# Scope of Work (SOW) Template for Retrofit Projects.

# *Purpose and Goal of this Template*

*This Scope of Work (SOW) template provides information that can be used to describe relevant Energy Conservation Measures (ECMs) or a Whole Building Retrofit for a school retrofit project. It provides information and instructions for construction work requirements on site as well as deliverables descriptions. This document may be used in conjunction with a Request for Proposals (RFP) document to solicit bids for design and construction services or on its own to describe SOW requirements for bidders.*

*The goal of this template is to provide examples of the areas of work that may be considered for energy efficiency and/or fuel switching projects. It is the intention of this document to provide a framework upon which a complete scope of work can be based and more fully developed by a public education administrator (the Agency) or their representatives and tailored to a specific project.*

*Included are sections that may be required in the RFP and some sections that are optional, depending on how this document is intended to be used (i.e., if it is being used alongside the RFP template, or not). These optional sections are clearly identified by the (Optional) designation.*

*NOTE: One important aspect of new construction and retrofit projects (projects) that is not covered in this template is how to best address IT security concerns that are inherent with installing networked building systems and equipment. Agency efforts should be focused on minimising cyber risk. Among the key topics for Agencies to consider in this regard are the vulnerability of connected devices, integration of new smart systems with legacy systems and equipment, concerns around maintaining data privacy, and establishment of formal frameworks and review processes that aim to continually improve standards in these areas, at the individual facility level.*

# *Instructions for Use of this Template*

*The retrofit project SOW includes the following sections:*

1. *Introduction and Project Goals*
2. *Site Description*
3. *Scope of Work*
   * *Mandatory Preliminary Site Visit*
   * *Construction Requirements and Responsibilities*
   * *Project Scope Description*
4. *Project Tasks*
5. *Performance Requirements*
6. *Timeline*
7. *Deliverables*
8. *Appendices*

*The Agency can use this structure as a basis for the final SOW document and should add sections as appropriate. For sections appearing in the RFP, which this document accompanies, these can be modified accordingly, or deleted.*

***Notes in italics between lines*** *(often under section headings) provide instructions to the Agency on the use of the template and should be deleted from the final version of the document before being issued to potential bidders.*

***Plain text (unitalicized)*** *is included in each section of this document. This contains suggested language / example content intended as indicative for what may be included in each section and is organized by building energy system type. The Agency should modify and / or delete example content for each section as appropriate, according to the specific characteristics of their project.*

***Italic text*** [***in parentheses and highlighted yellow***] *relates to site specific information or requirements that should be updated by the Agency. The parentheses and yellow highlighting should be removed before publication.*

*Finally, text that is included as* ***EXAMPLE BEGINS******→*** [*‘Example Content’*] ***← EXAMPLE ENDS*** *is there to assist with completing sections, to indicate the type of content and level of detail recommended for Agencies to include in that section. These should be deleted once the Agency has completed the document.*

***NOTE:*** *Once the SOW is completed to the satisfaction of the Agency, the Purpose and Goals and Instructions for Use sections shall be deleted from the document. Once appropriate detail from the Appendices has been moved to the main body of the document, the Appendices should also be deleted.*

*This Scope of Work template uses a Design Build method for project delivery, as opposed to a Design-Bid-Build methodology. If the Agency is unfamiliar with this method, it is recommended that they familiarize themselves - this may be a useful resource to begin with:* [*www.procore.com/library/design-build-construction*](http://www.procore.com/library/design-build-construction)*, but it is recommended to review other resources as well.*

# Disclaimer

This template is intended as a resource only and should be modified for your specific needs. It is the responsibility of the Agency to ensure that all procurements follow applicable local, state, and federal requirements and agency-specific policies and procedures. The use of the Design Build (DB) contracting model should be understood by the Agency and decision-makers early in the process. All documents comprising the Design Build agreement must be thoroughly reviewed by the Agency’s contracting and legal staff and should be modified to address each Agency’s unique acquisition process, and project-specific characteristics.

# Introduction and Project Goals

*This section should provide an overview of the proposed project, and call out key project objectives, including goals and associated metrics, and briefly refer to processes, requirements, or criteria that apply to the project’s implementation.*

*The Agency should make explicit any specific requirements around local or state legislation that bidders may be required to adhere to, and/or may be less familiar with or unaware of.*

The [*XX school / school district*] is soliciting a proposal from a qualified Engineering and Construction Services firm (the Contractor) to design and implement a project that improves the indoor thermal environment, indoor air quality, and energy performance of the school’s [*XX building*]. This is to be achieved by implementing an energy project for the systems and equipment that serve the building(s).

The Contractor is to provide the following services: [*complete design, secure relevant permits, manage site demolition and disposal (if required), construction, construct/install, commission, train staff on operations and maintenance, provide monitoring and verification services, close out the project with record documents to provide energy efficiency, health, and safety upgrades*]. Where applicable, this shall include specifying BABA[[1]](#footnote-0) (Buy American, Build American) compliant equipment - visit <https://www.energy.gov/management/build-america-buy-america> for further details.

## Project Performance Goals

The Contractor shall refer to specific building / facility performance goals identified below in their proposal and provide clear commentary that identifies how these goals will be achieved. Failure to include these statements will compromise the proposal due to the importance of these performance characteristics as bid assessment criteria.

*The Agency should:*

1. *Describe information and data that supports characterization of the existing building condition (the baseline), and*
2. *Specify a relevant performance standard for the scope of work.*

*There are two possible performance requirement paths identified below: building performance or building net zero-energy ready (NZER), that the Agency should select from. The Agency should select the path most appropriate for the project scope of work and delete the other section.*

*The Agency should make clear what additional performance metrics apply and include them in the relevant sections for path #1 or #2, particularly when it comes to criteria utilized in the assessment of bids. Examples for consideration include minimum performance levels for the following:*

* *Estimated annual energy savings (electricity, natural gas, other described as a quantity or % savings)*
* *Estimated annual energy cost savings ($/yr) or % energy cost savings*
* *Estimated annual generated electricity*
* *Estimated electrical peak demand reduction*
* *Indoor environmental quality (IEQ) improvements (i.e., indoor CO2, PM 2.5 particulates)*
* *Contribution towards improvement of local air quality (reductions in local SOx, NOx, emissions via displacement of direct fuel combustion on site)*

*The Agency should outline how much detail they require from the Contractor, regarding estimates or calculations of their proposed solutions against the above stated project performance goals. For instance, this may include requests to include the methodology and basis for energy savings calculations, summarizing assumptions and inclusion of detailed spreadsheet calculations which show how savings were determined. Where fuel switching is proposed (e.g. replacing a natural gas-based piece of equipment with one that only uses electricity), it is suggested that calculations that account for adjustments made on that basis be requested.*

*Under the Building Performance Path, energy metrics can be measured by overall British Thermal Units/year (BTUs/yr) reduced, including electricity and fuel reduction. Specify site BTUs for calculations that include fuel switching. The base year is the year against which reductions are tracked. Currently the U.S. K-12 School national median source (Energy Use Intensity) EUI is 101.4 kBtu/sq ft*3*, and site EUI is 48.5 kBtu/sq ft[[2]](#footnote-1).*

*Targets in terms of energy performance (examples below) are recommended to be aggressive. An aggressive level of reduction is one that is beyond business as usual. Recommend a minimum of 20% annual whole building energy consumption reduction.*

*If the Agency is adopting a Building Performance Path for the scope of work, all the content under Option #2 - Building NZER Path, should be deleted.*

**Existing Building Condition (Baseline)**

The following information is available to the Contractor for the purposes of determining the existing building condition, against which post-implementation performance will be evaluated. More detail on the site can be found in Attachment A of this document. This information includes, but is not limited to:

* Annual building energy consumption
  + Utility bills for [*XX*] years of operation
  + Other fuel bills for [*XX*] years of operation
* Building systems inventory
  + List of equipment and major components
* Details of relevant expansion, refurbishment or other projects that may impact energy use data during this baseline period
  + [*XX*] building equipment affected
  + [*XX*] floor area and/or locations affected
* Recorded indoor environmental conditions (e.g., classroom average daytime CO2 readings) and/or description of current conditions (e.g. no air conditioning and space temperatures reaches more than 80°F periodically during the school year)

**Option 1 - Building Performance Path - (Based on overall energy consumption).** The Contractor shall provide a proposed solution that achieves the following minimum targets:

* Reduce annual building energy consumption by [*XX*]%
* Reduce CO2 levels in classrooms by [*XX*]% on average
* Incorporate ANSI/ASHRAE/IES Standard 100-2024 and Energy and Emissions Building Performance Standard for Existing Buildings where applicable.
* Project must exceed the minimum performance standard in ASHRAE 90.1 or IECC 2021 as required by the local jurisdiction.
* Project must meet all local, state, and federal requirements.

*Under the NZER Path, this may include fuel switching of some systems, such as HVAC and domestic hot water. High efficiency electrical equipment should be specified for the replacement. This also includes implementation planning for and pathway to fuel switching of all building loads and may also include planning for and implementation of on-site renewable energy generation.*

*Targets in terms of energy performance (examples below) should be aggressive. An aggressive level of reduction is one that is beyond business as usual. Recommend a minimum of 30% reduction for projects that just include energy efficiency upgrades. For projects that also include on-site renewable energy, targets should reflect offsetting of grid supplied electricity with on-site use or export to the grid, and a net energy reduction of 50% or more.*

*If the Agency is adopting a Building NZER Path, all the content under Option 1 - Building Performance Path, should be deleted.*

**Option 2 - Building NZER Path.** The Contractor shall provide a proposed solution that achieves the following minimum targets:

* Reduce on-site fossil fuel use by [*XX*]%
* NZER planning pathway, including anticipated on site renewable generation capacity and estimated on site annual electricity production
* Incorporate ANSI/ASHRAE/IES Standard 100-2024, Energy and Emissions Building Performance Standard for Existing Buildings, where applicable.
* The project must meet all local, state, and federal requirements.

