progress Meetings

Plan and co-ordinate meetings as required to monitor construction and commissioning progress the work. Notify the Contracting Officer of construction job-site meetings to address co-ordination, deficiency resolution and planning issues.

1.3.3 Functional Testing Co-ordination

Do **not** "temporarily" start equipment for commissioning. Do not conduct functional performance testing until a pre-functional, start-up and TAB is completed for a given system. Do not functionally test the controls system and equipment it controls until all points have been calibrated and the pre-functional checklists are completed.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Commissioning Plan; G

Commissioning Schedule; G

SD-06 Test Reports

Functional Performance Testing Results; G

Seasonal Testing; G

Short-Term Diagnostic Testing; G

Deficiency Report and Resolution Record; G

SD-10 Operation and Maintenance Data

Operations and Maintenance Manuals; G

Training Plan; G

Operations and Maintenance Database; G

SD-11 Closeout Submittals

Final Commissioning Report; G

Warranty; G

1.5 QUALITY CONTROL

The Commissioning Agent will be provided by the Government.

1.6 DESIGN REVIEW AND DOCUMENTATION

Review construction documents to verify that commissioning is adequately specified, that each commissioned system can be commissioned and is likely to meet the Project Requirements.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Ensure instrumentation used for testing meets the following standards:

a. Sufficient quality and accuracy to test and measure system performance within the tolerances required to determine adequate performance.

b. Calibrated on the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument being used.

c. Maintained in good repair and operating condition throughout the duration of use on this project.

Provide all standard testing equipment required for performing startup and initial checkout and required functional performance testing for the system. Datalogging equipment or software required to test equipment will be provided by the Commissioning Agent, and not become the property of the Government.

2.1.1 Commissioning Plan

Develop a commissioning plan to identify how commissioning activities will be integrated into general construction and trade activities. The commissioning plan identifies how commissioning responsibilities are distributed. The intent of this plan is to evoke questions, expose issues, and resolve them with input from the entire commissioning team

early in construction.

The Plan identifies who is responsible for producing the various procedures, reports, forms, and notifications. It will include the commissioning schedule and describe the test/acceptance procedure.

2.2 START-UP/PRE-FUNCTIONAL CHECKLISTS

Coordinate start-up plans and documentation formats, including pre-functional checklists to be completed during the startup process. Manufacturer's start-up checklists and other technical documentation guidelines can be used as the basis for pre-functional checklists.

PART 3 EXECUTION

3.1 COMMISSIONING PROCESS

The Commissioning Agent coordinates all activities. The following activities outline the commissioning tasks and the general order in which they occur.

a. Design Review and documentation consisting of:

   (1) Documentation of Basis of Design and Project Requirements

   (2) Design Development Review

   (3) Construction Document Review

b. Commissioning Scoping Meeting

c. Commissioning Plan

d. Submittals Review

e. Start-Up/Pre-Functional Checklists

f. Functional Performance Testing

g. Short-Term Diagnostic Testing

h. Deficiency Report and Resolution Record

i. Operations and Maintenance Training

j. Record Documents Review

k. Final Commissioning Report Documentation

l. Deferred testing due to unforeseen deferred tests, seasonal testing or end of Warranty review.

3.2 FUNCTIONAL PERFORMANCE TESTING

Fully describe system test procedures identifying configuration and steps required for each test. Provide appropriate documents so that another party can repeat the tests with virtually identical results.

Submit documentation to the Contracting Officer verifying conformance with

the following standards:

3.2.1 Functional Performance Test Procedures

Develop functional performance test procedures for equipment and systems. Identify specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Coordinate test procedures with the contractor for feasibility, safety, equipment and warranty protection.

Include the following information on the functional performance test forms:

a. System and equipment or component name(s)

b. Equipment location and ID number

c. Date

d. Project name

e. Participating parties

e. Instructions for setting up the test, including special cautions, alarm limits, etc.

f. Specific step-by-step procedures to execute the test

g. Acceptance criteria of proper performance with a Yes / No check box

h. Comment section

3.2.2 Test Methods

Methods for functional performance testing and verification include direct manipulation of system inputs (i.e. heating or cooling sensors), manipulation of system inputs with the building automation system (i.e. software override of sensor inputs), trend logs of system inputs and outputs using the building automation system, or short-term monitoring of system inputs and outputs using stand alone data loggers. The Commissioning Agent determines which method, or combination of methods, is most appropriate.

3.2.3 Setup

Perform each test procedure under conditions that simulate normal operating conditions as closely as possible. Where equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met, have functional performance test procedures demonstrate the actual performance of safety shutoffs in a real or closely-simulated conditions of failure.

3.2.4 Sampling

The Commissioning Agent develops a sampling strategy when multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested. If, after three test attempts at testing the specified sample percentage, failures are still present, then test all remaining units at the contractors' expense.

3.2.5 Functional Performance Testing Results

Coordinate, observe and record the results of the functional performance testing. Coordinate retesting as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.

3.3 SHORT-TERM DIAGNOSTIC TESTING

After initial occupancy, perform short-term diagnostic testing, using the building automation system to record system operation over a three week period.

Investigate the dynamic interactions between components in the building system. Evaluate the scheduling, the interaction between heating and cooling, and the effectiveness of the HVAC system in meeting the comfort requirements.

3.4 DEFICIENCY REPORT AND RESOLUTION RECORD

Document items of non-compliance in materials, installation or operation.

3.4.1 Non-Conformance

Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies.

Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Agent. In such cases document the deficiency and resolution on the procedure form.

3.4.1.1 Identified Deficiencies Correction Procedure

If there is no dispute on the deficiency and the responsibility to correct it:

a. The Commissioning Agent documents the deficiency and the adjustments or alterations required to correct it. The Contractor corrects the deficiency and notifies the Commissioning Agent that the equipment is ready to be retested.

b. The Commissioning Agent reschedules the test and the test is repeated.

If there is a dispute about a deficiency or who is responsible:

a. The deficiency is documented on the non-compliance form and a copy given to the Green Consultant.

b. Resolutions are made at the lowest management level possible. Additional parties are brought into the discussions as needed. Contractor has responsibility for resolving construction deficiencies. If a design revision is deemed necessary and approved by the Contracting Officer, the Architect/Engineer has responsibility for providing a design revision.

c. The Commissioning Agent documents the resolution process.

d. Once the interpretation and resolution have been decided, the

appropriate party corrects the deficiency and notifies the Commissioning Agent that the equipment is ready to be retested. The Commissioning Agent reschedules the test and the test is repeated until satisfactory performance is achieved.

The Contractor is responsible for retesting costs.

3.5 OPERATIONS AND MAINTENANCE TRAINING

Provide complete operations and maintenance manuals, a training plan and an operations and maintenance database.

Coordinate and review with the Contracting Officers' representative the training program for O&M personnel.

Develop the database from the O&M manual containing the information required to start a preventative maintenance program.

Provide additional materials as necessary to stress and enhance the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation.

3.6 FINAL COMMISSIONING REPORT DOCUMENTATION

Compile and submit a Final Commissioning Report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process.

3.7 DEFERRED TESTING

3.7.1 Unforeseen Deferred Tests

If a test cannot be completed due to the building structure, required occupancy condition, or other deficiency, the functional testing may be delayed upon recommendation of the Commissioning Agent and the approval of the Contracting Officer. Conduct these tests in the same manner as the seasonal tests as soon as possible.

3.7.2 Deferred Tests

Schedule, coordinate, observe, and document additional testing for seasonal variation in operations and control strategies during the opposite season to verify performance of the HVAC system and controls. Complete testing during the warranty period to fully test all sequences of operation.

