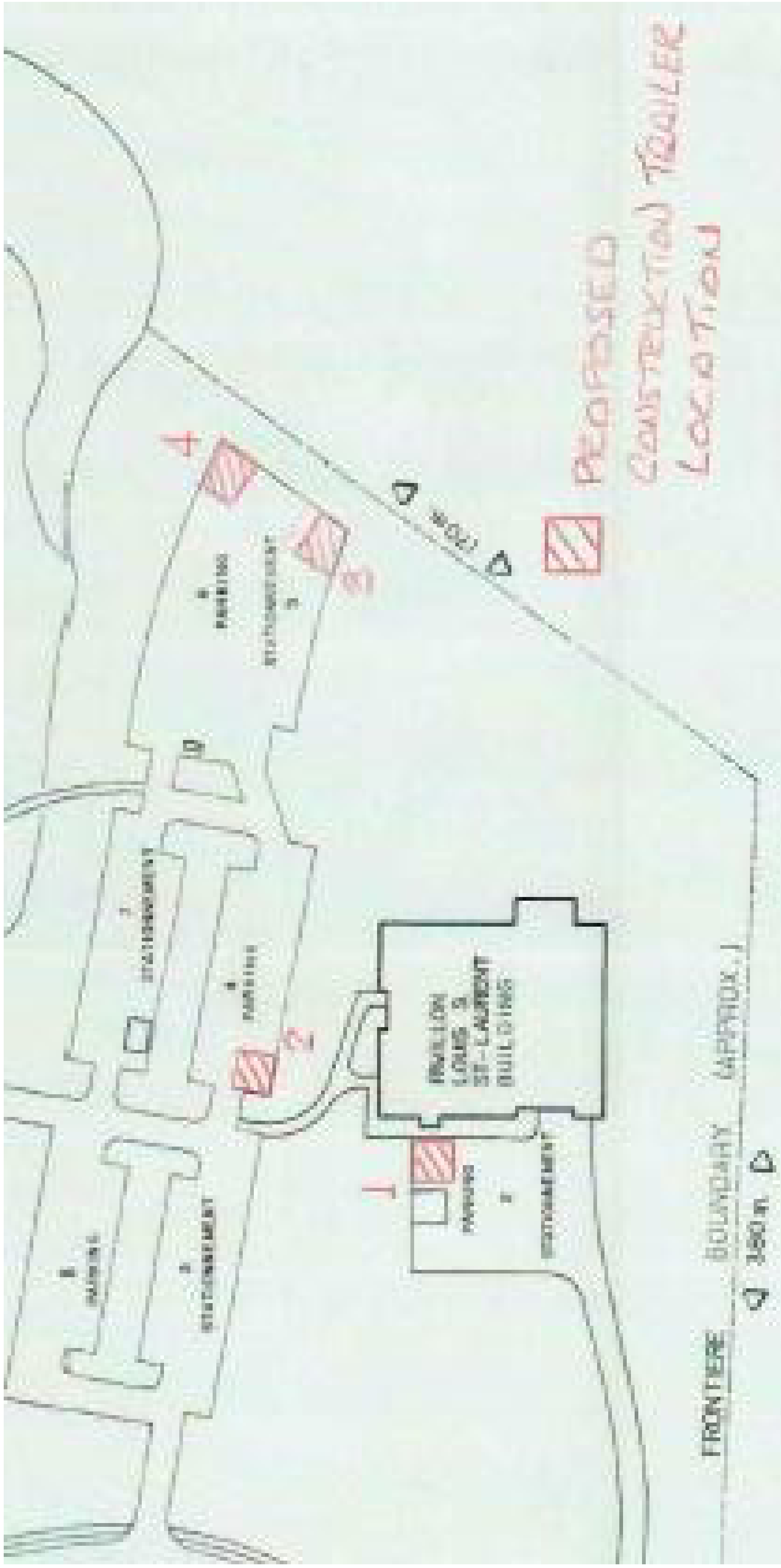
Appendix A

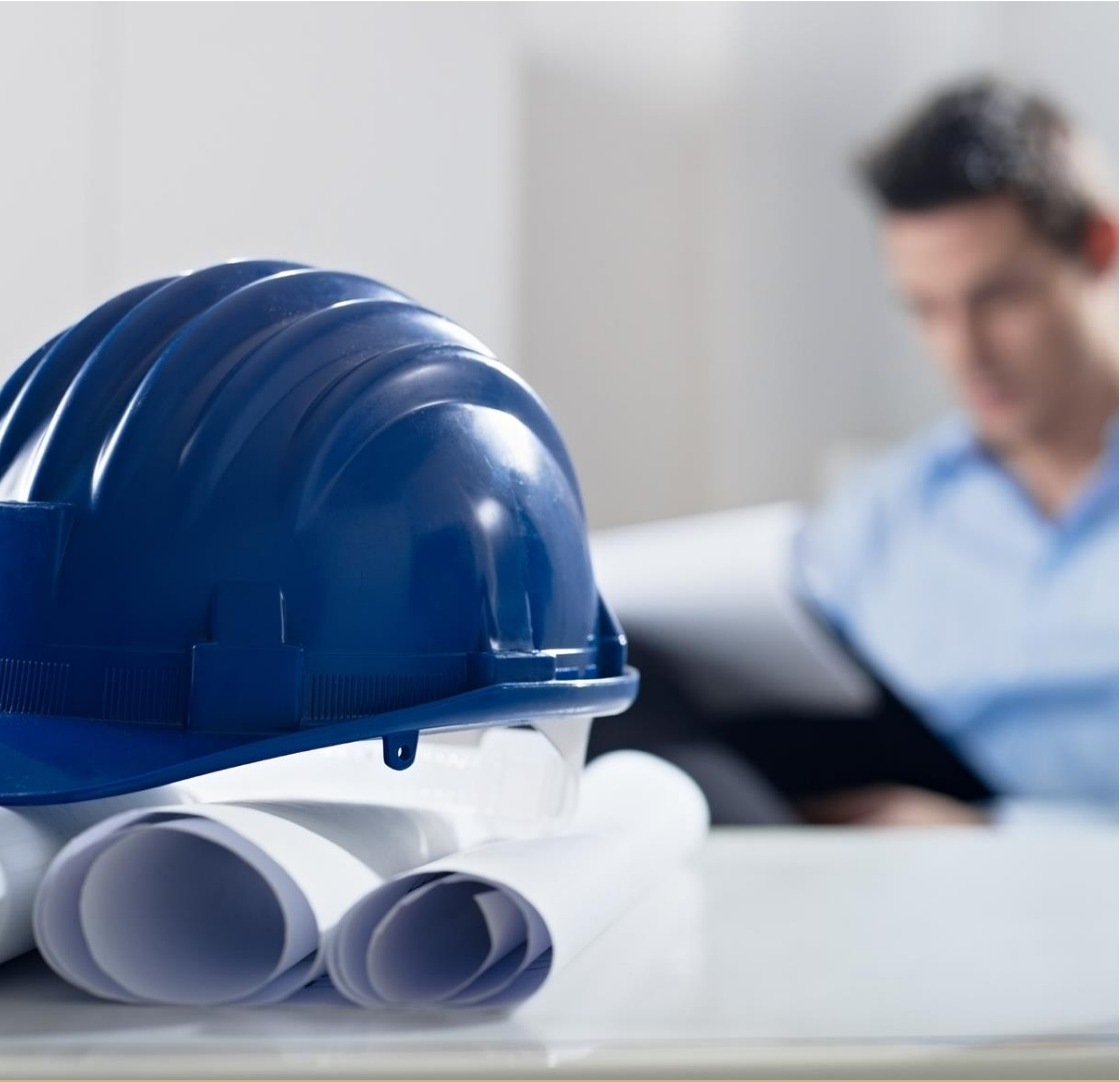
Site Limits


PROPOSED
CONSTRUCTION TRAILER
LOCATION
1
2
3
4
PAVILLON
LOUIS S.
ST-LAURENT
BUILDING
FRONTIERE
BOUNDARY (APPROX.)
380 m
170 m

Appendix B

Commissioning Documents

- Owners Project Requirements (OPR)
- Preliminary Commissioning Plan



Owner's Project Requirements

MARITECH
COMMISSIONING WORKS

77 VAUGHAN HARVEY BLVD., SUITE 210
MONCTON, NEW BRUNSWICK
E1C 0K2

Maritech Project No. 15-18-004

Public Works and Government Services Canada

Project No. R.065476.700
Mechanical & Sprinkler Upgrades,
Canadian Coast Guard College,
Sydney, NS

March 2018

TABLE OF CONTENTS

1 VERSION TRACKING

Submission Date	Comments
March 18, 2018	Draft Submission to PWGSC for review

2 INTRODUCTION

2.1 BACKGROUND

The Canadian Coast Guard College (CCGC), located in Westmount, NS is home to the Coast Guard's four year Officer Cadet training program. The College was built between 1981 and 1984 and house up to 300 cadets and college staff and operates year round. The college is comprised of a Main Campus consisting of twelve interconnected buildings and three other buildings for an approximate area of 37,000 m^2.

Main Campus
- Cabot
- Artic
- Atlantic
- Pacific
- Great Lakes
- Saquenay
- Miramichi
- MacKenzie
- Telecom/MTCS
- St. Laurent
- Alert
- D'Iberville Centre

Other Buildings
- Louis S. St Laurent Marine Engineering Training Building
- Walter E. Foster Boathouse
- George L. Hopkins Pavilion

Not include in Project
2 staff residence also located on the site

While some upgrades were completed between 2008 and 2013 on the campus HVAC systems, the majority of the mechanical systems are original to the college buildings and have reached the end of their working life. This poses a significant risk in operating the College as most of these systems are no longer reliable and there are no parts available to maintain the existing equipment.