# Site Description

*The Agency should include a detailed site description in this document, with sufficient detail provided to indicate the areas of focus for the project - example text is provided below. The description should be sufficiently detailed for the contractor to understand the basis of the project and to provide guidance for them to conduct any additional investigations as needed during their site visit. All relevant supporting information should also be included. Several essential elements to include are listed below:*

* *Site address*
  + *Building/campus description*
  + *Include gross square footage*
  + *Include the number of buildings on the campus*
    - *Include details of buildings that the scope of work applies to*
    - *Include space type descriptions i.e., admin offices, classrooms, workshops etc.*
* *Describe the existing building equipment or systems proposed to be retrofit by the project*
  + *Envelope or equipment type (e.g. envelope, lighting, Heating, Ventilation, Air-Conditioning (HVAC), domestic hot water (DHW))*
  + *Age, condition, and other relevant information*
  + *Location(s) per building / campus description details above*
* *Energy and utility concerns (Optional)*
  + *Examples may include descriptions of legacy electrical infrastructure, possible presence of hazardous materials (e.g. asbestos), oil tanks, ducting, or piping issues*
* *What are fuels/energy sources of existing systems, and stipulated or preferred fuel/energy sources that should be included in the project proposal? (Optional)*
* *Future construction plans, aside from this project, if relevant. (Optional)*
* *Previous/planned site or equipment changes that may impact this scope. (Optional)*

*An example description follows, which should be modified to suit the existing conditions.*

***EXAMPLE BEGINS →*** [*The* [*XX*] *school site consists of* [*X*] *buildings, of* [*X*] *vintages. The* [*XX*] *Building (Building* [*X*] *on location map) is the focus of this project. The* [*Main Building*] *has an occupied square footage of* [*XX*]*, was constructed in the* [*1970’s*]*, and is in* [*fair*] *condition.*

*The facility underwent an expansion in 1998, where a new administrative office area was added to the existing structure. The building construction, including the office extension, consists of concrete blockwork with a steel frame*.

*The HVAC system underwent a single major upgrade in 1995, but since then has been operated and maintained only, with no major equipment replacement. The HVAC system has not been commissioned since the mid-90’s retrofit and is not integrated into a central control system (BAS). It is currently scheduled with local controls and not setback. The system consists of a central plant with multi-zone constant air volume for space heating for space heating, with hot water reheat. Packaged multi zone rooftop units provide [heating and] cooling for the kitchen, cafeteria, and gym areas, and for the administrative offices that were part of the 1998 expansion. In-window air conditioning units provide cooling to the classrooms - these were installed in 2001*.

*The site underwent a full lighting system retrofit in 2015, replacing all lighting with LEDs, which have to be replaced with higher efficiency LEDs as they burn out. Light fixtures are 2’ x 4’ troffer type, with linear LED lamps, with an efficacy of 85 lumens per watt, color temperature of 3500K. Lights are controlled by wall switches and a facility wide vacancy schedule. No further lighting or lighting control upgrades have taken place since the 2015 LED installation*.

*The envelope [has/has not] been substantially updated since original construction. Building insulation is consistent with that era and is in good condition, and windows are single glazing with aluminum frames with no apparent cracks, leaks or moisture issues. The roof is a built-up flat roof, with the insulation installed entirely above the roof deck. Roof maintenance has consisted of surface patching/maintenance, prompted by water leaking into some occupied areas, and creating areas of damp. On initial inspection, water leaks are not thought to have affected the structural integrity of the roofs or ceilings, but it has resulted in minor corrosion of a small number of window frames. Resolving building water tightness issues is therefore a priority. The wooden exterior doors require replacement due to mild warping, and associated air infiltration and ingress of water locally during heavy rain*.

*The existing domestic hot water system consists of 2 hot water storage tanks, with integrated gas burners. These units are estimated to be 25 years old - the school does not have documentation for this equipment. Pumps were installed at the same time as the storage tanks. Insulation on the tanks and piping was last upgraded in 2010*.

*The facility has a medium size car park on its north side, and the buildings have flat roofs - both areas may provide suitable sites for solar PV installation, although as noted above, a roof replacement is within the project scope*.]

***← EXAMPLE ENDS***

The Contractor is encouraged to site verify all conditions and can review site conditions further during the preliminary site visit, to verify and gather additional information required to provide a bid on the overall scope of work. Further information on the facility is provided in Attachment A, at the end of this document.

# Scope of Work

*This section should contain all information that pertains to the technical aspects of work to be done at the Agency project site. The content should identify and describe all supporting documentation that will be made available to the Contractor, to inform development of their proposal, and that will influence their approach to project design and construction.*

## Introduction

The Contractor should describe their proposed technical solution in response to the work description, performance specification and general requirements outlined in this section, and where necessary include details that explain innovative solutions in terms of design and / or construction.

## Mandatory Preliminary Site Visit

The Contractor shall conduct a site visit(s) as needed to verify all dimensions, layouts, counts, and existing conditions of the facility elements relevant to the project. The Contractor shall also compile a list of questions to submit to the Agency in order to more fully understand the challenges currently presented by the facility systems, and by any constraints at the site, physical or otherwise.

## Construction Requirements and Responsibilities

The Contractor shall conduct regular site inspection/field observation visits. Site inspection/field observation visits may be conducted in conjunction with regularly scheduled [*insert meeting frequency*] construction job meetings, depending on the progress of work, for weeks that construction job meetings are scheduled. The Contractor shall submit a field observation report for each site inspection to The Agency’s designated Project Manager within three (3) calendar business days of the site visit. Also, they shall conduct inspections during major construction activities including, but not limited to the following examples: concrete pours, steel and truss installations, structural and electrical code inspections, final testing of systems, achievement of each major milestone required on the construction schedule, and requests from the Project Manager. The assignment of a full-time on-site Subcontractor does not relieve the Contractor of their site visit obligation.

The Contractor shall complete project activities to include complete installation, including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work’s conclusion.

The Contractor’s scope shall include all relevant site preparation, protection, demolition, materials removal and disposal, installation, functional performance testing, startup, and commissioning, and handover, to support a fully functioning retrofit or repair.

## Project Scope Description

*The Agency should describe the anticipated project scope in broad terms, as a narrative to support the following sections. The description below is an example, to be amended as appropriate to reflect details of the project in question.*

[*The Agency*] is interested in identifying the most effective measures that can be taken to reduce consumption and operating costs for [*heating, cooling, ventilation, lighting, water heating and other energy uses*] in the facility within their available budget. Measures shall involve [*controlling, modifying, adding, or replacing*] equipment and systems in order to achieve the performance specified.

The technical strategies addressed in the project proposal should include the following items:

1. [HVAC systems and controls retrofit/replacement
2. Lighting system retrofit/replacement
3. Building envelope retrofit/replacement
4. Domestic hot water heater retrofit/replacement
5. Renewable energy generation installation - solar photovoltaics]

All applicable codes and standards must be adhered to.

#### HVAC Equipment Retrofit/Replacement

*If the project scope is specific about equipment type for the project, The Agency should look to specify high efficiency equipment whenever possible. Cost-effective and significant savings can be realized without compromising the functional performance of the product; The energy efficiency specifications should be achievable by more than one manufacturer to enable a competitive bid.*

**Work Description**

The Contractor shall complete the following HVAC scope providing a complete [*demolition/removal/ and installation*], including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work's conclusion. The Contractor should describe execution and implementation for the following elements of the project:

Removal / Demolition

* Removal of existing mechanical systems.
  + [*Specify what equipment needs to be removed, name / specify locations. Example: Remove Rooftop Units with natural gas heating and DX cooling located on the main school building that serve the classrooms and the gymnasium, including any structural supports.*]
* Removal of existing electrical connections.
  + [*Specify removal of electrical connections, conduit, service panels and gear where conditions warrant replacement, like end of useful or doesn’t have more than 30 years of life remaining*]
* Removal or modification of existing ductwork.
  + [*Specify what needs to be removed or modified, and if relevant, what the needs of the modified ductwork are. See below for specific language for three examples.*]
* Removal or modification of existing piping.
  + [*Specify what needs to be removed or modified, and if relevant, what the needs of the modified system are, such as remove end of useful life piping, or abandon in place with permission of district, capping off and sealing at agreed upon location. See below for specific language for three examples.*]
* Details of Equipment Removal
  + [*Specify what needs to be removed or modified, and if relevant, what the needs of the modified system are*]

***EXAMPLE BEGINS →*** [*RTU removal scope.*

*For each RTU location indicated above for removal:*

* *Disconnect electrical power from the unit and remove the electrical disconnect mounted to the unit*
* *Remove and replace electrical disconnect from electric supply*
* *Close off gas valve at the unit*
* *Disconnect gas supply line for unit*
* *Disconnect control communications wires at the unit*
* *Remove condensate piping from units and discard* 
  + *Reuse is acceptable if the line is free from defects and properly supported*
* *Remove existing packaged RTUs from roof curb*
  + *Contractor will be responsible for removal and disposal of units according to state and/or regulations at the approved disposal facility*
* *If curb cap shows any signs of deterioration, remove and replace.*
  + *Dispose of removed platforms at an approved disposal facility*
  + *Supply and install new minimum 24- gauge galvanized platform cover*]

*←* ***EXAMPLE ENDS***

***EXAMPLE BEGINS →***[*Chiller removal scope.*

*For each chiller location indicated above for removal:*

* *Demolition and remove existing chiller including capturing and disposing of refrigerant per local and state requirements*
* *Modify existing structural support as necessary to accommodate the new unit.*
* *Disconnect and demo existing chilled water piping above roof only.*
* *Provide rigging/crane services for equipment removal.*
* *Demo / cut and clear feeds at unit re‐using wire where possible.*
* *Provide and install disconnect per NEC.*
* *Reinstall wiring to chiller, and provide new wire where needed.*
* *Remove lightening protection from chiller and re‐install on new chiller (certification included)*]

***← EXAMPLE ENDS***

***EXAMPLE BEGINS →***[*Oil fired hot water boiler removal scope.*

*For each boiler location indicated above for removal:*

* *De-energize the electrical system and follow the applicable lock out*
* *tag out requirements.*
* *Disconnect the fuel line and filter from the boiler.*
* *The fuel line shall be purged and cleaned.*
* *All purged fuel, filter and material shall be disposed of off-site in accordance with all applicable laws and regulations.*
* *Disconnect the existing circulator pumps and control relays.*
* *Disconnect the existing expansion tank.*
* *Disconnect the existing boiler.*
* *Disconnect the existing hot water tank (DHW is attached to the boiler).*
* *Remove the existing circulator pumps, control relays, expansion tank, hot water tank, burner, and boiler from the site and shall dispose of or salvage all material in accordance with all applicable laws and regulations.*
* *Replace the existing vent pipe in accordance with the manufacturer's recommendation for the new boiler.*]