3.7.3 End-of-Warranty Review

Conduct end of warranty review prior to the end of the warranty period. Review the current building operation with the facility maintenance staff. Include in the review all outstanding issues from original or seasonal testing. Interview facility staff to identify concerns with building operation. Provide suggestions for improvements and assist Contracting Officer in developing reports or documentation to remedy problems.

Update O&M manuals and Record Documents as necessary due to the testing.

3.8 EQUIPMENT AND SYSTEM SCHEDULE

Commission the following equipment in this project.

System	Equipment	Check
HVAC System	Chillers	
	Pumps	
	Cooling Tower	
	Variable frequency drives	
	Air Handlers	
	Packaged AC units	
	Terminal units	
	Unit heaters	
	Heat exchangers	
	Fume hoods	
	Lab room pressures	
	Exhaust fans	
	Supply fans	
Lighting Controls	Sweep or scheduled lighting controls	
	Day light dimming controls	
	Lighting occupancy sensors	
BAS System		
Domestic Hot Water		

System	Equipment	Check

-- End of Section --

SECTION 22 08 00.00 22

COMMISSIONING OF PLUMBING SYSTEMS
09/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline (2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard (2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition

1.2 SUMMARY

The requirements of this section apply to all sections of Division 22. Refer to Division 1 Section 01 91 00.00 40 COMMISSIONING for general commissioning requirements applicable to the entire project.

This Section includes Commissioning process requirements for plumbing systems, assemblies, components and equipment to ensure that the work has been completed as specified and that systems are functioning in the manner as described herein, and as specified in the system operating criteria for this project.

a. Commissioning will commence according to the approved construction schedule, after plumbing system rough-in, and after the preliminary inspection punchlist items and commissioning deficiencies are completed by the Contractor and his subcontractors.

b. Construction phase commissioning process shall include the following:

   1. Step One: Installation Verification

   2. Step Two: System Startup

   3. Step Three: Functional Performance Testing

The plumbing commissioning process includes the following tasks:

a. Testing and startup of plumbing equipment and systems.

b. Plumbing equipment and system verification checks.

c. Assistance in functional performance testing to verify equipment and system performance.

d. Provide qualified personnel to assist in commissioning tests, including seasonal testing.

e. Complete and endorse construction phase checklists provided by Commissioning Authority (CxA) to assure equipment and systems are fully operational and ready for functional performance testing.

f. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process and to fulfill contract and warranty requirements.

g. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.

h. Provide assistance to CxA to develop, edit, and document system operation descriptions.

i. Provide training for systems specified in this Section, coordinated with the CxA.

The commissioning process will also be used to develop test protocol and record the associated test data in an effort to advance the building plumbing systems from a state of substantial completion to a full dynamic operation.

The commissioning process is also intended to assist the Government's operating and maintenance staff in the training and familiarization with new plumbing systems and equipment. The Commissioning Plan and final Commissioning Report should also serve as tools to reduce post-occupancy critical systems operational difficulty or failure. Operational staff training is essential to the commission process and will run concurrently with Steps One through Three referenced above.

The commissioning required by this section is intended to supplement the inspection, testing, and training requirements contained in the technical sections and to consolidate the reports required by those sections. Duplication of the inspection, testing and training required by the technical sections is not required. This section does include additional commissioning requirements.

1.3 DEFINITIONS

Refer to Division 1 Section 01 91 00.00
40 COMMISSIONING, Article "Definitions" for definintions applicable to this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Commissioning Plan; G
Prefunctional Checklists; G
Functional Performance Test (FPT) procedures; G

Narrative descriptions of the design intent for each of the systems identified; G

SD-06 Test Reports

Commissioning Report; G

1.5 COMMISSIONING SUBMITTAL REQUIREMENTS

Commissioning Authority (CxA) shall prepare Commissioning Plan, Prefunctional Checklists, Functional Performance Test (FPT) procedures, narrative descriptions of the design intent for each of the systems identified, and the Commissioning Report, and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Government for review and approval.

a. Contractor shall provide CxA with documentation required for Commissioning Work. At minimum, documentation shall include: detailed start-up procedures, full sequences of operation, Operating and Maintenance data and performance data, control drawings, and details of Government-contracted tests.

b. Contractor shall submit to CxA the manufacturers' installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

c. Contractor shall review and approve other relative documentation for impact on FPT's of the systems:

1. Verify manufacturer's installation instructions are followed by completing the Prefunctional checklists for all plumbing equipment.

2. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT's.

3. Completed equipment Start-up certification forms along with the manufacturer's field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's. Government may require that system one-line diagrams and applicable Specification Section(s) be attached to the FPT documentation.

4. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

1.6 SYSTEMS TO BE COMMISSIONED

The following systems shall be commissioned as part of this project:

a. Domestic Hot Water Systems: Domestic water heaters, and controls.

1.7 COMMISSIONING RESPONSIBILITIES

1.7.1 Plumbing Installer Commissioning Responsibilities

a. Attend commissioning meetings.

b. Provide instructions and demonstrations for Government personnel.

c. Ensure subcontractors perform assigned commissioning responsibilities as specified herein.

d. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications and/or the commissioning plan.

e. Develop startup and initial checkout plan using manufacturer's startup procedures and prefunctional (construction) checklists for equipment and systems to be commissioned.

f. During verification check and startup process, execute Plumbing related portions of checklists for equipment and systems to be commissioned.

g. Perform and document completed installation checklists, startup checklists and reports, and system operational checkout procedures, providing copy to CxA.

h. Where specified in the technical sections, provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.

i. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.

j. Provide personnel to assist CxA during equipment or system verification checks and functional performance tests.

k. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.

l. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.

m. Provide factory supervised startup services for equipment and systems where specified. Coordinate work with manufacturer and CxA.

n. Perform verification checks and startup on equipment and systems as specified.

o. Assist CxA in performing functional performance tests on equipment and systems as specified.

p. Perform operation and maintenance training sessions scheduled by contractor in accordance with the Commissioning Plan.

q. Conduct Plumbing system orientation and inspection.

1.8 SEQUENCING AND SCHEDULING

Begin the work described in this Section only after all work required in related Sections has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Pre-Functional (Construction) Checklists shall be performed for the installation of plumbing equipment, at appropriate times during the construction phase of the Contract.

PART 2 PRODUCTS

2.1 GENERAL

All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

B. All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable, and shall be in accordance with the requirements of the NEBB Commissioning Standard or the ACG Commissioning Guideline. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

PART 3 EXECUTION

3.1 GENERAL

The Contractor and his Subcontractors shall be responsible for performing procedures presented in the specifications, and as indicated on the contract drawings and as detailed in the Functional Performance Tests (FPT) procedures. Members of the designated Commissioning Team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Government and the Commissioning Authority (CxA).

Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor and his Subcontractors.

The Contractor shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints,

calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 COMMISSIONING PLAN

The commissioning plan shall be developed by the CxA and submitted to the Government for approval. The approved commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

3.3 CONSTRUCTION CHECKLIST

A. A checklist shall be developed by the CxA for each component of commissioned equipment and systems to ensure that the specified equipment has been provided, is properly installed, and has been initially started and checked out adequately in preparation for full operation and functional testing (e.g., belt tension, fluids topped, labels affixed, gages in place, sensors calibrated, voltage balanced, rotation correct, etc.).

B. The CxA for this project shall develop 'Prefunctional (Construction) Checklists' for this project, which shall be reviewed and approved by the Government; and then provided to, and completed by the Contractor and his sub-contractors to ensure that all equipment and systems are installed properly; have been started up preliminarily, and are reading for commissioning and performance verification testing.