2.2 PURPOSE OF THE PROJECT

The Canadian Coast Guard College will undergo a midlife mechanical systems upgrade including the replacement of the original HVAC and Controls Systems, the replacement of the dry sprinkler system in the residences, and the introduction of green technologies like a seawater heating and cooling exchange system. The aim is to reduce overall energy consumption and GHG emissions, increase comfort, indoor environmental quality and safety in the campus.

2.3 DELIVERY OF THE PROJECT

Public Works and Government Services Canada (PWGSC) has been tasked with completing this project on behalf of the building Owner and the primary tenant at the college. They have assembled a project team consisting of the following members:

Public Works and Government Service Canada	Owner Representative
Department of Fisheries and Oceans	Building Owner
Canadian Coast Guard	Primary Tenant
Maritech Commissioning Works Ltd.	3rd Party Commissioning Agent
M&R Engineering	Prime Consultant
M&R Engineering	Mechanical, Electrical Engineering
M&R Engineering	Energy Modelling
Campbell Comeau Engineering Limited	Structural Engineering
Exp Architects Inc.	Civil Engineering
Colliers International	Project Management
R J Bartlett Engineering Ltd.	Code Compliance
Lydon Lynch	Architectural
QSolv Incorporated	Cost Management

2.4 PURPOSE OF THE OWNER'S PROJECT REQUIREMENTS DOCUMENT

The Owner's Project Requirement (OPR) is a written document that details the Owner's functional requirements for a project and their expectations of how the building will be used and operated. The OPR forms the foundation for the design, construction, occupancy and operation of the facility and lays the foundation for the Construction Documents and the Commissioning Process. The OPR is to be considered a living document and should evolve during the development of the project.

This OPR document was prepared by Maritech Commissioning Works, the Commissioning Agent for the project, and is based on information found in the following documents:

- *Request for Proposal – Commissioning CCGC Mechanical Upgrade*, dated December 2017
- *RS-3 Design Development Report – Mechanical & Sprinkler Upgrade Project, Canadian Coast Guard Project, Sydney, NS*, dated August 15, 2016

This initial OPR document outlines the requirements of the systems and equipment at the beginning of the project. Over time, as the use of the facility evolves, these requirements may become outdated. It is incumbent upon the facility's operation and maintenance staff to update the OPR document as changes occur. The document would then outline the requirements of the facility at that point in time and would serve as the foundation for any future recommissioning exercises.

It is therefore the operation & maintenance staff's responsibility to review and update the OPR on a minimum annual basis in order to ensure that any changes in the requirements are documented. This review should be done in consultation with all building stakeholders to ensure that all new requirements are documented.

3 OWNER'S PROJECT REQUIREMENTS

3.1 GENERAL PROJECT DESCRIPTION

The project will consist of upgrading the existing mechanical and sprinkler systems at the CCGC that have reached the end of their working life. This will include the following:

- Replacement of select sprinkler systems, including the addition of pre-action systems to certain areas;
- Upgrade heating, ventilation, air-conditioning and control systems throughout the majority of the campus, including the provision of a new seawater heating and cooling heat pump plant;
- Upgrade of the electrical distribution system associated with the new mechanical equipment;
- Hot water heaters/plants for plumbing systems;
- Pool water filtration, treatment and pumping systems at D'Iberville.

3.2 OBJECTIVES

The primary objectives of the project are as follows:

- Upgrade the mechanical equipment, systems and infrastructure in order to increase operational reliability and overall safety;
- Reduce energy consumption and associated greenhouse gases with high efficiency equipment and sea water based geothermal heating and cooling system;
- Improve indoor air quality through improved ventilation and humidification;
- Improve thermal comfort by adding air conditioning.

3.3 FUNCTIONAL AND PERFORMANCE REQUIREMENTS

The following elements are required to meet the functional and performance requirements of the Owner and end users:

- The completed project must meet the PWGSC expectations for quality. The PWGSC Quality Review process will be followed. A 3rd party commissioning agent will help ensure that the work meets the Owner's Project Requirements and the Design Intent.
- The primary mission of the College will remain the same for the foreseeable future. All equipment and system performance must support this mission by delivering and indoor environment which is in keeping with the intended use of each building and the individual spaces within these buildings. These conditions, based on the national Building Code of Canada, are summarized as follows:

Ambient	Winter	-19°C DB; 1%NBCC
	Summer	27°C DB, 21°C WB; 2.5% BNCC
Indoor	Winter	21.1°C, 30% RH (if humidification is available)
	Summer	23.9°C, 50% RH
Exceptions		
D'Iberville Pool	Summer	28.9°C, 50% RH
Walter E. Foster Boathouse	Winter	8°C (no summer conditions)
Seawater Pumphouse	Winter	21.1°C (no summer conditions)