***← EXAMPLE ENDS***

Installation

* Installation of new HVAC equipment (such as chillers, rooftop units (RTUs) and boilers), especially large plant being installed in enclosed spaces, and heavy items installed above grade, for which there will be building / general structural considerations
  + [*Specify equipment install including any structural requirements. See below for specific language for three examples.*]
* Installation of new HVAC infrastructure, including ductwork, piping, and electrical.
  + [*Specify what the needs of the system are, for example, the maximum design occupancy of the building(s) . See below for specific language for three examples.*]

The new HVAC equipment and supporting infrastructure shall be installed in accordance with local building code and manufacturers’ recommendations. In addition, the proposed HVAC system shall:

* Comply with all applicable codes and meet minimum performance specifications.
* Be accompanied by design drawings that include ventilation amounts and schedules for all spaces.
* Provide acceptable vibration and sound levels for the unit and in ducting.
* Provide all necessary measures for surge protection of the equipment.
* Meet capacity requirements for heating, cooling and ventilation needs.
* Incorporate new or upgraded controls and sequence of operation for the new and existing equipment to deliver the thermal comfort and energy performance. This should be added to a central control system if one exists.
* Retrofit/install variable frequency drives and variable flow controls on all affected HVAC system pumps and fans

***EXAMPLE BEGINS →***[*RTU installation scope.*

*For each RTU location indicated above for installation:*

* *Place and secure new units*
  + *Match existing supply and return ducting, with modifications if required*
  + *If curb adaptor is required for down-shot configuration, include costs in the proposal*
* *Replace condensate lines with new copper tubing*
  + *All condensate lines shall be installed in accordance with local and state plumbing codes*
  + *All condensate lines are to be supported*
* *Repair area of roof where AC unit was removed to a watertight condition.*
* *Install new electrical disconnects*
  + *Three phase disconnects with amperage and voltage requirements to match new mechanical equipment specifications*
  + *Include wire, conduit, and other electrical components needed for complete installation.*
  + *Following new equipment installation, attach new electrical disconnect to the unit.*
* *Mechanical contractor will be responsible for structural compliance including anchoring all units per structural engineering specification*
* *Install local controls or connect to existing or new building automation system (BAS) and commission per sequence of operation on startup.*
* *Startup services are to be included, and fully operational per desired controls.*]

***← EXAMPLE ENDS***

***EXAMPLE BEGINS →*** [*Boiler installation scope.*

*For each boiler location indicated above for installation:*

* *Contractor shall install new boiler in accordance with the local and state Building Code and the manufacturer's recommendations, including:*
* *Contractor must install all electrical components of the new boiler, controls, and related systems per Building Code.*
* *Unit shall be installed in accordance with manufacturer’s recommendations.*
* *Connect the new boiler to the existing water supply and heat piping and boiler stack.*
* *Note: The unit shall be installed to allow proper function and service and may include additional piping and connections per piping manufacturer recommendations.*
* *Contractor shall install the new boiler in accordance with the building code and the manufacturer’s recommendations including: Install the circulator pumps, control relays, expansion tank, filter and replace boiler, burner, and heat-zone piping in accordance with the manufacturer recommendations.*
* *Establish a two-zone heating system with independent thermostatic programmable controls.*
* *Connect the new boiler and heat-zone piping in a neat and orderly fashion.*
* *Insulate new piping and fittings.*
* *Note: The installation shall allow the new boiler to function properly and be easily serviced. The new piping shall not interfere with the swing of service doors or access.*
* *Contractor shall patch any floor holes to industry best practices and patch any holes utilized by new piping.*
* *Contractor shall reestablish the plumbing necessary, including shut offs, to provide water to the fixtures.*
* *Startup services are to be included, and fully operational per desired controls.*]

***← EXAMPLE ENDS***

***EXAMPLE BEGINS →***[*Chiller installation and controls scope.*

*For each new chiller location indicated above for installation:*

* *Controls Work:*
  + *Chiller shall connect into existing BAS system backbone via closest MS/TP loop.*
  + *Points shall include: Enable, Chiller Status, Local Chilled water setpoint, compressor Run Status(s), Fault codes, Leaving Chilled Water Temperature, and Return Chilled Water Temperature at minimum.*
  + *Includes One (1) Year Warranty.*
  + *Includes adding chiller to graphics.*
* *Mechanical Work:*
  + *Modify existing structural support as necessary to accommodate the new unit.*
  + *Provide chilled water piping from roof to unit.*
  + *Pipe insulation to be fiberglass insulation + .016 SE aluminum jacket.*
  + *Provide rigging/crane services for equipment delivery and installation.*
  + *Permits and inspections included.*
* *Electrical work:*
  + *Provide and install disconnect per NEC.*
  + *Reinstall wiring to chiller and provide new wire where needed.*
  + *Remove lightning protection from chiller and re‐install on new chiller (certification included).*
  + *Provide heat trace and insulation for piping from roof to chiller.*]

***← EXAMPLE ENDS***

**Energy Efficiency** **Performance Specification**

*The Agency should specify appropriate equipment requirements with energy efficiency performance in mind. For example, CEE Tier 1 is EnergyStar equivalent, and may be considered energy efficient. Tiers 2, 3, and 4, represent efficiency upgrades (a higher number equals better energy performance). The retrofit options available from the stated CEE Tier should be specified by the Contractor at minimum, and they should be encouraged to consider premium performance options (i.e., if the Agency specifies CEE Tier 2, the Contractor should also ideally demonstrate consideration of Tier 3 and 4 options).*

* The Contractor should refer to Consortium for Energy Efficiency (CEE) Tier [*1, 2, 3, or 4*] as minimum equipment performance requirements where applicable.[[3]](#footnote-2) Product types that are included in CEE Tiers 2-4 (but not Advanced, which targets early adopters and is less well served by vendors) and are cited in the Inflation Reduction Act of 2022 (IRA) with regards to 25C tax credits, include:
  + Air Source Heat Pumps
  + Central Air Conditioners
  + Heat Pump Water Heaters
  + Natural Gas Water Heaters
  + Natural Gas Furnaces and Boilers
* For equipment not covered under the CEE Tier System, the Contractor shall provide equipment qualified under the relevant Environmental Protection Agency’s Energy Star/AHRI certifications as applicable.[[4]](#footnote-3)

**HVAC System Testing and Balancing**

**Work description**

The Agency requires that Testing-Adjusting-Balancing (TAB) of the [*air/air and hydronic*] systems be completed and documented for the [*modified / new HVAC systems/BAS controls modifications covered by this SOW*].

**Performance Specification**

* The Contractor shall perform testing, adjusting, and balancing in accordance with ANSI/ASHRAE Standard 111-2008 “Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.”
  + Balancing airflow and water flow at source equipment and/or within distribution systems, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
  + Adjusting total HVAC systems to provide indicated quantities
  + Measuring electrical performance of HVAC equipment
  + Verifying that automatic control devices are functioning properly
  + Documenting and reporting results of the TAB activities and procedures
* The Contractor shall plug all holes that have been made in the ducts for taking test readings, to prevent air leakage. Disruption of duct, pipe, and/or equipment insulation shall also be appropriately repaired by the contractor.

**General Requirements**

* Implement TAB procedures in accordance with local building code and manufacturers recommendations.
* Prepare a TAB plan that includes strategies and step-by-step procedures
  + Prepare test reports for affected equipment, infrastructure, and monitoring / control points.
  + Prepare schematic diagrams of systems “as-built” duct layouts (air) [and piping layouts (hydronic)].
  + Determine best locations for accurate measurements in ducts.
* Complete system readiness check prior to TAB activities.
* Prepare a TAB report that documents results and outcomes of TAB plan activities.

### HVAC System Controls Upgrade

*The Agency should identify and complete sections below that apply to their HVAC project and delete sections that do not apply.*

*As part of this installation, the Agency shall specify whether the upgrade covers just the newly installed equipment, or if it also shall control any existingHVAC equipment not currently on the BAS. Other HVAC equipment should be included whenever possible for complete central control. If so, existing BAS inputs and outputs are to be replicated in the new BAS, which will also serve as a control system capable of integrating future buildings and replacement equipment with industry-standard communications protocols]*

*The Building Automation System shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. The BAS shall be a web-based system.*

#### Building Automation System (BAS) Upgrade (HVAC System Controls)

**Work Description**

The Contractor should describe execution and implementation for the following [*removal/installation*] elements of the project:

Removal

* Removal of or modification of existing controls and related infrastructure.
  + [*Specify what existing HVAC controls needs to be removed or modified, and if relevant, what the needs of the modified system are, name / specify locations*]

***EXAMPLE BEGINS →*** [*BAS removal:*

* + *Remove all equipment cabinets, panels, data communication network cables needed, and all associated hardware no longer in use.*
  + *Disconnect, cap off and remove all existing interconnecting cables between supplied cabinets, application controllers, and input/output devices no longer in use.*
  + *Remove all equipment and BAS points no longer used from BAS graphics.*]

***← EXAMPLE ENDS***

Installation

* Installation of new BAS equipment and software.
  + [*Specify what the needs of a new system are, for example to maintain thermal comfort in occupied spaces during challenging hot/cold conditions [insert design temperatures], and compliance with all relevant local Codes and Standards.*]

***EXAMPLE BEGINS →*** [*BAS installation*

* *The Contractor shall procure and install an integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities.*
* *All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.*
* *BAS manufacturers shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.*
* *BAS will integrate with existing equipment not modified in other ways to allow both monitoring and control of the existing equipment.*
* *BAS shall be an extension of the existing BAS system. The new BAS shall utilize scalable system architecture to provide interoperability of the new facility through the existing Client/Server network.*
* *Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.*
* *A New Operator Workstation including Microsoft Windows 11 will be provided by the customer to replace the current workstation*
* *Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.*
* *Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.*
* *Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.*
* *Provide and install all interconnecting cables between all operator’s terminals and peripheral devices (such as printers, etc.) supplied under this section.*
* *Provide complete manufacturer’s specifications for all items that are supplied.*
* *Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.*
* *Provide a comprehensive operator and technician training program as described herein.*
* *Provide as-built documentation, operator’s terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.*]

***← EXAMPLE ENDS***

The installation of the control system shall be completed in accordance with manufacturer instructions, with the shop drawings, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer.

**Performance Specification**

The design of the BAS shall include both network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels, a campus-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.

The design of the BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

Onsite operator workstation(s) shall be capable of simultaneous direct connection and communication with BACnet, Modbus, OPC etc. networks without the use of interposing devices.