3.4 FUNCTIONAL PERFORMANCE TEST (FPT) PROCEDURES

The FPT procedures at a minimum shall consist of the following sections:

a. Narrative Description: Provide a narrative description of the design intent of each of the plumbing systems to be tested, their intended modes and sequences of operation.

b. Testing Prerequisites: Provide verification and documentation that primary mechanical, electrical, and controls systems that support or interact with the system that the FPT has been prepared for are completed, tested and operational.

c. Installation Verification: Provide verification that the system installation is completed and is ready for commissioning.

d. Commencement of Functional Performance Testing: Record the date and time of the start of system commissioning.

e. System Condition Prior to Starting Performance Testing: Record the current set points and parameters of the system at the start of commissioning.

f. Functional Performance Test: This section shall provide the following:

    1. Sequential steps required to set parameters and conditions required to test components and functions throughout intended ranges of operation.

    2. Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems,

systems and interfaces between systems function in accordance with the contract documents and design intents.

3. All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

g. End of Functional Performance Test: Record the date and time of the completion of system commissioning. Include the items in the final commissioning report.

h. Field Notes: Provide a copy of the notes and remarks made and documented during system commissioning.

i. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.

j. List problems discovered during Commissioning that were corrected.

k. List problems discovered during Commissioning that were not corrected.

l. List recommended party that should take action on these 'uncorrected' problems.

The CxA for this project shall develop 'Functional Performance Test' (FPT) procedures for this project, which shall be reviewed and approved by the Government; and then provided to, and completed by the Contractor and his sub-contractors, under the supervision of the CxA, to ensure that all equipment and systems are installed properly; have been started up preliminarily, and are reading for commissioning and performance verification testing.

3.5 OPERATIONAL AND MAINTENANCE STAFF TRAINING

System narrative descriptions will be prepared by the CxA and supported by flow diagrams, one line diagrams, and appropriate specification sections for major systems to be commissioned. The CxA will coordinate "system description" meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

The Contractor, his sub-contractors and associated manufacturer's representatives shall provide the required training to the Government's operational staff after the system description meetings have occurred. These Contractor training sessions for Government personnel shall provide a more detailed analogy of systems operation and maintenance.

3.6 DOCUMENTATION

The Contractor and his installing subcontractors shall be responsible for collection of pertinent data during system installation, inspection and checkout; during system start-up; and during functional performance testing. The Contractor and his subcontractors shall submit to the CxA documentation of all construction inspections, startup procedures and results, as well as any tests performed prior to and after system start-up. Documentation shall also include the equipment manufacturer's start-up procedures as reviewed and approved by Commissioning Team,

including startup reports for equipment and systems conducted by a factory-certified technician or engineer, as specified in the Division 22 Sections for this project.

Provide a title sheet for each section and list the following:

a. Section Title and Specification Section Name and Number requiring this submittal.

b. Project name, project number, and address.

c. Contractor and subcontractor names, addresses, and phone numbers.

d. Name, title, signature, and date of person making the submittal.

e. Table of Contents for each Section.

f. Name of Command, a blank line for signature, and the name and title of person accepting the submittal, and the date accepted by signature.

g. Name, address, and phone number of CxA. Include a blank line for signature; and date of person accepting the submittal.

Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order.

3.6.1 STEP ONE - INSTALLATION VERIFICATION

General Commissioning Responsibilities:

a. Before system start-up begins, the Commissioning Team shall conduct a final installation verification audit. The Contractor and his subcontractors shall be responsible for completion of work including change orders and punch list items to the Government's satisfaction. The audit shall include, but not be limited to, checking of:

    1. Piping specialties including balance, control, and isolation valves.

    2. Control sensor types and location.

    3. Identification of piping, valves, equipment, controls, etc.

    4. Major equipment, pumps, valves, starters, gauges, thermometers, etc.

    5. Documentation of prestart-up tests performed, including manufacturer's factory tests.

b. If work is found to be incomplete, incorrect, or non-functional, the Contractor and his subcontractors shall correct the deficiencies before system start-up work proceeds.

3.6.2 STEP TWO - SYSTEM START-UP

General Commissioning Responsibilities: A start-up plan shall be developed and submitted to the Government by the Contractor and his installing subcontractors, for approval. Start-up plan shall include the

following:

a. Flushing and cleaning of pipe.

b. Check and replace filters, strainers, and screens, as required.

c. Review control valve min-max, and operating positions.

d. Electrical startup procedures and tests for equipment.

e. Completion of required piping pressure tests.

f. Verification of completion of equipment operating controls, including safeties and interlocks.

g. Verify that copies of manufacturer's factory tests are available. Verify that manufacturer's startup tests and reports are complete and that all recommendations by the startup engineer have been addressed and completed.

The start-up plan will be reviewed and approved by the Government. After approval is complete, a prestart-up inspection shall be performed by the CxA, and by designated members of the Commissioning Team. The Contractor and his installing subcontractors shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed.

a. Designated members of the Commissioning Team shall witness system start-ups and list system and equipment deficiencies noted during start-up. The Contractor and his subcontractors shall take corrective action on system deficiencies noted and shall demonstrate satisfactory and suitable system operation to the CxA and to the Commissioning Team.

b. Designated systems requiring test and balance work shall have this activity commence after systems have successfully completed start-up. System and equipment deficiencies observed during this activity shall be noted and corrected.

3.6.3 STEP THREE - FUNCTIONAL PERFORMANCE TESTING

General Commissioning Responsibilities:

a. Functional Performance Testing begins after operational testing, adjusting, and balancing of the systems have been completed by the Contractor and his subcontractors. Ideally, the Commissioning training for Government operators and maintenance personnel, including the description of the systems, as well as the hands-on training sessions will also have been completed.

b. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.

c. To attain this objective the CxA will develop individual systems testing protocols which, when implemented by the Contractor/subcontractors will allow the Commissioning Team to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over

a range of load and functional levels.

d. Functional Performance tests for the systems to be commissioned will be defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

-- End of Section --

SECTION 23 08 00.00 22

COMMISSIONING OF HVAC SYSTEMS
09/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline	(2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard	(2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition

1.2 SUMMARY

The requirements of this section apply to all sections of Division 23. Refer to Division 1 Section 01 91 00.00 40COMMISSIONING for general commissioning requirements applicable to the entire project.

This Section includes Commissioning process requirements for HVAC&R systems, assemblies, components and equipment to ensure that the work has been completed as specified and that systems are functioning in the manner as described herein, and as specified in the system operating criteria for this project.

a. Commissioning will commence according to the approved construction schedule, after the completion of the HVAC test, balance and adjust (TAB) report, and after the preliminary inspection punchlist items and commissioning deficiencies are completed by the Contractor and his subcontractors.

b. Construction phase commissioning process shall include the following:

   1. Step One: Installation Verification

   2. Step Two: System Startup

   3. Step Three: Functional Performance Testing

The HVAC commissioning process includes the following tasks:

a. Testing and startup of HVAC equipment and systems.

b. HVAC equipment and system verification checks.

c. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.

d. Provide qualified personnel to assist in commissioning tests, including seasonal testing.

e. Complete and endorse construction phase checklists provided by Commissioning Authority (CxA) to assure equipment and systems are fully operational and ready for functional performance testing.

f. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process and to fulfill contract and warranty requirements.

g. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.

h. Provide assistance to CxA to develop, edit, and document system operation descriptions.

i. Provide training for systems specified in this Section, coordinated with the CxA.

The commissioning process will also be used to develop test protocol and record the associated test data in an effort to advance the building HVAC systems from a state of substantial completion to a full dynamic operation.