- Sufficient training must be provided to the facility's operations and maintenance staff to ensure:
    - A solid understanding of the design intent and the fundamental operating strategies in order to maintain performance and efficiency at optimal levels;
    - The capability exists to operate the equipment and systems at their peak performance levels;
    - The capability exists to conduct regular maintenance to ensure a high level of performance and long term reliability;
    - An understanding of the expertise required to address equipment issues and identify situations where qualified outside contractors are required.
- Meet all applicable codes, standards, laws and decisions by Authorities Having Jurisdiction;
- Deliver greenhouse gas emission levels which are in keeping with targets established by the Federal Government. The current target is a 21% reduction based on the 2016 GHG emissions of the CCGC. Final target will be established once the design is finalized.
- Deliver a reduction in energy consumption and operating costs. The current target is a 49% energy consumption reduction and a 25% reduction in operating costs based on 2016 utility rates. Final target will be established once the design is finalized.
- In keeping with the Federal Government's Sustainable Development Strategy, the PWGSC Federal Office Building Standards (FOBS) and its amendments, identify the sustainable development policies and technical criteria. While the project will not be seeking LEED® V4 certification, the project is targeting the following LEED® V4 credits in order to support the overall objectives of the project.
    - Water efficiency credit 5: Water Metering
    - Earth and Atmosphere Prerequisite 2: Minimum Energy Performance
    - Earth and Atmosphere Prerequisite 1: Enhanced Commissioning
    - Earth and Atmosphere Prerequisite 3: Advanced Energy Metering
    - Earth and Atmosphere Prerequisite 6: Enhanced Refrigerant Management
    - Materials and Resources Prerequisite 2: Construction Demolition Waste Management Planning
    - Indoor Environmental Quality Prerequisite 1: Minimum Indoor Quality Performance
    - Indoor Environmental Quality Prerequisite 3: Minimum Acoustic Performance
    - Indoor Environmental Quality Credit 3: Construction Indoor Air Quality Management Plan

- A risk management strategy is crucial for PWGSC Project Management and integrates project planning into procurement planning. All the stakeholders of the project will be an integral part of the risk management strategy, culminating in an integrated product team. Specific services required for project delivery will be outlined in each consultant's Required Services.
- PWGSC recognizes the responsibility to ensure the health and safety of all persons on Crown construction projects and the entitlement of both federal employees and private sector workers to the full protection afforded them by occupational health and safety regulations. In keeping with the responsibility and in order to enhance health and safety protection for all individuals on federal construction sites, PWGSC will voluntarily comply with the applicable provincial/territorial construction health and safety acts and regulations, in addition to the related Canada Occupational Safety and Health Regulations.

3.4 PROJECT DELIVERY REQUIREMENTS

The CCGC will remain an active facility during this multi-year project. As such, the construction will require phasing which minimize impact on the activities at the College. The Design Consultant has been developing the construction phasing as part of the specifications with the support of DFO, PWGSC and Coast Guard College (CGC) representatives. This phasing will take into consideration student vacations, exams and graduation each year, peak occupancy periods, operations of the 24hour/365 day per year Marine Communications and Traffic Services Center, swing space availability and HVAC equipment zoning. A complete annual schedule of the facility will be provided to the successful proponent in order to assist with the commissioning activities.

Every year there is a two-week period in August where cadets are not present, otherwise there are always cadets living, eating, and learning on campus. This is to be taken into consideration when preparing the phasing of this project.

The work on the main HVAC generation system outside the indoor occupied space can take place anytime and concurrent with the work inside. Any distribution type HVAC, fire protection and controls related work (i.e. chilled water lines, wet sprinkler lines, ventilation ductwork, controls wiring, electrical wiring, etc.) inside the residence buildings could be approached as follows:

- Alert building is the core area of the residence section of the campus. All the wings off Alert will tie into the distribution lines for various systems. For sprinklers, Alert will be the conduit of both wet and dry systems until all wings are converted to the new wet combination system.
- St. Laurent as a recently renovated wing (2008) could potentially be used as a swing space for the majority of the students. It is believed that the students in St. Laurent could be relocated into vacant residential space or hotel rooms in the College. The timing of the renovation will impact the requirements for swing space as certain times of the year the wing is almost vacant, while other times it is full.
- The remaining residential/office wings could be scheduled at any time throughout the (assumed) 5-year construction contract, with considerations for operational requirements of the College:

    - Great Lakes and Pacific
    - Saguenay and Miramichi
    - Arctic and Atlantic
    - Telecom and MacKenzie. The Telecom section houses the MCTS which is a 911 call center for vessel traffic. Because of operational requirements it is preferred to be renovated in the winter and it will present some challenges (i.e. needs to remain operational) due to the presence of the MCTS servers on level 100.
- The D'Iberville Centre (sports facility, including an indoor pool) could be renovated in the warm season (May to October) when the student usage will be reduced or could be replaced with outdoor activities.
- The Foster Building (boathouse) could be renovated anytime hence allows for some flexibility.
- The Hopkins Building (training building) needs to be renovated in the winter time.
- The Risley Building (MET) building will have to be renovated outside its academic schedule and coordinated with the College staff.
- For Cabot building phasing of HVAC replacement work, a strategy of maintaining a similar building zoning is recommended. This approach will minimize the impact on building operations and will also allow the use of existing mechanical rooms and some main ductwork trunks if found to be suitable. Also the summer break in courses at the campus should be used as an opportunity to do some of the work in this building.
- The contract construction documents will clearly reflect the extent of the work and proposed phasing to allow a full grasp of the challenges and minimize the impact on the schedule and budget.

3.5 PROJECT CHALLENGES

The requirement for the continual operation of the College facility while the intrusive work of the project is ongoing could drive cost increases. Phasing of the work, with the goal to minimize disruption to the College and cadets will be a key objective.

PWGSC, DFO RPSS and the Management of the College have created a governance structure including a Steering Committee, which will keep the CCGC informed and engaged throughout the design and implementation phases. By involving the end user's representatives in the design phase, not as reviewers or approvers of the design but as informed stakeholders, will help them prepare for construction phases. The ability of the CCGC staff to be flexible and mobile will come from gaining 'buy in' early.

The intention is to tender the construction as one contract, eliminating the need for one contractor to rely on another to complete his work before proceeding, and providing the entire campus as the work site. With proper schedule control and planning, the contractor should always have somewhere to work, reducing potential delay claims, and increasing schedule efficiency. The academic calendar for CCGC operations was made be available to the consultants and will be made available to contractors to aid in planning work.

4 CONCEPT DESIGN

A concept design has been developed by M&R Engineering, the Prime Consultant for the project. It is presented here to support the Owner's Project Requirements as it was developed through consultation with all the project stakeholders.

4.1 GENERAL CONCEPT

The sea water heating and cooling system utilizes water-to-water heat pump technology to provide heating and chilled water to meet the heating and cooling needs of the campus. The plant shall use sea water from Sydney Harbour as the heating source and sink.

The seawater plant shall be located in a new Seawater Pumphouse Building located on the shoreline adjacent to the Foster Building. Plant components shall consist of three (3) seawater pumps (P-1A, 1B, & 1C), a duplex vacuum prime pump set, two (2) seawater plate heat exchangers (HE-1A & 1B), and heat exchanger glycol system pumps (P-2A & 2B). The seawater system recirculates salt water from Sydney Harbour, drawing it in from a pipe inlet located approximately 650 meters from the pumphouse. The seawater shall be filtered, passed through the plate heat exchanger, than discharged back into the harbour near the shoreline at the pumphouse.

Water-to-water heat pumps (WWHP) shall be the primary source of hydronic heating and cooling for the campus. The primary components of this part of the plant shall be located in mechanical rooms on the basement level of the Cabot Building. Each WWHP's condenser shall be connected to the heating water primary loop and supply it with low temperature hot water at 43 °C. Each WWHP's evaporator shall be connected to the primary chilled water loop and shall supply chilled water at 7.2 °C. Secondary pumping circuits from each primary loop shall distribute heating and chilled water to heating and cooling equipment located throughout the campus.

Seawater shall be used as the heat source and sink for the plant. The seawater system shall be connected to both the condenser and evaporator sides of the heat pump loop via Heat Exchanger Glycol Supply and Return Piping (HXGS & R) which runs underground between the new pumphouse and the Cabot Building. Any excess heat produced that is not being used for building heating or domestic hot water preheating shall be rejected into the seawater from the Heating Water Primary Loop via heat exchangers (HE- 3A & 3B). At times when seawater is cold enough to provide free cooling, the chilled water primary loop shall use the seawater as a cooling source instead of operating the heat pumps.

The two (2) existing oil fired hot water boilers shall remain and be used for domestic hot water heating and for back-up to the heat pump plant. All connections to the new heat pump system shall be with new piping.

Primary equipment components of the seawater heat pump plant include:

- Seawater intake piping: 300 mm diameter, schedule 80 PVC pipe.

- Seawater Pumps (P-1A, 1B, and 1C, each 50% capacity): Capacity 37.5 L/s at 120 kPa head, Pump motor complete with VSD.
- Duplex Vacuum Prime Pump set
- Seawater filters: Fibreglass basket filters with 316 SS mesh baskets and copper electroplating
- Seawater plate heat exchangers (HE-1A & 1B, one acting as standby): Titanium plate heat exchanger with EPDM gasket material. Total heat transfer capacity 1060 kW, fluid flow rates 75 L/s.
- Heat exchanger glycol piping systems (Glycol solution)
- Heat exchanger glycol pumps (P-2A & 2B, one acting as standby): Capacity 75 L/s, pump motor complete with VSD.