The new BAS should provide the following minimum functionality:

* The BAS shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection of [*existing and/or*] new equipment.
* The BAS system design must include solutions for the integration of open system protocols such as BACnet, ModBus, OPC and digital data communication to third party microprocessors such as chiller controllers, fire alarm panels (if required) and variable frequency drives (VFDs).
  + Implemented controls setting to reflect priorities of The Agency, and relevant local and state codes
* Scheduling and override of building operations
* The scheduling interface should be capable of programming at least 12 months into the future, including routine recurring events and specific one-time events lasting up to multiple weeks.
* Real-time graphical viewing and control environment
* Collection and analysis of historical data, with a minimum 12-month retention.
* The system should be set up to automatically archive trends older than a month to a building automation system server, stored by calendar year, on a weekly basis.
* Alarm reporting, routing, messaging, and acknowledgment, including for interruptions in communications between the BAS controls and operator workstation(s).
* Point database shall be organized by floor and equipment.
* Program editing.
* Transfer trend data to third-party software.
* Scheduling reports.
* Operator activity log.

**General Requirements**

* Implement HVAC building controls in accordance with local building code and manufacturers recommendations.

Controls shall be tied to and compatible with the existing or new BAS and should include control points, such as the following:

* Zone Temperature Control
* Zone Humidity Status and Control
* Zone Supply Air Temperature
* Return Air Temperature
* Temperature and static pressure setpoint resets

The BAS shall be configured to support trend all the control points listed above, plus record equipment and system status and operation, such as:

* Outside Air Temperature
* Heating coil valve signals or direct gas fired and discharge temperatures
* Cooling coil valve signals or DX coil signal and discharge temperatures
* Statuses or signal and control for all dampers
* Statuses for all fans

**Additional HVAC Control Sequences (Optional)**

For HVAC systems that operate on a modern BAS, there are additional control sequences that deliver enhanced thermal comfort and energy efficiency outcomes.

Where appropriate, consider utilizing controls sequences presented and described in ASHRAE Guideline 36 “High Performance Sequences of Operation for HVAC Systems” (G36). Examples of G36 sequences of operation include:

* Un-occupied zone temperature setbacks
* Supply temperature resets
* Static pressure resets
* Building and equipment scheduling
* Optimum start
* Trim and Respond
* Demand-based controls
* Automated Fault Detection and Diagnostics (AFDD)

### Lighting System Project

*The Agency should consider organizing the lighting scope of work request so each space design criteria is specified individually, or by space type-groups where the same design criteria apply – this will allow bidders to clearly understand the scope.*

#### Lighting Fixture Retrofits

*The example description below assumes a like for like replacement, i.e., if existing fixtures are 2’ x 4’ fluorescent troffers, the replacement item would be 2’ x 4’, and either be LED fixtures or LED retrofit kits.*

**Work Description**

The Contractor should describe execution and implementation for the following elements of the project:

* Removal and disposal of [*XX # of fixtures for space type Y*] existing fluorescent troffer-type light fixtures from [*name / specify locations to be retrofitted. Repeat for each space type.*]
* Provide and install [*XX # of fixtures for space type Y*] new high-performance LED 2x4 continuous dimming flat panel fixtures in [*name / specify locations to be retrofitted. Repeat for each space type.*].

**Performance Specification**

1. Light level target values and energy goals:
   1. Task illuminance: at full light output, the lighting system will produce a minimum of [*XX*] average horizontal maintained footcandles on task surfaces (assuming no daylight contribution).
   2. Lighting power density (LPD) OR target annual lighting energy use: [*select one*]
      1. Maximum connected lighting load including task lighting shall not exceed [*XX*] W/ft2. [*Determine which code(s) are applicable to the project; e.g., IECC 2012/ASHRAE 90.1-2010/CA Title 24/etc. Then determine the maximum permissible connected lighting load.*]
      2. Energy use from connected lighting load (including task lighting) shall not exceed [*XX*] kWh/square foot/year. [*Determine which code(s) are applicable to the project; e.g., IECC 2012/ASHRAE 90.1-2010/CA Title 24/etc. Then determine the maximum permissible normalized annual lighting energy consumption.*]
2. Overhead light fixtures for ambient light:
   1. Dimming: All overhead light fixtures shall be dimmable-on in a continuous range between 0-100% of full light output.
   2. Light source color: Correlated color temperature (CCT) – LEDs shall have a published CCT of 3500K or 4100K. Actual CCT for LEDs as shown on IES LM-79 tests may have a tolerance of ±100K. Therefore, they must be in the range of either 3400-3600K (for nominal 3500K) or 4000-4200K (for nominal 4100K).
   3. For Coloring rendering index (CRI) and lighting efficacy, The Contractor should propose solutions in line with DesignLights Consortium Technical Requirements[[5]](#footnote-4)

**General Requirements**

* Install new light fixtures in accordance with local building code and manufacturers recommendations.
* Selected equipment must meet DesignLights Consortium (DLC) Solid-State Lighting Technical Requirements and be listed on the DLC SSL Qualified Products List, <https://www.designlights.org/search/>.
* Light fixture retrofits may comprise LED fixtures OR LED replacement kits
* Selected equipment must be UL (Underwriters Laboratories) or NRTL (Nationally Recognized Testing Laboratory) approved
* Minimum 5-year warranty

#### Lighting Controls Project

*Lighting controls scope should be described so each space design criteria is specified individually, or by space type-groups where the same design criteria apply – this will allow bidders to clearly understand the brief.*

**Work Description**

The Contractor should describe execution and implementation for the following elements of the project:

* Removal and disposal of [*XX existing controls infrastructure from space type Y*] from [*name / specify locations to be retrofitted, repeat for each space type*].
* Provide and install [*XX existing controls infrastructure in space type Y*] in [*name / specify locations to be retrofitted, repeat for each space type*].
* Reuse of existing switches/line voltage wiring etc. where appropriate, should be encouraged. The Contractor should describe how this would be accomplished in support of reducing overall costs of the project, compared with full removal and replacement.

**Performance Specification**

*The Agency should include lighting controls functionality and features they wish to include in the SOW from the list below and modify the details and content of the items according to the specifics of the project. The unwanted list items should be deleted.*

*The Agency should also describe the extent to which there will be a requirement for the lighting controls system to exchange data with other networked systems such as building or energy management systems (BMS/EMS), heating ventilation and air conditioning (HVAC) systems, or other lighting and building systems via BACnet, Modbus, LonWorks or other open protocols, application program interface (API) or other methods.*

* Select appropriate lighting controls system to deliver advanced controls features required for this package, meeting DLC Networked Lighting Controls Technical Requirements and listed on DLC’s qualified products list, <https://qpl.designlights.org/networked-lighting-controls>.
* Lighting controls shall be “an intelligent network of individually addressable luminaires and control devices, allowing for application of multiple control strategies, programmability, building- or enterprise-level control, zoning and rezoning using software, and measuring and monitoring.” DesignLights Consortium Network Lighting Controls Requirements. <https://www.designlights.org/workplan/networked-lighting-controls-specification/>.
* Any selected Networked Lighting Control (NLC) system shall be listed on the DLC Networked Lighting Controls Qualified Product List (<https://qpl.designlights.org/networked-lighting-controls>).
* Many lighting control systems have provisions to allow for integration with other building management systems using BACnet (or other) protocol. If this function is desired, verify the availability of a BACnet (or other) interface with the vendor during design and specification.

Control Strategies for Implementation

1. Scheduling – the lighting control system shall allow the creation of a schedule that will determine which “control profiles” are in effect at what times. Assuming inclusion of occupancy/vacancy controls, schedules should be implemented to permit lighting operation, but not to turn lights on by default. The Contractor should implement this strategy at the zone level via the BAS.
2. Occupancy/vacancy sensing – occupancy/vacancy shall be determined using passive infrared (PIR), ultrasonic (US), dual-technology or other types of occupancy sensors (microwave, acoustic, etc.). The Contractor should implement a solution that turns lights on immediately in response to detecting occupancy of the lighting zone and switches off in response to vacancy following some pre-determined timeout period [suggest 20 minutes].
3. Tuning – the control system shall allow for presetting a reduction in light levels throughout a specific zone(s). This variable will be set in each control profile and will be active when a given profile is active based on the schedule. The Contractor should ensure that this functionality is provided. Design operation will be verified and approved as part of the commissioning process, specifically to achieve the desired task illuminance levels identified by the Agency.
4. Daylight harvesting – the availability and amount of daylight shall be determined using photosensors. Luminaires in areas with sufficient daylight shall dim (or potentially turn off) in response to available daylight if those options are selected in the control profile in use at a specific time. The Contractor should ensure that this functionality is provided. Design operation will be verified and approved as part of the commissioning process, specifically to achieve the desired task illuminance levels identified by the Agency.
5. Manual overrides – the following devices or methods may be used to manually control any zone or combination of zones [include those that are required on a project and delete the others]:
   1. Manual switches – wall mounted.
   2. Switching via appropriate Application Programming Interface (API), made available to local mobile devices / tablets
6. Security Lighting

**General Requirements**

The Contractor should provide a description of the proposed approach and methodology to satisfy the Scope of Work. This shall include:

1. Installation of new lighting control systems in accordance with local building code and manufacturers recommendations.
2. Removal and disposal of existing lighting controls products and refuse from the retrofit must comply with all state and federal regulations.
3. A diagram of the architecture of the proposed lighting control system.
4. A detailed description of how the proposed technology provides the capabilities listed in Scope of Work.
5. A description of any additional capabilities that may be of interest to the Owner but are not specified in the Scope of Work.
6. Where applicable, screenshots of selected product graphical user interface to clearly illustrate key operational, reporting, visualization, or analysis capabilities.
7. A description of the training and ongoing technical support and maintenance services that will be provided by the manufacturer.

**Lighting Retrofit – Completion Requirements**

Work can commence based on a final design drawings (DD) set signed off by a State-registered Professional Engineer (PE). Per the Construction Requirements and Responsibilities, The Contractor shall complete scope to include complete installation, including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work's conclusion.