The commissioning process is also intended to assist the Government's operating and maintenance staff in the training and familiarization with new HVAC systems and equipment. The Commissioning Plan and final Commissioning Report should also serve as tools to reduce post-occupancy critical systems operational difficulty or failure. Operational staff training is essential to the commission process and will run concurrently with Steps One through Three referenced above.

The commissioning required by this section is intended to supplement the inspection, testing, and training requirements contained in the technical sections and to consolidate the reports required by those sections. Duplication of the inspection, testing and training required by the technical sections is not required. This section does include additional commissioning requirements.

1.3 DEFINITIONS

Refer to Division 1 Section 01 91 00.00 40 COMMISSIONING, Article "Definitions" for defininitions applicable to this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Commissioning Plan; G
Prefunctional Checklists; G
Functional Performance Test (FPT) procedures; G
Narrative descriptions of the design intent for each of the systems identified; G

SD-06 Test Reports

Commissioning Report; G

Commissioning Authority (CxA) shall prepare Commissioning Plan, Prefunctional Checklists, Functional Performance Test (FPT) procedures, narrative descriptions of the design intent for each of the systems identified, and the Commissioning Report, and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Government for review and approval.

a. Contractor shall provide CxA with documentation required for Commissioning Work. At minimum, documentation shall include: detailed start-up procedures, full sequences of operation, Operating and Maintenance data and performance data, control drawings, and details of Government-contracted tests.

b. Contractor shall submit to CxA the manufacturers' installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

c. Contractor shall review and approve other relative documentation for impact on FPT's of the systems:

1. Verify manufacturer's installation instructions are followed by completing the prefunctional checklists for all HVAC equipment.

2. Draft Test, Adjust and Balance (TAB) Reports: Review and provide comments to Government.

3. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT's.

4. Completed equipment Start-up certification forms along with the manufacturer's field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's. Government may require that system one-line diagrams and applicable Specification Section(s) be attached to the FPT documentation.

5. Final TAB Reports: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's.

6. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

1.5 COMMISSIONING SUBMITTAL REQUIREMENTS

Commissioning Authority (CxA) shall prepare Commissioning Plan,

Prefunctional Checklists, Functional Performance Test (FPT) procedures, narrative descriptions of the design intent for each of the systems identified, and the Commissioning Report, and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Government for review and approval.

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6. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

1.6 SYSTEMS TO BE COMMISSIONED

The following systems shall be commissioned as part of this project:

a. Air Handling Systems: Fans, motors, variable speed drives, cooling coils and control valves, heating coils and control valves, filters, dampers, safeties such as smoke detectors or freezestats and damper end switches, controls, gages, and vibration isolation.

b. Dehumidification Systems, piping systems, pumps, ductwork systems, packaged DX roof top equipment, split-system DX air conditioning equipment and heat pumps, self-contained air conditioning units, fan-coil units, heat exchangers, computer room air conditioning (CRAC) units, constant and variable volume air terminals, fire dampers and smoke dampers, indoor air quality, equipment sound control (if noted), equipment vibration control (if noted), DDC controls, and test, adjust and balance (TAB) work.

c. Energy Recovery Devices: Enthalpy wheels, fans, motors, variable speed drives, cooling coils and control valves, heating coils and control valves, filters, dampers, safeties, controls, gages, and vibration isolation.

d. Heating Hot Water Generation and Distribution Systems: Boilers, controls, instrumentation and gages, flues, heating water pumps and motors, variable speed drives, mixing valves.

e. Exhaust Fans: Fan, motor, variable speed drives, controls and safeties.

f. Direct Digital Control Systems (DDC), Building Automation Systems (BAS), Energy Control and Management Systems (EMCS), Utility Management and Control Systems (UMCS): BACnet or similar Local Area Network (LAN), Operator Work Station hardware/software, building controller hardware/software, terminal unit controller hardware/software, all sequences of operation, system accuracy and response time, point-to-point verification.

g. Room/Building Pressurization Systems: Pressure sensors, terminal units/dampers, and controls and alarms.

1.7 COMMISSIONING RESPONSIBILITIES

1.7.1 HVAC Equipment/System Installer Commissioning Responsibilities

a. Attend commissioning meetings.

b. Ensure temperature controls installer performs assigned commissioning responsibilities as specified herein.

c. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified herein.

d. Provide instructions and demonstrations for Government personnel.

e. Ensure subcontractors perform assigned commissioning responsibilities.

f. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications and/or the commissioning plan.

g. Develop startup and initial checkout plan using manufacturer's startup procedures and prefunctional (construction) checklists for equipment and systems to be commissioned.

h. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.

i. Perform and document completed installation checklists, startup

checklists and reports. and system operational checkout procedures, providing copy to CxA.

j. Where specified in the technical sections, provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.

k. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.

l. Provide personnel to assist CxA during equipment or system verification checks and functional performance tests.

m. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.

n. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.

o. Provide factory supervised startup services for equipment and systems where specified. Coordinate work with manufacturer and CxA.

p. Perform verification checks and startup on equipment and systems as specified.

q. Assist CxA in performing functional performance tests on equipment and systems as specified.

r. Perform operation and maintenance training sessions scheduled by Contractor in accordance with the commissioning plan.

s. Conduct HVAC system orientation and inspection.

1.7.2 HVAC Temperature Controls Installer Commissioning Responsibilities:

a. Attend commissioning meetings.

b. Review design for ability of systems to be controlled including the following:

1. Confirm proper hardware requirements exists to perform functional performance testing.

2. Confirm proper safeties and interlocks are included in design.

3. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.

4. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.

5. Confirm sensors selected are within device ranges.

6. Review sequences of operation and obtain clarification from Architect/Engineer.

7. Indicate delineation of control between packaged controls and building automation system (BAS), listing BAS monitor points and BAS adjustable control points.

8. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.

c. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.

d. Submit proposed procedures for performing automatic temperature control system point-to-point checks to CxA and Architect/Engineer.

e. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.

f. Perform training sessions to instruct Government's operations and maintenance personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan.

g. Demonstrate system performance and operation to CxA during functional performance tests including each mode of operation.

h. Provide control system technician to assist during CxA verification check and functional performance testing.

i. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.

j. Assist in performing operation and maintenance training sessions scheduled by the Contractor.

1.7.3 Testing, Adjusting, and Balancing (TAB) Agency Commissioning Responsibilities:

a. Attend commissioning meetings.

b. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample (percent) of measurements contained in testing, adjusting, and balancing report as indicated in commissioning plan.

c. Assist in performing operation and maintenance training sessions scheduled by the Contractor.

1.8 SEQUENCING AND SCHEDULING

Begin the work described in this Section only after all work required in related Sections has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Pre-Functional (Construction)

Checklists shall be performed for the installation of mechanical equipment, at appropriate times during the construction phase of the Contract.

PART 2 PRODUCTS

2.1 GENERAL

All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

B. All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable, and shall be in accordance with the requirements of the NEBB Commissioning Standard or the ACG Commissioning Guideline. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

PART 3 EXECUTION

3.1 GENERAL

The Contractor and his Subcontractors shall be responsible for performing procedures presented in the specifications, and as indicated on the contract drawings and as detailed in the Functional Performance Tests (FPT) procedures. Members of the designated Commissioning Team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Government and the Commissioning Authority (CxA).

Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor and his Subcontractors.

The Contractor shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 COMMISSIONING PLAN

The commissioning plan shall be developed by the CxA and submitted to the Government for approval. The approved commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

3.3 CONSTRUCTION CHECKLIST

A. A checklist shall be developed by the CxA for each component of commissioned equipment and systems to ensure that the specified equipment has been provided, is properly installed, and has been initially started and checked out adequately in preparation for full operation and functional testing (e.g., belt tension, fluids topped, labels affixed, gages in place, sensors calibrated, voltage balanced, rotation correct, etc.).