Water-to Water Heat Pump Plant:

- Water-to Water Heat Pump units:
    - Based on Multistack MS050 Water-to-Water Heat Pump Units.
    - Six (6) modules each at 50 nominal tons cooling, Flow rates 8.8 L/s
    - Condenser Loop: 49 °C supply temp., 5.5 °C temp diff.
    - Evaporator Loop: 7.2 °C supply temp., 5.5 °C temp diff.
    - Total capacity: 1055 kW, 52.8 L/s
- Oil fired hot water boiler No. 1 (Existing): Buderus Model GE615/11, Net IBR Rated Capacity: 845 kW
- Oil fired hot water boiler No. 2 (Existing): each are Buderus Model GE615/14, Net IBR Rated Capacity: 865 kW

System Pumps:

- Condenser water pumps (P-3A & 3B, one acting as standby): Capacity 53.0 L/s, pump motor complete with variable frequency drive.
- Evaporator water pumps (P-4A & 4B, one acting as standby): Capacity 53.0 L/s, pump motor complete with variable frequency drive.
- Chilled glycol primary loop pumps (P-5A & 5B, one acting as standby): Capacity 53.0 L/s, 30% Glycol, pump motor complete with variable frequency drive.
- Heat rejection water pumps (P-6A & 6B, one acting as standby): Capacity 53.0 L/s, pump motor complete with variable frequency drive.
- Heating water primary loop pumps (P-7A & 7B, one acting as standby): Capacity 53.0 L/s, pump motor complete with variable frequency drive.

Secondary Pumps:

- Secondary heating pumps serving Cabot Building (P-8A & 8B, one acting as standby): Capacity 16.5 L/s, pump motor complete with variable frequency drive.
- Secondary heating pumps serving the campus loop (P-9A & P-9B, one acting as standby): Capacity 45 L/s, pump motor complete with variable frequency drive.

- Secondary chilled water pumps serving Cabot Building (P-10A & P-10B, one acting as standby): Capacity 23 L/s, pump motor complete with variable frequency drive.
- Secondary chilled water pumps serving the campus loop (P-11A & P-11B, one acting as standby): Capacity 30 L/s, pump motor complete with variable frequency drive.

Heat Exchangers:

- Chilled water plate heat exchangers (HE-2A & 2B): 316 SS plate heat exchanger with EPDM gasket material. Total heat transfer capacity 1060 kW, fluid flow rates 75 L/s.
- Heat rejection plate heat exchangers (HE-3A & 3B): 316 SS plate heat exchanger with EPDM gasket material. Total heat transfer capacity 1060 kW, fluid flow rates 75 L/s.

Domestic Hot Water Preheat Tanks (PH-1 to 4):

- Each 454 L, stainless steel tank in tank construction insulated with high density fibreglass insulation.

4.1.1 New Seawater Mechanical Building

A seawater pumping facility will be required with a footprint of 7.62 m x 7.62 m, with an interior clear ceiling height of 3.1 m. The building will be built on a concrete foundation with slab on grade construction. The foundation of the new seawater building will consist of a reinforced concrete strip footing, complete with a reinforced concrete frost wall. The ground floor will consist of a 150 mm thick cast-in-place concrete slab on grade reinforced with welded wire mesh.

The load-bearing exterior walls will be constructed of concrete blocks, reinforced and grouted solid. The exterior walls will have insulation, sheathing, and cedar siding.

The roof will be constructed of structural steel with galvanized steel and a heavy galvanized coating on the steel. The roof will be a shed type roof, sloped for drainage with insulation and metal standing seam roofing. The roof system will consist of a heavy-galvanized corrugated steel deck supported upon galvanized structural steel beams. Doors will be required for the installation and maintenance of the equipment and louvers will be required in the exterior walls for ventilation.

A new underground electrical service will be added from the HVAC switchboard located in the Cabot Building Main Electrical Room to the New Seawater Mechanical Building. Spare ducts will be added for fire alarm, communications and security infrastructure to be tied back into the Cabot Building. The electrical equipment located in the new building shall consist of:

- 225 A, 347/600 V, 3-Phase, 4-wire distribution panelboard.
- 75 kVA, 600 V-120/208 V Dry-Type transformer.
- 225 A, 120/208 V, 3-Phase, 4-wire branch circuit panelboard.
- Primary and Secondary Feeders associated with new transformer and panelboard.

In lieu of motor control centres and starters the pumps shall utilize variable speed drives complete and be fed from breakers located in the 600 V panelboard.