### Building Envelope Retrofit / Replacement

*The Agency should organize scope so envelope retrofit activities are described for each structure or affected area of the structure as a coherent, integrated effort, so that work on roofs, walls and windows in the same area can be easily understood as being related / interconnected.*

Building envelope scope of work shall include the following elements: [*roof upgrade/replacement, wall insulation replacement, upgrade, and finishing, window (glazing and/or frames) replacement as follows*]:

#### Roof Replacement

*The Agency will need to determine what kind of roof is appropriate for the site in question. This will reflect characteristics and condition of the building(s), constraints on the work, and local environmental factors that influence choice and type of insulation.*

**Work Description**

The Contractor should expect to complete the following activities as part of the roof retrofit:

* Removal of existing roof
  + The existing roof system, insulation, flashings, and related trim shall be completely removed to the original decking and disposed of based on local requirements.
  + Provide all requirements for safety devices, chutes, cranes, dumpster locations, protection from the weather, protection of property and personnel, building access, contractor use of premises, parking, security procedures, equipment and materials storage, waste disposal, and other potential requirements.
  + Remove any unused towers, antennas, conduit, structural steel support, piping.
* Corrective maintenance to any of the supporting structure, including removal of dust, rust, and complete necessary sanding, patching, and painting
* Install new roof materials, appropriate to local climate and weather
  + The new roof shall be from a manufacturer with at least 5 years of producing selected roofing materials.
  + The roofing system shall follow local codes and high efficiency codes.

**Performance Specification**

* + Minimum overall roof U-factor < 0.200 in Climate Zones 1-5 and < 0.120 in Climate Zones 6-8.
    - Refer to the IECC Climate Zone map at https://basc.pnnl.gov/images/iecc-climate-zone-map
  + For climate zones 0-3, external low-slope roof surfaces should have 3-year aged solar reflectance rating of 0.55, a 3-year aged thermal emittance of 0.75, and a 3-year aged solar reflectance index of 64, in accordance with IECC Table 402.3.
  + All appropriate roof deck joints shall use high performance sealant as part of the foot system.
  + Sealant manufacturers must provide a warranty with a minimum of twenty (20) years for any repairs to maintain joints in a leak free condition.
  + Insulation shall meet or exceed current energy code requirements.
  + All rooftop HVAC curbing, skylights, parapet walls, pipe supports, pipe vents, roof hatch, and other roof penetrations must have new flashing installed as part of a roof replacement.
  + Perform any necessary corrective maintenance for all sections of gutters, remove dust, rust, and apply asphalt cement to seal.
  + Maintain building’s waterproofing integrity for the duration of the project

**General Requirements**

The Contractor shall complete all work unless otherwise specified herein. This should include the following:

* Install new roof materials in accordance with local building code and manufacturers recommendations.
* Removal and disposal of existing roof and roof insulation products and refuse from the retrofit must comply with all state and federal regulations.
* Ensure continuity of the air, water, and thermal management with the wall system to the extent possible considering the retrofit scope.

#### Wall Fabric / Insulation Project

*The Agency will need to determine what kind of insulation is appropriate for the site in question. This will reflect characteristics and condition of the building(s), constraints on the work, and the goal of the project itself. There are three options for insulation improvement:*

* *Internal wall insulation, typically used for older buildings.*
* *Cavity wall insulation, typically used for brick buildings, where the gap between the double brick layer is filled with foam or paper.*
* *External wall insulation, where the insulating material is fastened to the exterior of the building*

*There are pros and cons with each of these approaches that should be considered and discussed prior to selecting the appropriate option for inclusion in the SOW.*

**Work Description**

The Contractor should expect to complete the following activities as part of the wall insulation project.

* Remove [*all or a portion of*] existing insulation [*as indicated in drawing / site map X*]. Dispose of all materials in accordance with regulations and specifications.
* Provide and install [*new insulation to replace*] in [*name / specify locations to be retrofitted*].
* Installation needs to be phased in to minimize disruption to building occupants and users

**Performance Specification**

* For details on minimum wall U-factor < 0.200 in Climate Zones 1-5 and < 0.120 in Climate Zones 6-8. Refer to the IECC climate zone map
  + https://basc.pnnl.gov/images/iecc-climate-zone-map
* Reference IECC C402.1.3 and 402.1.4 in IECC for more code details.

**General Requirements**

The Contractor shall complete all work unless otherwise specified herein. This should include the following:

* Install new wall insulation in accordance with local building code and manufacturers recommendations.
* Removal and disposal of existing insulation products and refuse from the retrofit must comply with all state and federal regulations.
* Ensure continuity of the air, water, and thermal management with the wall system to the extent possible considering the retrofit scope.

#### Windows / Skylights Upgrade

*The Agency should determine the extent to which the windows project applies to the facility and specify locations (ideally referencing a site location map and building drawings showing units for replacement, for confirmation). The Agency should also decide whether the windows project comprises glazing only, or installation of insulated glass units (IGUs) that also include frames.*

*The Agency should select the appropriate Climate Zone column from Table X below and delete columns that do not apply.*

*Note that glazing Solar Heat Gain Coefficient (SHGC) performance specifications should also be considered, although this aspect is dependent on characteristics of the glazing and any solar shading present or proposed as part of a window retrofit. Visit the IECC website*[[6]](#footnote-5) *to determine appropriate specifications for the site and include it in the SOW specification OR direct the Contractor to the IECC website so that they select appropriately performing products.*

**Work Description**

The Contractor should expect to complete the following activities as part of the window / skylight project.

* Remove [*all or a subset of*] windows [*as indicated in drawing / site map X*], including related trim, and sealants. Dispose of all materials in accordance with regulations and specifications.
* Provide and install [*XX # of windows type 1*] in [*name / specify locations to be retrofitted.*].
* Provide and install [*XX # of windows type 2*] in [*name / specify locations to be retrofitted.*].
* Provide and install [*XX # of windows type X*] in [*name / specify locations to be retrofitted.*].

**Performance Specification**

* New windows and installation methods and materials must meet all current minimum energy performance requirements as indicated in Table X below.
* Reference IECC C402.1.3 and 402.1.4 in IECC for more code details.

Table X: Windows and Fenestration Minimum Performance Specification according to Climate Zone

| Climate Zone | 1 | 2 | 3 | 4 (except Marine) | 5 (+ Marine 4) | 6 | 7 | 8 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | U-factor | | | | | | | |
| Fixed fenestration | 0.5 | 0.5 | 0.46 | 0.38 | 0.38 | 0.36 | 0.29 | 0.29 |
| Operable fenestration | 0.65 | 0.65 | 0.6 | 0.45 | 0.45 | 0.43 | 0.37 | 0.37 |
| Skylights | 0.75 | 0.65 | 0.55 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Entrance doors | 1.1 | 0.83 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |

**General Requirements**

The Contractor shall complete all work unless otherwise specified herein. This should include the following:

* Install new windows in accordance with local building code and manufacturers recommendations.
* Removal and disposal of windows, frames and any other project-associated material or debris must comply with all state and federal regulations.
* Selection of appropriate fenestration products and materials, including considerations such as local climate, exposure to the elements, and the impact of any physical attachments proposed.
* Correct any damage and / or defects in the existing construction necessary to support appropriate installation and preserve expected useful lifetime of the selected product.
* Establish continuity of the air, water, and thermal management with the wall system to the extent possible considering the project scope. Ensure that the structural integrity of the affected part of the building is maintained.
* The Agency reserves the right to inspect and test all the work under this contract at any time. If any of the work does not conform to the contract requirements and specifications, the Agency may require the Contractor to perform the services again at no additional cost to the Agency.
* Windows are to match existing window style, functionality, and appearance unless otherwise indicated on contract drawings.
* Window installation includes all finishes and sealants.
* Installation of windows needs to be phased in to minimize impact to occupied areas.

**Envelope Project – Completion Requirements**

Work can commence based on a final design drawings (DD) set signed off by a State-registered Professional Engineer (PE). Per the Construction Requirements and Responsibilities, The Contractor’s scope shall include a complete installation, including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work's conclusion.

### Service or Domestic Water Heater Retrofit

*If the project scope is specific about equipment type for the project, The Agency should look to specify high efficiency equipment whenever possible. Cost-effective and significant savings can be realized without compromising the functional performance of the product; The energy efficiency specifications can be achieved by more than one manufacturer.*

**Work Description**

The Contractor’s design proposal shall include the following:

* Removal and disposal of existing [XX equipment and / or infrastructure] from [name / specify locations to be retrofitted].
* Provide and install new high-performance [XX equipment and / or infrastructure] in [name / specify locations to be retrofitted].

**Performance Specification**

* Capability to store hot water at ≥140°F, and supply hot water at >120°F.
* Qualifying equipment must meet at least the current ASHRAE 90.1\_2022 or IECC standard for the local climate zone. Install heat pump water heaters when possible.
  + New service hot water systems IECC standards are in section R403.5.
* For details on specific technologies and performance characteristics, search the commercial water heaters section of the EPA’s Energy Star website[[7]](#footnote-6).

**General Requirements**

* Install new domestic hot water heater systems in accordance with local building code and manufacturers recommendations.
* Removal and disposal of existing domestic hot water heaters and any associated materials or debris must comply with all state and federal regulations.
* Install all supply lines, electrical, ventilation, and plumbing as needed, to include but not limited to filters, pressure relief valves, controls, fittings.
* Tie the new domestic hot water heating system into the established domestic hot water supply stems, including all piping modification required.
* Clean and disinfect potable domestic water piping of existing piping that have been altered, extended, and repaired before using the system.

**Hot Water System Project – Completion Requirements**

Work can commence based on a final design drawings (DD) set signed off by a State-registered Professional Engineer (PE). Per the Construction Requirements and Responsibilities, The Contractor shall complete scope to include complete installation, including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work's conclusion.

### Renewable energy generation installation – Solar Photovoltaics

*Note that although the solar photovoltaics (PV) market is regarded as mature, maintenance, reliability and structural integrity issues persist in the industry. These are often due to substandard implementation practices, including selection of inappropriate modules, and poor structural design and installation – additional detail in this section has been included to reflect this accordingly.*

*Appendix A contains additional content also suitable for inclusion in this section, at the discretion of the Agency. As noted in the Purpose and Goals section, Appendix A should be deleted from the final SOW document once appropriate content has been moved from it to the SOW document.*

*The Agency should determine who will own and operate the solar PV system. If specified, the services of the Contractor could include ownership, operation, and maintenance of the system proposed.*

**Work Description**

The Contractor should expect to complete the following activities as part of the renewable energy generation project.

* Install a [*roof-mounted/carport roof/ground-mount*] PV system that [*meets X% of the current annual electricity consumption for the project site* ***OR*** *aim to maximize available space for installation of solar PV panels. For the latter, the Contractor should provide a clear estimate of the installed capacity and annual energy generation*].

**Performance Specification**

PV Modules

The Contractor shall refer to the nationally recognized test labs (NRTL) results of testing of modules by PV industry manufacturers to determine brands that have been qualified. Non-qualifying brands are not suitable for inclusion as part of the proposal.