B. The CxA for this project shall develop 'Prefunctional (Construction) Checklists' for this project, which shall be reviewed and approved by the Government; and then provided to, and completed by the Contractor and his sub-contractors (HVAC, Controls, TAB, etc.) to ensure that all equipment and systems are installed properly; have been started up preliminarily, and are reading for commissioning and performance verification testing.

3.4 FUNCTIONAL PERFORMANCE TEST (FPT) PROCEDURES

The FPT procedures at a minimum shall consist of the following sections:

a. Narrative Description: Provide a narrative description of the design intent of each of the HVAC systems to be tested, their intended modes and sequences of operation.

b. Testing Prerequisites: Provide verification and documentation that primary mechanical, electrical, and controls systems that support or interact with the system that the FPT has been prepared for are completed, tested and operational.

c. Installation Verification: Provide verification that the system installation is completed and is ready for commissioning.

d. Commencement of Functional Performance Testing: Record the date and time of the start of system commissioning.

e. System Condition Prior to Starting Performance Testing: Record the current set points and parameters of the system at the start of commissioning.

f. Functional Performance Test: This section shall provide the following:

    1. Sequential steps required to set parameters and conditions required to test components and functions throughout intended ranges of operation.

    2. Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.

    3. All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

g. End of Functional Performance Test: Record the date and time of the completion of system commissioning.

h. Field Notes: Provide a copy of the notes and remarks made and documented during system commissioning. Include these items in the final commissioning report.

i. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.

j. List problems discovered during Commissioning that were corrected.

k. List problems discovered during Commissioning that were not corrected.

l. List recommended party that should take action on these 'uncorrected' problems.

The CxA for this project shall develop 'Functional Performance Test' (FPT) procedures for this project, which shall be reviewed and approved by the Government; and then provided to, and completed by the Contractor and his sub-contractors (HVAC, Controls, TAB, etc.), under the supervision of the CxA, to ensure that all equipment and systems are installed properly; have been started up preliminarily, and are reading for commissioning and performance verification testing.

3.5 OPERATIONAL AND MAINTENANCE STAFF TRAINING

System narrative descriptions will be prepared by the CxA and supported by flow diagrams, one line diagrams, and appropriate specification sections for major systems to be commissioned. The CxA will coordinate "system description" meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

The Contractor, his sub-contractors and associated manufacturer's representatives shall provide the required training to the Government's operational staff after the system description meetings have occurred. These Contractor training sessions for Government personnel shall provide a more detailed analogy of systems operation and maintenance.

3.6 DOCUMENTATION

The Contractor and his installing subcontractors shall be responsible for collection of pertinent data during system installation, inspection and checkout; during system start-up; and during functional performance testing. The Contractor and his subcontractors shall submit to the CxA documentation of all construction inspections, startup procedures and results, as well as any tests performed prior to and after system start-up. Documentation shall also include the equipment manufacturer's start-up procedures as reviewed and approved by Commissioning Team, including startup reports for equipment and systems conducted by a factory-certified technician or engineer, as specified in the Division 23 Sections for this project.

Provide a title sheet for each section and list the following:

a. Section Title and Specification Section Name and Number requiring this submittal.

b. Project name, project number, and address.

c. Contractor and subcontractor names, addresses, and phone numbers.

d. Name, title, signature, and date of person making the submittal.

e. Table of Contents for each Section.

f. Name of Command, a blank line for signature, and the name and title of person accepting the submittal, and the date accepted by signature.

g. Name, address, and phone number of CxA. Include a blank line for signature; and date of person accepting the submittal.

Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order.

3.6.1 STEP ONE - INSTALLATION VERIFICATION

General Commissioning Responsibilities:

a. Before system start-up begins, the Commissioning Team shall conduct a final installation verification audit. The Contractor and his subcontractors shall be responsible for completion of work including change orders and punch list items to the Government's satisfaction. The audit shall include, but not be limited to, checking of:

    1. Piping specialties including balance, control, and isolation valves.

    2. Ductwork specialty items including turning devices, balance, fire, smoke, control dampers, and access doors.

    3. Control sensor types and location.

    4. Identification of piping, valves, equipment, controls, etc.

    5. Major equipment, pumps, valves, starters, gauges, thermometers, etc.

    6. Documentation of prestart-up tests performed, including manufacturer's factory tests.

b. If work is found to be incomplete, incorrect, or non-functional, the Contractor and his subcontractors shall correct the deficiencies before system start-up work proceeds.

3.6.2 STEP TWO - SYSTEM START-UP

General Commissioning Responsibilities: A start-up plan shall be developed and submitted to the Government by the Contractor and his installing subcontractors, for approval. Start-up plan shall include the following:

a. Flushing and cleaning of pipe. Cleaning of interior of ductwork and air handling units.

b. Check and replace filters, strainers, and screens, as required.

c. Review control valve/damper min-max, and operating positions.

d. Electrical startup procedures and tests for equipment.

e. Completion of required pressure tests for piping and ductwork.

f. Verification of completion of equipment operating controls, including safeties and interlocks.

g. Verify that chemical treatment systems are as specified, and are operational.

h. Verify that copies of manufacturer's factory tests are available. Verify that manufacturer's startup tests and reports are complete and that all recommendations by the startup engineer have been addressed and completed.

The start-up plan will be reviewed and approved by the Government. After approval is complete, a prestart-up inspection shall be performed by the CxA, and by designated members of the Commissioning Team. The Contractor and his installing subcontractors shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed.

a. Designated members of the Commissioning Team shall witness system start-ups and list system and equipment deficiencies noted during start-up. The Contractor and his subcontractors shall take corrective action on system deficiencies noted and shall demonstrate satisfactory and suitable system operation to the CxA and to the Commissioning Team.

b. Designated systems requiring test and balance work shall have this activity commence after systems have successfully completed start-up. System and equipment deficiencies observed during this activity shall be noted and corrected.

3.6.3 STEP THREE - FUNCTIONAL PERFORMANCE TESTING

General Commissioning Responsibilities:

a. Functional Performance Testing begins after operational testing, adjusting, and balancing of the systems have been completed by the Contractor and his subcontractors. Ideally, the Commissioning training for Government operators and maintenance personnel, including the description of the systems, as well as the hands-on training sessions will also have been completed.

b. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.

c. To attain this objective the CxA will develop individual systems testing protocols which, when implemented by the Contractor/subcontractors will allow the Commissioning Team to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over a range of load and functional levels.

d. Functional Performance tests for the systems to be commissioned will

be defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

-- End of Section --

SECTION 26 08 10.00 22

COMMISSIONING OF ELECTRICAL SYSTEMS
09/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline	(2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard	(2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/NEIS 90	(2009) Standard for Commissioning Building Electrical Systems

1.2 SUMMARY

1.2.1 General

The requirements of this section apply to all sections of Division 26. Refer to Section 01 91 00.00 40 COMMISSIONING for general commissioning requirements applicable to the entire project.

The purpose of this Section is to define Contractor responsibilities in the commissioning process, which are being directed by the Government. Additional electrical system testing is required under some Division 27, and 33 Specification Sections. NECA/NEIS 90 provides additional guidance for the commissioning of electrical systems.