New lighting shall incorporate the use of energy efficient L.E.D. fixtures and low voltage controls. Occupancy sensors shall be utilized where appropriate to reduce energy costs.

A fire alarm annunciator panel shall be added to the new building.

4.1.2 Distribution System through Main Campus Buildings

All existing heating system piping and equipment shall be removed. New distribution loop mains shall be provided from both plants to supply heating and cooling to the buildings on campus. Routings shall be similar to the existing heating loop presently serving the campus. Loop mains originating from the plant mechanical rooms on the basement level of Cabot Building shall be routed through the East Tunnel, into the Artic Building, through the Great Lakes/ Pacific Buildings then back to the plant via the West Tunnel. Secondary piping systems located in mechanical rooms in the residence buildings shall be used to distribute flow to serve their heating needs. On the heating side, two (2) loops shall be provided. One being a hot water heating circuit supplying the heating coils in the fan coil units with a programmed water temperature set points scheduled water system. The second, a glycol heating circuit serving the heating coils in the ERV Units. On the cooling side, the secondary chilled water loop will supply the cooling coils in the fan coil units.

A summary of secondary system pumping equipment is as follows:

Great Lakes Mechanical Room:

- Secondary heating pump (P-12A, Artic/Atlantic): Capacity 7.0 L/s, pump motor complete with variable frequency drive.
- Secondary heating pump (P-13A, Great Lakes/Pacific): Capacity 7.0 L/s, pump motor complete with variable frequency drive.
- Secondary heating pumps (P-14A & 14B, Glycol services to ERV Heating Coils, Artic/Atlantic, Great Lakes/ Pacific): Capacity 4.0 L/s, pump motor complete with variable frequency drive.
- Secondary chilled water pump (P-15, Artic/Atlantic, Great Lakes/ Pacific): Capacity 15 L/s, pump motor complete with variable frequency drive.

Saguenay Mechanical Room:

- Secondary heating pump (P-16, Alert and Telecom/MacKenzie): Capacity 7.0 L/s, pump motor complete with variable frequency drive.
- Secondary heating pump (P-17, Saguenay/Miramichi and St Laurent): Capacity 7.0 L/s, pump motor complete with variable frequency drive.
- Secondary heating pumps (P-18A & 18B, Glycol services to ERV heating coils): Capacity: 6.0 L/s, pump motor complete with variable frequency drive.
- Secondary chilled water pumps (P-19, Alert, Telecom/MacKenzie, Saguenay/Miramichi and St Laurent): Capacity 20 L/s, pump motor complete with variable frequency drive.

D'Iberville Mechanical Room:

- Secondary heating pump (P-20, D'Iberville): Capacity 3.2 L/s, pump motor complete with variable frequency drive.
- Secondary heating pump (P-21, D'Iberville Pool): Capacity 9.2 L/s, pump motor complete with variable frequency drive
- Secondary heating pumps (P-22A & 22B, Glycol services to AHU & ERV heating coils): Capacity: 5.6 L/s, pump motor complete with variable frequency drive.
- Secondary chilled water pump (P-23, D'Iberville): Capacity 5 L/s, pump motor complete with variable frequency drive.

4.1.3 HVAC

Zone temperature control – Four (4) pipe fan coil units

For the Option 1 HVAC Plant, spaces in the Cabot and residence buildings shall be served by a 4-pipe fan coil system with ventilation air supplied by energy recovery ventilation (ERV) units. A 4-pipe fan coil system consists of separate heating (HWS & HWR) and chilled water (CHWS & CHWR) circuits piped to each fan coil unit. This system provides all season availability of heat and cooling at each unit with no summer/winter changeover requirements. In this option, the existing perimeter baseboard heating systems shall be removed as heating shall be provided by the fan coil units. Chilled water shall be supplied to the fan coils at a temperature of 7.2 °C. Heating water shall be supplied from the seawater heat pump plant at a temperature of 43.3 °C.

Each fan coil unit shall consist of a filter section, chilled water cooling coil, hot water heating coil, and supply fan. The fan coil units are generally located in the ceiling space of the room being served or located in an adjacent room and ducted to the space. The heating and cooling coils shall be supplied with low temperature hot water from the heating loop side of the seawater heat pump plant and chilled water supplied from the plant's cooling side. In operation, return air drawn into the unit from the space is mixing with a fixed supply of ventilation air delivered from the ERV unit. This air is filtered and heated or cooled as required to maintain space temperature set point conditions as sensed by the space thermostat in response to space needs. Duct silencers shall be provided at the inlet and outlet of each fan coil unit.

Separate secondary heating and cooling distribution piping circuits shall be required on each floor for delivery of heating and chilled water to the fan coils. The circuits shall be piped in a reverse return piping arrangement. Two-way control valves shall be provided to control the capacities of the coils. All piping shall be thermally insulated with vapour barriers provided on the insulation system for the chilled water piping. Drain lines shall be provided to drain condensate from each fan coil unit.