1. PV Evolution Labs (PVEL) annual scorecard: <https://www.pvel.com/pv-scorecard/>
2. Renewable Energy Test Center (RETC) – PV Module Index (PVMI): <https://www.retc-ca.com/pvmi>

If quality standards are met first, then the Contractor shall seek to utilize EPEAT registered products.[[8]](#footnote-7) If quality and safety are met and then EPEAT registered products are not available or suitable, quality and safety standards shall take priority.

The Contractor shall ensure that modules delivered to the project site have the same bill of materials (BOM) as those tested by PVEL and RETC.

Inverters

The Contractor shall choose an inverter from the PV Evolution Labs Inverter Scorecard as follows:

1. Inverter test results published by PVEL:<https://www.pvel.com/inverter-scorecard>
2. The inverter shall comply with the latest version of the following requirements:
   1. UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, Supplements A and B
   2. IEEE (Institute of Electrical and Electronics Engineers) 1547
   3. IEC (International Electrical Code) 62109

Installation – Location Type-Specific Requirements

*The Agency should select from the following option(s) that apply to the intended location for the PV at their site, and delete requirements for locations that do not apply.*

1. **Arrays on Low-Sloped (gradient of between 2:12 and 4:12) and Flat Roofs (gradient <2:12)** 
   1. Rack systems shall be fully anchored to building structure or hybrid (combination of ballast and anchoring) but not solely ballasted. System must comply with Structured Engineers Association of California (SEAOC) PV2-2012 standards and with American Society of Civil Engineers (ASCE) 7-22 (regardless of version adapted in-state).
   2. Contractor shall select the racking-select system and install all roof systems to achieve roof friendly conditions on low sloped roofs. Roof friendly shall include:
      1. Unimpeded access to array to allow regular inspection and routine maintenance and repair
         1. Protect conduit, pipe, and/or duct runs passing underfoot from damage and allow for the movement of personnel, tools, and replacement parts.
      2. Unimpeded access to the underlying roofing system to allow for visual inspection and physical repair without requiring disassembly of the array.
      3. All walkways shall comply with the International Fire Code (IFC) and NFPA 101.
      4. No part of the array shall block access to other building equipment (HVAC, telecommunications, rigging).
      5. Any surface mounted conduit running parallel to the roof surface must be bridged by a commercially off the shelf (COTS) approved step bridge.
2. **For Ground or Carport Racking Systems:** Contractor shall provide:
   1. Purlins (Panels Rails) pre-drilled for panel mounting holes as specified by panel manufacturer
   2. Module frames shall not be used to stiffen purlins from torsional movement.
   3. “C” - Channel purlins preferred, with cross bracing with bolted joints is required to prevent torsional movement.
   4. If “Z” - Channel purlins are used, cross bracing with bolted fasteners is required.
   5. (No “Tek” Self – Tap screws allowed in racking structural fastening or panels fastening system)
   6. Purlin splices to be overlapped and over posts only.
3. **PV Ground Mount Racking:** Contractor shall provide:
   1. Ground Mount Racking to have front and rear support posts. (2 post design)
   2. Ground mounted rack must be braced for lateral forces with bolted fasteners in east-west AND north-south directions.
4. **PV Carport Structure:** 
   1. Contractor shall use a COTS design that can be engineered for the site conditions including weather, topography, soil conditions, marine corrosive, thermal cycles, etc.

**General Requirements**

The Contractor shall install a safe and reliable solar photovoltaic (PV) system(s) with an expectation for 30 years of service life. The electricity generated by the system(s) shall feed into local electrical distribution systems on the "customer side" of the utility meter. The Contractor will design and construct the solar PV system(s).

At a minimum, each system shall consist of:

* A solar PV generation system
* All necessary support structures and mounting provisions
* All necessary reinforcement of the existing support structure
* Terminal and combiner boxes
* Quick-connect solar panel electrical connector
* Cable and wiring
* Conduits
* DC disconnect
* Grid-tied inverter or module-level power electronics
* AC disconnect
* All metering and control equipment
* System monitoring and data retrieval subsystem
* Ground and arc fault protection and alarming
* An electrical grounding subsystem
* Everything necessary to interconnect with the site electrical distribution system

In addition, the Contractor shall provide all incidentals required, such as the agency's electrical distribution system impact studies and needed modifications, permits, approvals, environmental and historic compliance, freight, financing, procurement, monitoring, inspection, and billing as necessary to design, construct, operate, and maintain all the complete solar PV systems, described hereinafter.

**Exclusions**

The Contractor shall comply with the following guidance, or if not, shall present a compelling written and documented case for why any points below will not be adhered to:

* Existing IEC test standards are not considered adequate to screen modules and shall not be used to select modules. Investment grade BNEF Tier 1 modules shall not be used to represent qualified modules.
* Under no circumstances shall split washers, nylon-insert nuts, double-nutting, star washers, and/or serrated flange nuts be used to provide fastener locking capability.
* Under no circumstances shall self-tapping sheet metal screws of any grade be used to hold array structural elements together or to mount conduit, electrical enclosures, metering, and weather station components. Further, these screws shall not be used for field-assembled fencing, lighting, security camera systems, and communications equipment.
* Under no circumstances shall clamping systems be used to hold:
  + Underlying structural frame members together
  + Module frame to underlying structural frame member
* Under no circumstances shall nylon-containing plastic wire ties be used to secure DC string wiring regardless of the polymer and manufacturer's claims. An acceptable alternative is **Polyvinylidene fluoride (**PVDF) engineered plastic ties (e.g. Strongtie) or purpose-built stainless-steel wiring supporting device.

**Solar PV Project – Completion Requirements**

Work can commence based on a final design drawings (DD) set signed off by a State-registered Professional Engineer (PE). Per the Construction Requirements and Responsibilities, The Contractor shall complete scope to include complete installation, including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work's conclusion.

### Building system commissioning (Cx) or retrocommissioning (RCx) services

*This section can either be a) where commissioning is the main project element or covers existing equipment or systems remaining in place, or b) is part of a broader project effort where existing systems are upgraded or replaced, and will be commissioned once installed. For a) the pre-commissioning investigation task should be included in this SOW. This is necessary in cases where a building is underperforming / not meeting the needs of occupants and/or has not been commissioned recently (i.e., within the previous 5 – 10 years).*

*The objective of commissioning is to provide documented confirmation that the facility fulfills the functional and performance requirements of The Agency, occupants, and operators. To reach this goal, it is necessary for the commissioning process to establish and document The Agency’s Project Requirements, which are criteria for system function, performance, and maintainability (design intent); and to also verify and document compliance with these criteria throughout design, construction, start-up, and the initial period of operation.*

*Agencies are encouraged to require a Contractor to include a third-party Commissioning Agent (CxA) as part of their proposal. During construction, the CxA coordinates the execution of a testing plan, which includes observing and documenting all systems’ performance to ensure that the systems are functioning in accordance with the Agency’s Project Requirements and the contract documents. A third-party CxA provides the necessary independence from the Contractor that incentivizes positive practices and outcomes.*

*Appendix B contains additional detail suitable for inclusion in this section, at the discretion of the Agency. Appendix Y should be deleted from the SOW document once moved to the main body.*

***The Agency should modify the list of systems to be commissioned below as needed, and include details that apply to the project.***

*Where appropriate, the Agency should also include relevant detail to make the commissioning activities integrated across building systems (i.e., alignment in occupancy-based operations for lighting and HVAC systems) and therefore lead to better, more robust results and outcomes in terms of energy performance according to design intent.*

Commissioning

Coordinate and direct the commissioning activities of the systems covered below in a logical, sequential, and efficient manner, using pre-functional checklists, testing protocols, and supporting documentation to execute against the commissioning plan. Involve all relevant stakeholders in decision-making as needed. Produce a report that describes the processes adopted during, and results and outcomes from commissioning activities.

The following is a general list of systems and assemblies to be commissioned.

1. Central building automation system, including HVAC controls sequences of operation.
2. All equipment of the heating, ventilating and air conditioning systems
3. Scheduled or occupancy sensor lighting controls
4. Daylight dimming controls and interior dimming system controls
5. Lighting and Lighting Control Systems and Clock Systems
6. Building envelope including the different types of curtain wall assemblies (specify roofing, windows and doors, construction joints, etc.)
7. Electrical (service switchgear, switchboards, distribution panel boards, transformers, motor control centers, power monitoring and metering, transient voltage surge suppressors, variable speed drives, grounding and ground fault systems, overcurrent protective devices, low voltage busway, thermographic survey, electronic calendaring or directory, white sound system).
8. Domestic water pumping systems
9. Plumbing
10. Solar photovoltaics system

**Performance Specification**

The Contractor shall complete the following activities:

* Update commissioning plan according to systems and components installed, process to be followed, documentation and reporting requirements, and schedule.
* Field verification of installation, start up and initial checkout for safe operation and effective operation of equipment and systems.
* Functional performance testing for new or modified systems, during the construction phase. Testing procedures must comply with manufacturers’ recommendations, and documentation shall record results of tests, and note pass/fail as appropriate, according to descriptions and metrics included in the Design Intent. For failed tests, maintain an audit trail of changes required to achieve a satisfactory (pass) outcome.
* Final acceptance recommendation to the Agency. Provide documentation that summarizes ‘pass/fail’ status for all functional performance tests. In instances where there is existing ‘fail’ status, describe a process through to satisfactory resolution of issues in order that these items will ‘pass’.

**General Requirements**

The Contractor shall expect to do the following:

* Independent of the design team, conduct a review of the design prior to the construction documents phase and report results, findings, and recommendations
* Conduct a review of the construction documents near their completion and prior to issuing the contract documents for construction.
* Conduct at least one commissioning review of the Design Intent, Basis of Design (BoD), and A/E design documents prior to the construction phase,
* Review the contractor submittals relative to systems being commissioned for compliance with project requirements and Basis of Design.
* Provide the Agency with a single manual that contains the information required for re-commissioning building systems.
* Have a contract in place to review building operations with Agency O&M staff, including a plan for resolving outstanding commissioning-related issues, within 10 months after substantial completion.

More detail for requirements during the commissioning process are included in Appendix B.

**Building System Commissioning – Completion Requirements**

Work can commence based on a final design drawings (DD) set signed off by a State-registered Professional Engineer (PE). Per the Construction Requirements and Responsibilities, The Contractor shall complete scope to include complete installation, including all necessary supporting structural, architectural, and other service considerations to create a fully safe and functioning site, ready for occupation at work's conclusion.