This Section includes Commissioning process requirements for electrical systems, assemblies, components and equipment, and requires the participation of the Contractor, to ensure that the work has been completed as specified and that systems are functioning in the manner consistent with the Contract Documents as described herein, and as specified in the system operating criteria for this project.

a. Commissioning will commence according to the approved construction schedule, after electrical system rough-in, and after the preliminary inspection punchlist items and commissioning deficiencies are

completed by the Contractor.

b. Construction phase commissioning process shall include the following:

1. Step One: Installation Verification.

2. Step Two: System Startup.

3. Step Three: Functional Performance Testing.

The electrical commissioning process includes the following tasks:

a. Testing and startup of electrical equipment and systems.

b. Electrical equipment and system verification checks.

c. Assistance in functional performance testing to verify equipment and system performance.

d. Provide qualified personnel to assist in commissioning tests, including seasonal testing.

e. Complete and endorse construction phase checklists provided by Commissioning Authority (CxA) to assure equipment and systems are fully operational and ready for functional performance testing.

f. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process and to fulfill contract and warranty requirements.

g. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.

h. Provide assistance to CxA to develop, edit, and document system operation descriptions.

i. Provide training for systems specified in this Section, coordinated with the CxA.

The commissioning process will also be used to develop test protocol and record the associated test data in an effort to advance the building electrical systems from a state of substantial completion to a full dynamic operation.

The commissioning process is also intended to assist the Government's operating and maintenance staff in the training and familiarization with new electrical systems and equipment. The Commissioning Plan and final Commissioning Report should also serve as tools to reduce post-occupancy critical systems operational difficulty or failure. Operational staff training is essential to the commissioning process and will run concurrently with Steps One through Three referenced above.

The commissioning required by this section is intended to supplement the inspection, testing, and training requirements contained in the technical sections and to consolidate the reports required by those sections. Duplication of the inspection, testing and training required by the technical sections is not required. This section does include additional commissioning requirements.

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Functional Performance Test (FPT) procedures; G
Narrative descriptions of the design intent for each of the systems identified; G

SD-06 Test Reports

Commissioning Report; G

1.5 COMMISSIONING SUBMITTAL REQUIREMENTS

Commissioning Authority (CxA) shall prepare Commissioning Plan, Prefunctional Checklists, Functional Performance Test (FPT) procedures, narrative descriptions of the design intent for each of the systems identified, and the Commissioning Report, and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Government for review and approval.

a. Contractor shall provide CxA with documentation required for Commissioning Work. At minimum, documentation shall include: detailed start-up procedures, full sequences of operation, Operating and Maintenance data and performance data, control drawings, and details of Government-contracted tests.

b. Contractor shall submit to CxA the manufacturers' installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

c. Contractor shall review and approve other relative documentation for impact on FPT's of the systems:

1. Verify manufacturer's installation instructions are followed by completing the prefunctional checklists for all electrical equipment.

2. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT's.

3. Completed equipment Start-up certification forms along with the manufacturer's field or factory performance and Start-up test

documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's. Government may require that system one-line diagrams and applicable Specification Section(s) be attached to the FPT documentation.

4. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

1.6 SYSTEMS TO BE COMMISSIONED

1.6.1 Electrical (Divisions 26 and 33)

The following systems shall be commissioned as part of this project. Comply with the requirements of Section 26 08 00 APPARATUS INSPECTION AND TESTING as applicable.

a. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1. Distribution and Branch Circuit Panelboards.

2. Normal Power Distribution Systems: Building grounding system tests, coordination study review, major circuit breaker settings, meters and gages, receptacles, switches, and controls, etc.

b. Section 26 51 00 INTERIOR LIGHTING.

1. Lighting Fixtures and Controls: Occupancy sensors, and architectural dimming control system hardware/software/scene settings/zone settings/occupancy sensor interface/unoccupied cycle control.

c. Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

d. Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

1.7 COMMISSIONING RESPONSIBILITIES

1.7.1 Electrical Installer Commissioning Responsibilities

a. Attend commissioning meetings, preinstallation meetings and other project meetings scheduled to facilitate the commissioning process.

b. Provide manufacturer's data sheets and shop drawings for equipment to be commissioned. Provide instructions and demonstrations for Government personnel. Provide additional requested documentation to the CxA for the development of Prefunctional Checklists and Functional Performance Test procedures.

c. Ensure subcontractors perform assigned commissioning responsibilities as specified herein.

d. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual

equipment specifications and/or the Commissioning Plan.

e. Develop startup and initial checkout plan using manufacturer's startup procedures and prefunctional (construction) checklists for equipment and systems to be commissioned.

f. During verification check and startup process, execute electrical related portions of checklists for equipment and systems to be commissioned.

g. Perform and document completed installation checklists, startup checklists and reports, and system operational checkout procedures, providing copy to CxA.

h. Where specified in the technical sections, provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.

i. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.

j. Provide personnel to assist CxA during equipment or system verification checks and functional performance tests.

k. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.

l. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.

m. Provide factory supervised startup services for equipment and systems where specified. Coordinate work with manufacturer and CxA.

n. Perform verification checks and startup on equipment and systems as specified.

o. Assist CxA in performing functional performance tests on equipment and systems as specified.

p. Assist in performing operation and maintenance training sessions scheduled by the Contractor.

q. Conduct electrical system orientation and inspection.

1.7.2 Electrical Testing Agency (ETA) Commissioning Responsibilities:

When requested by Government, Contractor shall retain an independent Electrical Testing Agency (ETA) for the purpose of checking and testing of the electrical power distribution equipment per National Electrical Testing Association (NETA). Commissioning responsibiliteis shall include:

a. Attend commissioning meetings.

b. Obtain all required manufacturer's data to facilitate tests.

c. Provide assistance to the CxA in the completion of the specific prefunctional checklists and functional performance test procedures. Generally, ETA shall provide their standard forms to document the NETA tests to be incorporated into the Prefunctional Checklist and Functional Performance Tests record.

d. During related tests, execute and document the tests in the approved forms and/or test record.

e. Perform and clearly document all completed Start-up and system operational checkout procedures, providing a copy to the Contractor.

f. Clearly indicate any deficiencies identified during testing and add to an action list for resolution and tracking. The field technicians shall keep a running log of events and issues. Submit reports of discrepancies, deficient or uncompleted work by others, Contract interpretation requests and lists of completed tests to the Contractor at least twice a week and provide technical assistance in the resolution of deficiencies.

g. Provide skilled technicians to execute testing. Ensure that they are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

1.8 SEQUENCING AND SCHEDULING

Begin the work described in this Section only after all work required in related Sections has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Pre-functional (construction) checklists shall be performed for the installation of electrical equipment at appropriate times during the construction phase of the Contract.

PART 2 PRODUCTS

2.1 GENERAL

All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 TEST EQUIPMENT

Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable, and shall be in accordance with the requirements of the NEBB Commissioning Standard or the ACG Commissioning Guideline.

Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall be responsible for performing procedures presented in the specifications, and as indicated on the contract drawings and as detailed in the Functional Performance Tests (FPT) procedures. Members of the designated Commissioning Team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Government and the Commissioning Authority (CxA).

Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor.

The Contractor shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 COMMISSIONING PLAN

The commissioning plan shall be developed by the CxA and submitted to the Government for approval. The approved commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

3.3 CONSTRUCTION CHECKLIST

A checklist shall be developed by the CxA for each component of commissioned equipment and systems to ensure that the specified equipment has been provided, is properly installed, and has been initially started and checked out adequately in preparation for full operation and functional testing (e.g., belt tension, fluids topped, labels affixed, gages in place, sensors calibrated, voltage balanced, rotation correct, etc.).

The CxA for this project shall develop 'Construction Checklists' for this project, which shall be reviewed and approved by the Government; and then provided to, and completed by the Contractor to ensure that all equipment and systems are installed properly; have been started up preliminarily, and are ready for commissioning and performance verification testing.