# Tasks

*This section is intended to outline specific tasks and activities to be performed under this scope of work, including design and construction elements. This may be used independently or inside of the RFP based on the structure of the project contracting. The construction may be bid on independently.*

## Design Phase

Using the SOW, the Contractor shall provide design services and documentation (drawings, specifications) to support the construction phase of the project. This includes the following:

### Schematic Design

The Contractor shall create a Basis of Design (BOD) document. The BOD will describe design requirements for the scope of work, specifications, and standards for the project. The BOD documents shall provide sufficient detail to illustrate, describe and clearly delineate the design intent to allow for detailed design for construction. All design items in this scope of work are to be addressed and included in the project drawings and specification sections where appropriate. Specific items to address are:

* Project overview
* Design objectives
* Technical specifications
* Sustainability considerations
* Size and layout
  + Schematic Design (SD) Phase (with examples)
  + Floor plans
  + Schematic site plans
  + Crucial building sections, with detail as appropriate
  + Exterior elevations
  + Sufficient details for the design team to proceed to the next phase of design development with approval from the Agency or their representatives (see description of approval requirements in the final bullet point)
* Relevant energy efficiency standards
* Safety and compliance requirements (including applicable codes), e.g.,:
  + ASHRAE 90.1 (energy performance)
  + ICC International Energy Conservation Code (IECC)
  + NFPA 70 - National Electric Code (NEC)
  + UMC Uniform Mechanical Code (UMC)
  + ASHRAE Standard 55 - Thermal Environmental Conditions for Human Occupancy
  + ASHRAE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality
  + Local, state, and federal
  + Other construction requirements shall be identified in the design documents.
* [*Specify any client approvals required during the design phase from all relevant authorities, and that are necessary to proceed with design development*]

### Design Development

The Contractor shall complete design development (DD) documentation according to schedule established as part of this task. Specific requirements include:

* Create a design development task schedule. This may be included as part of the scope of work proposal, or as part of the RFP response. This will consist of:
  + Site Access Approvals & Schedule Design Kick-off Meeting
  + Survey and Assessment Phase (if needed)
  + Design Development (DD) Phase (with examples)
    - Comprehensive building sections
    - Detailed and accurate elevations
    - Initial specifications of equipment
    - Takes the schematic design to generate a clearer representation of the final project.
* Design progression documents (e.g. 50% and 100% DD sets)
* Cost estimates that reflect the 100% DD set

### Construction Documents

The Contractor shall prepare a set of plans and specifications that describe the detail of the project. This task shall include development and submission of the following:

* Final design construction documents (CD) include, but are not limited to, floor plans, architecture, mechanical, electrical, and elevation drawings, and site plans.
* At conclusion, the final design drawing set shall be signed off by a State-registered Professional Engineer (PE).

## Construction Phase

*This section should be supported by the desired project management program / implementation schedule. Agencies should specify requirements for regular reporting (i.e., no less frequently than quarterly) that will cover the general progress of the project. They should also consider how best to support planning and mitigation for issues that may contribute to delays. Agencies may wish to provide a project planning and implementation template that meets their requirements to ensure a satisfactory response.*

Referring to the Construction Documents, the Contractor shall describe the construction services to be provided under this SOW, adding relevant detail where necessary. This should include the following:

* Site construction administration, and requirements and documentation to be produced for all construction job meetings
* Description of necessary construction activities, including materials, methods, and safety considerations to assure compliance with all safety, plans, specifications, and other contract documents.
* Document identifying key construction milestones and deliverables, and describing key project constraints.
* Documentation to support and report construction activities
  + Construction Schedule
    - Revised versions submitted as required
  + As-built drawings
  + Commissioning Plan
  + Commissioning Report
* Related to the project implementation schedule and planning, Contractors should develop a risk register that appropriately identifies, allocates and manages project risks.
* Specify any approvals required during the construction phase.
* Other services offered during this phase with a narrative of these services.

## Measurement and Verification (M&V) (Optional)

*This section should include a description of the goals and objectives of the proposed measurement and verification activities, and include or link to appropriate templates, such as for the proposed M&V plan. M&V may be bid on independently.*

*Agencies may wish to provide a template M&V plan to support the proposal for this activity.*

**Work Description and General Requirements**

M&V activities shall comprise the following elements:

* Development of a plan for ongoing measurement and verification of energy savings, and indoor environmental quality (IEQ) measurements (the M&V plan). This should encompass initial baseline energy usage measurements, regular monitoring post implementation, and methods for validating energy savings against baseline.
* [Optional] An M&V template will be provided for federal U.S. Department of Energy Renew America’s Schools grant reporting purposes. Data required to fill in that template includes, but not limited to, energy (kWh and kW)) generated and consumed and thermal energy consumption for at least 12 months in the base case prior to any implementation of measures in this scope of work and at least 12 months in the post case, after all measures have been complete, and IEQ measurements, such as indoor carbon dioxide and particulate matter concentrations in room air.
* Execution of the M&V plan, including analysis of the data collected, as described therein.

**Performance Specification**

* Data collected during post-retrofit periods will be processed and analyzed to support rigorous comparison of the baseline and retrofit cases, to determine the estimated benefits of the retrofit in terms of energy savings and indoor environmental quality.
* For retrofits that include HVAC, weather normalization of energy data is required. The M&V schedule should include a total of 6 months of measurement and data collection, and include periods in the peak heating and cooling seasons, to support a rigorous analysis of energy savings (for example, solstice-to-solstice).
* The M&V analysis should be updated with new data quarterly according to the process described in the M&V plan, with a final annual report using IPMVP C, the whole building method.

# Handover and Closeout

*This section should describe in full the prerequisites to project handover and sign off from The Agency or Agencies Representative.*

The Contractor shall complete the following tasks and comply with the relevant requirements of the process and protocols described by the documents identified herein:

**Mandatory Handover Procedures and Related Documentation**

* Commissioning Report, signed by a state-registered Professional Engineer (PE).
* Develop and document a performance assurance plan that includes strategies for measuring and presenting baseline consumption and operating hours, design consumption and operating hours, as-installed consumption, and operating hours for each ECM; provides for appropriate commissioning, M&V, operations and maintenance (O&M), and periodic process review to assure performance at design targets for the life of the equipment. Training on all equipment, with video recordings of the trainings available when possible
* Operations and Maintenance (O&M) equipment manuals provided, including operating procedures, maintenance procedures, frequency, cut sheets, parts lists, warranties, guarantees, and detailed drawings for all equipment installed.
* Certify a 10-year warranty that covers the design, construction, and equipment-provided O&M services
* Close out documentation and certification of project completion in accordance with contract documents

**Construction Site Condition**

* The site must be restored to pre-construction condition, including making all infrastructure, surfaces and finishes in accordance with standard of construction work.
* Appropriate disposal of all site materials - compostables, reusable materials, recyclable materials (including recyclable material fractions) and waste.
  + Hazardous work processes and hazardous materials utilized or generated in the performance of this contract shall be controlled and disposed of by the Contractor in a manner that is safe and in accordance with the appropriate local, state and US Government laws and directives established for the control of those processes and materials.

**Work Specification Requirements**

All new work shall conform to the applicable codes and standards, such as the following – the Contractor shall use the most current version at the date of this contract’s award:

* National Fire Protection Agency, National Electrical Code
* NFPA, Standard for Electrical Safety in the Workplace
* NFPA, Life Safety Code
* Institute of Electric and Electronic Engineers, National Electrical Safety Code
* Unified Facilities Criteria, Seismic Design for Buildings
* UFC, Electrical Engineering
* Illuminating Engineering Society of North America, Lighting Handbook
* International Energy Conservation Code

**Environmental Compliance**

* The Contractor shall comply with all Federal, State, and Local regulations, as well as Agency installation rules and policies regarding the use, storage, transport and disposal of hazardous materials and wastes.
* Hazardous work processes and hazardous materials utilized or generated in the performance of this contract shall be controlled and disposed of by the Contractor in a manner that is safe and in accordance with the appropriate local, state and US Government laws and directives established for the control of those processes and materials.
* The Contractor shall provide for clean-up of all hazardous and non-hazardous spills when they may occur in, around, or as a result of the Contractor’s operation. The Contractor shall also provide for transportation and disposal off the facility of all hazardous and non-hazardous waste products generated in the performance of this contract. The Contractor shall immediately notify the Agency or their representatives of any hazardous waste spills.

# Project Timeline: (Optional)

*This section may be omitted if it is included in the RFP response.*

Provide a detailed timeline for the entire project (sample table below), including milestones, key dates, and completion deadlines for each phase.

This should contain detail that applies to all the building system projects SOW sections, so that The Agency is able to clearly understand how the different elements (i.e., HVAC, lighting) of the scope are to be implemented as part of a coherent plan.

| Task | Anticipated Completion Date |
| --- | --- |
|  |  |
|  |  |
|  |  |
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|  |  |

# Deliverables

*This section should include a list of all documentation and deliverables expected from the project, such as design documents and drawings, construction plans, reports, and any other relevant items.*

The Scope of Work deliverables to include *(examples)*:

* Design documentation.
* Construction plans including permit set stamped and signed by architects and/or engineers of record.
* Detailed findings and supporting analysis by individual building.
* Performance Assurance Plan including commissioning, M&V, and O&M
* O&M manuals for all equipment.
* Warranty documentation for all equipment.
* As-Built drawings in hard copy and electronic format.
* Closeout package.

# Appendix A – Additional Guidance on Solar PV Implementation

*The Agency should select the sections below that apply to the desired solar PV installation location and include it in the section solar PV Performance Specification section in the main body of this SOW document. This Appendix should be deleted from the final version of the SOW.*

**Notes and Exclusions**

* The Contractor shall seek a letter from the module manufacturer agreeing to the mounting method (type, quantity, location of fastener) based on the wind, snow, and ice accumulation characteristics identified.
* Through-bolt modules to the underlying racking only top-down clamps shall be avoided except for steep sloped roof systems that require top fastening to rails.
* Use of chemical locking compounds is discouraged.
* For stainless threaded fasteners, application of anti-galling compounds shall be used.
* All fasteners must be locking and meet DIN 65151 standards using Junker tests described in the standard.
* Sub-assemblies and fasteners shall be torqued to manufacturer’s specification using torque wrenches or drivers designed to provide calibrated and metered forces and be rated by ISO 6780-2. Follow manufacturer’s assembly procedures and recommended torque values. At a minimum, field assembly and audit procedures shall use an assembly tool that provides metered torque values and mark torqued fasteners (torque-striped) to aid in commissioning and auditing. For field- assembled components of disparate manufacturers or from custom fabrications, the engineer of record (EOR) shall specify torque ratings and field assembly procedures to be included in submittals and construction drawings. These torque ratings and procedures shall be included in operations and maintenance manuals for later use.
* All PV racking components shall be of corrosion-resistant material. Aluminum, hot-dipped galvanized, or pre-galvanized steel may be used under ASTM A123 or ASTM A653 specifications. Fasteners shall be compliant with ASTM F2329 or ASTM F2833.
* For fasteners holding friction or clamping forces, Section 3.3 of ICC AC 428, 2012 shall apply.