3.4 FUNCTIONAL PERFORMANCE TEST (FPT) PROCEDURES

The FPT procedures at a minimum shall consist of the following sections:

a. Narrative Description: Provide a narrative description of the design intent of each of the electrical systems to be tested, their intended modes and sequences of operation.

b. Testing Prerequisites: Provide verification and documentation that primary systems that support or interact with the system that the FPT has been prepared for are completed, tested and operational.

c. Installation Verification: Provide verification that the system installation is completed and is ready for commissioning.

d. Commencement of Functional Performance Testing: Record the date and time of the start of system commissioning.

e. System Condition Prior to Staring Performance Testing: Record the current set points and parameters of the system at the start of commissioning.

f. Functional Performance Test: This section shall provide the following:

1. Sequential steps required to set parameters and conditions required to test components and functions throughout intended ranges of operation.

2. Full range of checks and tests carried out to determine if connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.

3. All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

g. End of Functional Performance Test: Record the date and time of the completion of system commissioning.

h. Field Notes: Provide a copy of the notes and remarks made and documented during system commissioning.

i. List systems modifications, not required by the Contract Documents, but provided by the Contractor. List other questions regarding such system modifications.

j. List problems discovered during Commissioning that were corrected.

k. List problems discovered during Commissioning that were not corrected.

l. List recommended party that should take action on these 'uncorrected' problems.

The CxA for this project shall develop 'Functional Performance Test' (FPT) procedures for this project, which shall be reviewed and approved by the Government; and then provided to, and completed by the Contractor under the supervision of the CxA, to ensure that all equipment and systems are installed properly; have been started up preliminarily, and are ready for commissioning and performance verification testing.

3.5 OPERATIONAL AND MAINTENANCE STAFF TRAINING

System narrative descriptions will be prepared by the CxA and supported by flow diagrams, one line diagrams, and appropriate specification sections for major systems to be commissioned. The CxA will coordinate "system

description" meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

The Contractor and associated manufacturer's representatives shall provide the required training to the Government's operational staff after the system description meetings have occurred. These Contractor training sessions for Government personnel shall provide a more detailed analogy of systems operation and maintenance. Coordinate this training with that required in the technical specification sections.

3.6 DOCUMENTATION

The Contractor shall be responsible for collection of pertinent data during system installation, inspection and checkout; during system start-up; and during functional performance testing. The Contractor shall submit to the CxA documentation of all construction inspections, startup procedures and results, as well as any tests performed prior to and after system start-up. Documentation shall also include the equipment manufacturer's start-up procedures as reviewed and approved by Commissioning Team, including startup reports for equipment and systems conducted by a factory-certified technician or engineer, as specified in the Division 26, 27, and 33 Sections for this project.

Provide a title sheet for each section and list the following:

a. Section Title and Specification Section Name and Number requiring this submittal.

b. Project name, project number, and address.

c. Contractor and subcontractor names, addresses, and phone numbers.

d. Name, title, signature, and date of person making the submittal.

e. Table of Contents for each Section.

f. Name of Command, a blank line for signature, and the name and title of person accepting the submittal, and the date accepted by signature.

g. Name, address, and phone number of CxA. Include a blank line for signature; and date of person accepting the submittal.

Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order.

3.6.1 STEP ONE - INSTALLATION VERIFICATION

General Commissioning Responsibilities:

a. Before system start-up begins, the Commissioning Team shall conduct a final installation verification audit. The Contractor shall be responsible for completion of work including change orders and punch list items to the Government's satisfaction. The audit shall include, but not be limited to, checking of:

    1. Provide documentation of all prestart-up tests performed,

including manufacturer's factory tests.

2. Verify integrated performance of all components, including control system components and all interlocks and interactions with other equipment and systems.

3. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.

4. All safety trips shall require a manual reset to allow a system restart.

5. Verify shut down and restart capabilities both for scheduled and unscheduled events (e.g. power failure recovery and normal scheduled start/stop).

6. Verify time of day schedules and setpoints.

7. Verify all energy saving control strategies.

8. Verify that monitoring system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.

9. Verify operator control of all commandable control system points including proper security level access.

b. If work is found to be incomplete, incorrect, or non-functional, the Contractor shall correct the deficiencies before system start-up work proceeds.

3.6.2 STEP TWO - SYSTEM START-UP

General Commissioning Responsibilities: With the assistance of the CxA, a start-up plan shall be developed by the Contractor. The start-up plan shall include all electrical equipment. The Contractor shall submit the equipment start-up plan to the Government for approval. Start-up plan shall include the following:

a. The CxA shall review the respective prefunctional checklists to provide guidance and comments for the startup plans.

b. The CxA shall obtain from the Contractor the equipment manufacturer's installation, startup and checkout data, including actual field checkout/startup sheets used by the equipment manufacturer's startup technicians.

c. The CxA shall copy all pages of the equipment manufacturer's installation instructions and startup manuals with important instructional data and procedures from the startup and checkout manuals not covered elsewhere in the manufacturer's equipment installation and checkout sheets.

d. The pages referenced above, along with the respective startup data from the prefunctional checklist provided by the CxA, and the manufacturer's equipment installation checkout sheets become the basis for the equipment "Startup and Checkout Plan" for each individual piece of equipment, developed by the Contractor.

e. For systems that may not have adequate manufacturer startup and checkout procedures, particularly for components being integrated with other equipment, the Contractor shall provide the added necessary detail and documentation to the CxA for information and review, prior to execution.

f. The CxA shall review the individual equipment "Startup and Checkout Plans", compile this information into a "full Startup and Checkout Plan", and then transmit same to the Contractor. The Contractor will designate which trade or subcontractor is responsible to fill out each line item on the prefunctional (construction) checklists from the CxA, and support the startup and checkout of each piece of equipment. The Contractor shall then transmit the full start-up plan to the Subcontractors for their review and use.

3.6.2.1 Grounding Systems

a. Provide grounding system tests as required in the technical specification sections.

3.6.2.2 AC Motors - General Across Systems

a. Verify proper alignment, installation, and rotation.

b. Measure the insulation resistance, phase balance, and resistance to ground.

c. Verify that properly sized overloads are in place.

d. Measure voltage available to all phases at time of initial connection and again after motor has been placed in operation. Measure current and speed (RPM) under load conditions.

e. Record all motor nameplate data.

3.6.2.3 Primary Service Feeders - 15 kV Class

a. Start-up checklists: Perform the following final checks before Start-up:

1. Inspect underground duct banks.

2. Inspect cable.

3. Inspect splicing and terminations.

b. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Visually and mechanically inspect to include the following: Exposed cable, compression type terminations, splices where approved by the Engineer and the Owner, and fireproofing in manholes, cable vaults, and similar items.

2. Correct color code identification and phasing arrangements.

3. Provide inspection and testing as required in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.6.2.4 Secondary Distribution

a. Start-up checklists: Perform the following final checks before Start-up:

1. Inspect transformer connections.

2. Inspect disconnect connections.

3. Inspect grounding.

4. Validate surge protector installation.

5. Verify control interconnections.

6. Check calibration/setting of protective devices from system coordination study.

7. Verify calibration/setting of digital metering.

8. Check installation of equipment nameplates and warning labels.

b. Provide inspection, testing and training as required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

c. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Visually and mechanically inspect to include the following: large junction and pull boxes, supports of raceways, and compression type terminations.

2. Correct identification and phasing arrangements.

3. Perform random continuity test of any branch circuit.

4. Receptacle Polarity Test: Test every receptacle installed or reconnected under this Contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.

5. Ground-Fault Receptacle Circuit Interrupter Tests:

(a) Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 milliamperes and will operate when subjected to a ground-fault current exceeding 6 milliamperes.