# Appendix B – Additional Guidance on Commissioning Tasks

*The Agency should select the sections below that apply to the required commissioning tasks and include it in the Commissioning section of this SOW document. This Appendix should be deleted from the final version of the SOW.*

**Commissioning Tasks**

1. Coordinate and direct the commissioning activities in a logical, sequential, and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
2. Coordinate the commissioning work with the design team and construction manager, to ensure that commissioning activities are being incorporated into the master schedule.
3. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures. Before start-up, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
4. Review submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the design team and Construction Manager reviews.
5. Review requests for information and change orders for impact on commissioning and Agency objectives.
6. Review coordination drawings to ensure that trades are making a reasonable effort to coordinate.
7. Write and distribute construction checklists for commissioned equipment.
8. Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.
9. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress.
10. Where appropriate:
    1. Witness HVAC piping pressure test and flushing, sufficient to be confident that proper procedures were followed. Include testing documentation in the Commissioning Record.
    2. Witness any ductwork testing and cleaning sufficient to be confident that proper procedures were followed. Include documentation in the Commissioning Record.
11. Document construction checklist completion by reviewing completed construction checklists and by selected site observation.
12. Document systems start-up by reviewing start-up reports and by selected site observation.
13. Approve air and water systems balancing by spot testing and by reviewing completed reports and by selected site observation.
14. Coordinate functional testing for all commissioned systems and assemblies. Witness and document manual functional performance tests performed by the Construction Contractor for all commissioned systems and assemblies, except: a) some smaller equipment may be tested and documented by the Construction Contractor at the Commissioning Agent’s discretion, b) electrical equipment testing and regulated testing may be directed and documented by the Construction Contractor with only spot witnessing and report review by the Commissioning Agent. The functional testing shall include operating the system and components through each of the written sequences of operation, and other significant modes and sequences, including start-up, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, security alarm when impacted and interlocks with other systems or equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors, and spot-checked by the commissioning provider during functional testing. Analyze functional performance trend logs and monitoring data to verify performance. Coordinate retesting as necessary until satisfactory performance is achieved. Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling seasons. However, some overwriting of control values to simulate conditions shall be allowed. Functional testing shall be done using conventional manual methods, control system trend logs, and readouts or standalone data loggers, to provide a high level of confidence in proper system function, as deemed appropriate by the Commissioning Agent and The Agency.
15. After annual testing and initial trouble shooting is complete, monitor system operation and performance for selected data points for up to two weeks by requesting trend logs from the Construction Contractor from the building automation system. For needed system points not able to be trended by the building automation system, furnish and install temporary portable data loggers that will monitor up to 20 points. Analyze monitored data to verify operation and performance and issue a written report. This time frame and monitoring points may be modified to accurately commission the building.
16. The final acceptance tests of all fire protection and life safety systems shall be witnessed by The Agency’s Fire Protection Engineer or their designated representative. Testing and commissioning for the fire protection and life safety systems shall be per the requirements of those sections of the specifications and the applicable governing codes and standards. No building or portion thereof shall be occupied until the Fire Protection Engineer has issued a certificate of occupancy. Once the Fire Protection Engineer has ensured that to the best of their knowledge all the fire protection and life safety systems have been completed, inspected, successfully tested and approved and all outstanding fire and life safety deficiencies have been corrected to afford a reasonable degree of safety to the building occupants from fire and similar emergencies, a certificate of occupancy will be issued.
17. Maintain a master issues log and a separate record of functional testing. Report all issues through the Construction Manager as they occur. Provide through the Construction Manager written progress reports and test results with recommended actions.
18. Review equipment warranties to ensure that The Agency’s responsibilities are clearly defined.
19. Facilitate, oversee and review the training of The Agency’s operating personnel. Oversee the videotaping of this training. Attend and participate in key training sessions.
20. Review the preparation of the O&M manuals for commissioned equipment.
21. Compile a Commissioning Record, which shall include:
    1. A brief summary report that includes a list of participants and roles, brief building description, overview of commissioning and testing scope, and a general description of testing and verification methods. For each piece of commissioned equipment, the report shall contain the disposition of the commissioning provider regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:
       1. Equipment meeting the equipment specifications,
       2. Equipment installation,
       3. Functional performance and efficiency,
       4. Equipment documentation, and
       5. Operator training.
    2. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.
    3. Also included in the Commissioning Record shall be the Commissioning Plan, Owner’s Project Requirements (from the Agency’s PM), Basis of Design (from A/E), commissioning specifications, design review, submittal review, issues log, construction checklists, CxA site visit and Commissioning Team meeting minutes, O&M review, training documentation, test procedures, warranty review and test data reports.
    4. A Recommissioning Management Manual which provides guidance and establishes timelines for recommissioning of building systems and components. The format of the Recommissioning Management Manual will closely parallel the Commissioning Plan for the facility.
    5. Submit 3 bound text copies of the Commissioning Records with 3 CD copies including all information listed in B & C above.
22. Coordinate and supervise required opposite season or deferred testing and deficiency corrections and provide the final testing documentation for the Final Commissioning Report and O&M manuals.
23. Return to the site at 10 months into the 12-month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have with operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reporting processes and protocols to address new operational issues as they arise.
    1. Investigation Phase
       1. Provide a site assessment to develop an in-depth understanding of building systems.
       2. Provide an assessment report with a list of deficiencies and potential improvements with detailed calculations with simple paybacks.
    2. Implementation Phase
       1. This may be the responsibility of the site, or the RCx agent that implements the measures recommended in the assessment report.
    3. Verification Phase
       1. Once completed, a Commissioning agent will perform verification with approved methods, metering, visual inspection, etc. for each implemented measure.
       2. NOTE: where the SOW comprises commissioning activities, it is recommended that the commissioning agent be an independent third party.

Attachment A: Facility Profile

1. Facility Location, Address, and Primary Contact Information

Name of Campus/site:

Address of Building:

Building Contact:

Phone:

Email:

1. Site Physical Data

Total Facility Floor Area:

Floor Area Affected by Project (if Different):

Space Use Types and Number:

Building A

| Space Types | Number | Total Floor Area |
| --- | --- | --- |
| Classrooms |  |  |
| Administration |  |  |
|  |  |  |

1. Site Operating Schedule

| Semesters and Holidays | Operating Hours | Start Date | End Date |
| --- | --- | --- | --- |
| Fall |  |  |  |
| Spring |  |  |  |
| Spring Break |  |  |  |
|  |  |  |  |

1. Utility and Energy Data

Utility and Fuel Use Summary (at least 12 months):

| Month, Year | Fuel Type | Consumption | Consumption per Unit Area (kBtu/ft2) |
| --- | --- | --- | --- |
|  |  |  |  |

1. Building Systems Inventory (Optional, but recommended)

[*XX school is heated by [XX fuel] boilers which circulate hot water through finned tube baseboard heaters. There are also direct-fired furnaces that provide conditioned air to select spaces throughout the facility. The HVAC system has a [manufacturer name] pneumatic system for maintaining space temperatures.*

*The major equipment includes:*

*Fans and Pumps*

*Heating Boilers*

*Chillers*

*Domestic Hot Water*

*Rooftop Units and Air Handling Units*

*Temperature Controls*

*Lighting*

*Lighting Controls*

*Other*

* ]

***EXAMPLE BEGINS →*** [*Lighting:*

*The building is primarily lit by 32-Watt linear fluorescent T8 lamps with electronic ballasts, as well as some compact fluorescent lamps (CFL), incandescent, and LED general purpose lamps. Fixture types include 2-lamp or 4-lamp, 2-foot or 4-foot-long troffers, surface mounted wraparound fixtures. Most fixtures are in good condition.*]

***← EXAMPLE ENDS***

***EXAMPLE BEGINS →*** [*HVAC Systems and Equipment:*

*The building is heated by [number and sizes/capacities] natural gas fired RTUs and a hot water baseboard system which serves the classrooms. The baseboard hot water is heated using two natural gas-fired boilers: two (2) 2,000 MBH condensing AERCO Modulex boilers, in fair condition and installed in 2005. The condensing boilers have a nominal thermal efficiency of 93%. The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include hot water pump motors, exhaust fan motors and variable speed supply fan motors.*]

***← EXAMPLE ENDS***

***EXAMPLE BEGINS →*** [*Domestic Hot Water Systems*

*The domestic hot water heating system is met by [number and sizes/capacities] A.O. Smith water heater(s) with an integrated 100-gallon storage tank which supplies hot water to the kitchen. The system is in good condition.*]

***← EXAMPLE ENDS***

1. Site Environmental Conditions

| Space Types | Pollutant | Concentration and metric |
| --- | --- | --- |
| Classrooms |  |  |
|  |  |  |

1. Priority Areas for Improvement
2. Special Circumstances for Consideration
   1. Other Planned Project

1. <https://www.energy.gov/management/build-america-buy-america> BABA may be a requirement of certain U.S. federal grant awards. [↑](#footnote-ref-0)
2. <https://portfoliomanager.energystar.gov/pdf/reference/USNational%20Median%20Table.pdf>

   3Thousand BTU [↑](#footnote-ref-1)
3. https://www.ahrinet.org/certification/cee-directory/cee-directory [↑](#footnote-ref-2)
4. https://www.energystar.gov/productfinder/?s=mega [↑](#footnote-ref-3)
5. https://www.designlights.org/wp-content/uploads/2023/07/DLC\_SSL-Technical-Requirements-Tables-V5-1\_07112023.pdf [↑](#footnote-ref-4)
6. https://codes.iccsafe.org/content/IECC2021P1/chapter-4-ce-commercial-energy-efficiency, Table 402.4 [↑](#footnote-ref-5)
7. https://www.energystar.gov/products/commercial\_water\_heaters [↑](#footnote-ref-6)
8. https://www.epeat.net/search-pvmi [↑](#footnote-ref-7)