(b) Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. "TEST" button operation will not be acceptable as a substitute for this test.

(c) Replace receptacles that do not shut off power with 6/1000 of an ampere within 1/40th of a second and retest. Submit test

report signed by Test Engineer who performed this test.

3.6.2.5 Lighting Fixtures and Lighting Controls

a. Start-up checklists: Perform the following final checks before Start-up:

1. Ensure all labeling is affixed and accurate.

2. Verify quantity, type and location of fixtures.

3. Verify type and location of switches.

4. Ensure all terminations are tight.

5. Check sensor placement is adequate for required duty.

6. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.

7. Ensure all circuits for the loads are energized and ready for testing.

b. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Test, calibrate, and set all digital and analog sensing, and actuating devices.

(a) Calibrate each instrumentation device by making a comparison between the graphic display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5 percent accurate, test equipment shall be +/-0.25 percent accurate over same range).

(b) Record the measured value and displayed value for each device in the Prefunctional Checklist.

(c) Check each digital control point by making a comparison between the control command at the control panel and the status of the controlled device.

(d) Check each digital input point by making a comparison of the state of the sensing device and the display.

(e) Record the results for each device in the Building Automation System Start-up checklist.

2. Verify operation of lighting controls (dimming, photo-control, regular switching).

3. Check loads on all breakers to ensure that the breaker is properly sized.

4. Enter all schedules per occupant's direction.

5. For operator interfaces, verify all elements on the graphics are functional and properly bound to physical devices and/or virtual

points and that hot links or page jumps are functional and logical.

6. Output all specified reports for review and approval.

7. Verify the alarm printing and logging is functional and per requirements.

8. Validate all interfaces with other systems on a point by point basis.

c. Provide inspection, testing and training as required in Section 26 51 00 INTERIOR LIGHTING.

3.6.2.6 Lightning Protection

a. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Visually and mechanically inspect to include the following: air terminal mountings, bonding connections of roof mounted HVAC equipment, down leads routing/roof penetrations, and grounding.

2. Review UL test certification.

3. Check for receipt of UL master label.

b. Provide inspection and testing as required in Section 26 41 00 LIGHTNING PROTECTION SYSTEM.

3.6.3 STEP THREE - FUNCTIONAL PERFORMANCE TESTING

General Commissioning Responsibilities: Functional Performance Testing begins after operational testing, adjusting, and balancing of the systems have been completed by the Contractor. Ideally, the Commissioning training for Government operators and maintenance personnel, including the description of the systems, as well as the hands-on training sessions will also have been completed.

a. When testing procedures for commissioned equipment are listed in NETA ATS the NETA test procedures shall be part of the testing requirements of this specification. Additional testing procedures may be listed in this specification.

b. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications. Verify equipment operates within tolerances specified in: governing codes, acceptance criteria contained in the construction documents, manufacturer's literature and according to good operating practice.

c. Electrical Controls Sequences: Verify functionality and compliance with the design intent for each individual sequence module in the sequences of operation. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Test every step in every written sequence and other

significant modes, sequences and operational features not mentioned in written sequences; including startup, normal operation, shutdown, scheduled on and off, unoccupied and manual modes, safeties, alarms, over-rides, lockouts and power failure.

d. Systems shall accomplish their intended function and performance.

e. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.

f. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).

g. Scheduled Lighting Controls:

1. Apply the applicable common testing requirements and acceptance criteria.

2. Test Methods. Utilize active testing, and trending when available. If able to trend, trend all zones over a week period and follow the trending guidelines in Section 01 91 00.00 40 COMMISSIONING.

3. Sampling Strategy. Manually test 20 percent of the zones or at least four. If more than 10 percent or two zones fail, test another 10 percent sample. If the second sample fails the Contractor shall document retesting on all zones on their own using a Commissioning Authority approved form.

h. Occupancy Sensor Lighting Controls:

1. Apply applicable common testing requirements and acceptance criteria.

2. Test all units functions, including sensor sensitivity and time-to-OFF functions and ensure that sensor location is proper and won't be tripped inadvertently by other occupants and movements outdoors, etc.

3. Test Methods: Utilize active test methods.

4. Sampling Strategy. Test 10 percent of the sensors or six, whichever is greater. If more than 10 percent or two sensors fail, test another 10 percent sample. If the second sample fails the Contractor shall document retesting on all units on their own using a Commissioning Authority approved form.

5. Additional Acceptance Criteria. Reasonable sensitivity, no inadvertent trips, lights go off within 15 seconds of design.

-- End of Section --

SECTION 33 40 00

STORM DRAINAGE UTILITIES
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM C231/C231M	(2014) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C425	(2004; R 2013) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C443	(2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C76	(2015) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C923	(2008; R 2013) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C990	(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2321	(2014; E 2014) Standard Practice for Underground Installation of Thermoplastic

	Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2729	(2011) Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT)

NCDOT	(2012) Standard Specifications for Roads and Structures

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pipe for Culverts
End Wall
Drainage Structures
Frames and Grates

Submit printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

Manufactured in accordance with and conforming to ASTM C76, Class IV.

2.1.2 Polyvinyl Chloride (PVC) Pipe

ASTM D2729.

2.2 DRAINAGE STRUCTURES

2.2.1 End Walls

Manufactured in accordance with NCDOT and details shown on plans.

2.2.2 Drop Inlet

Provide in accordance with details shown on the project drawings.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3,000 psi concrete under Section 03 30 00 CAST-IN-PLACE CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C231/C231M. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground.

2.3.2 Frame and Cover for Gratings

Frame and cover for gratings shall be heavy duty, cast gray iron, ASTM A48/A48M, Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12.

2.3.3 Joints

2.3.3.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with rubber-type gaskets for concrete pipe. The design of joints and the physical requirements for preformed flexible joint sealants shall conform to ASTM C990, and rubber-type gaskets shall conform to ASTM C443. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

2.3.3.2 PVC Plastic Pipes

Joints shall be solvent cement in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.4 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A48/A48M, Class 30B or 35B. Shape and size shall be as indicated.

2.5 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.

2.6 EROSION CONTROL RIPRAP

Provide nonerodible rock to the dimensions as indicated on the plans.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 23 00.00 20 EXCAVATION AND FILL and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 36 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in granular material minimum 4 inch in depth in trenches with soil foundation. Depth of granular bedding in trenches with rock foundation shall be 1/2 inch in depth per foot of depth of fill, minimum depth of bedding shall be 8 inch up to maximum depth of 24 inches. The middle third of the granular bedding shall be loosely placed. Bell holes and depressions for joints shall be removed and formed so entire barrel of pipe is uniformly supported. The bell hole and depressions for the joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.2.2 Plastic Pipe

Bedding for PVC, PE, SRPE and PP pipe shall meet the requirements of ASTM D2321. Use Class IB or II material for bedding, haunching, and initial backfill. Use Class I, II, or III material for PP pipe bedding, haunching and initial backfill.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe, excluding SRPE pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.

3.3.1 Concrete, PVC Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket

becomes visibly dislocated the pipe shall be removed and the joint remade.

3.5 DRAINAGE STRUCTURES

3.5.1 Inlets

Construction shall be of precast reinforced concrete, complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated.

3.5.2 Walls and Headwalls

Construction shall be in accordance with NCDOT as indicated.

3.6 BACKFILLING

3.6.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of RCP or has reached an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.6.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches. Use select granular material for this entire region of backfill for flexible pipe installations.

3.6.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be

repaired or replaced.

3.6.4 Compaction

3.6.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.6.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.6.5 Determination of Density

Testing is the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D6938. When ASTM D6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D6938 results in a wet unit weight of soil and ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D6938. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

-- End of Section --