In the Great Lakes, Saguenay, and St. Laurent buildings, the existing fan coil units and chilled water piping circuits in the shall be reused. New hot water reheat coils shall be added to these units and served from new secondary heating circuits.

Ventilation systems – ERV units

The majority of the Cabot Building ventilation needs shall be provided by one of eleven (11) energy recovery ventilation (ERV) units. A typical ERV unit shall consist of supply and exhaust air streams each with an inlet filter, fans, and with an energy recovery device between the two streams. The discharge of the supply fan shall include a glycol heating coil and an electric steam humidifier. Outside air drawn in from the outside air intake louvres shall recover heat from the exhaust air stream. The supply air shall be further heated and/or humidified as required then supplied to the inlet of the fan coil units through insulated supply ductwork. Exhaust air shall be drawn from the spaces and from the building washrooms in separate ductwork.

The residences buildings shall be ventilated by ERV units in a similar manner. These units shall be installed in new mechanical rooms located in the attic spaces of each building. Electric steam humidifiers shall be provided in the ERV units where they serve office spaces. Outside air drawn in from the outside air intake louvres shall recover heat from the exhaust air stream. The supply air shall be further heated and /or humidified as required then supplied to the inlet of the fan coil units through insulated supply ductwork. Exhaust air shall be drawn from the building washrooms. Separate ERV units shall be provided to serve the storage rooms on the lower levels of each wing.

Demand control ventilation on Cabot ERV units (Energy savings option)

Demand control ventilation shall be considered on Cabot Building ERV units using pressure independent VAV boxes located on the supply duct to each fan coil unit. The dampers shall modulate the flow of ventilation air to each fan coil in response to occupancy and CO2 sensors located in the space being served. Static pressure controls in the supply duct shall modulate Variable Speed Drives (VSDs) on the supply fan to maintain static pressure set point conditions. On the exhaust side, two (2) VAV boxes shall be provided; one to maintain constant airflow from the connected washrooms, and one on the common exhaust duct to modulate in sync with the supply air flow.

Other new Cabot HVAC systems to replace existing shall include the following:

- AHU-1 Cabot kitchen ventilation and air conditioning system: The existing kitchen make-up air and hood exhaust air system shall be replaced with a new more energy efficient system. The new system shall consist of a make-up air system and kitchen hood exhaust fan both provided with VSD controls. New kitchen hoods shall be Halton capture jet style kitchen hoods with a MARVEL demand control ventilation system which reduces ventilation system air flows (and related energy) in response to reduced operations of the cooking line. AHU-1 shall consist of an outside air intake section with intake damper, cartridge filter section, glycol heating coil, chilled water cooling coil, and supply fan section with a VSD fan motor control. All kitchen hood exhaust ductwork shall be new and designed and installed in accordance to NFPA 96 standards.
    - AHU-1 Kitchen Make-up air system: 5,500 L/s airflow with VSD motor
    - EF-1 Kitchen Hood Exhaust Fan: 5,500 L/s airflow with VSD motor
    - Kitchen Exhaust Hoods:
        - Halton Capture Jet Model KVE Canopy Hoods
        - Hood No.1: 3000 x 1575 mm, 780 L/s
        - Hood No. 2: 2250 x 1500 mm, 140 L/s

- Hood No. 3 (with UV): 3900 x 1350 mm, 2225 L/s
- Hood No. 4: 3900 x 1350 mm, 1300 L/s
- Hood No. 5: 2700 x 1425 mm, 570 L/s

- AHU-2 Cabot Auditorium air conditioning system: This shall be an air handling system of similar size to existing. The system shall be a constant volume air conditioning system providing conditioned air to the Auditorium. The system shall consist of a supply fan and return fan with mixing damper and economizer controls. The supply air unit shall consist of a mixing section with inlet and return air dampers, cartridge filter section with pre-filters, glycol heating coil, a chilled water cooling coil, electric steam humidifier, and supply fan section. Glycol shall be the source of heat for the unit. The system shall have demand control ventilation with CO2 and occupancy sensors located in the space.
  - AHU-2: 3,000 L/s
  - RF-2: 3,000 L/s

- Miscellaneous Cabot Building ventilation systems: New miscellaneous building ventilation systems shall include:
  - Electrical room ventilation exhaust system
  - Boiler room ventilation system
  - Level 100 Carpentry shop exhaust
  - Loading bay ventilation exhaust system
  - Chemistry lab fume hood exhaust systems, (two separate systems, 200 L/s each)
  - Atrium smoke exhaust fans (two (2) exhaust fans, 7,500 L/s each)

4.1.4 Domestic Hot Water Generation

Cabot Building

In this option the central seawater heat pump plant is only capable of providing lower temperature heating water of approximately 29.1 °C. In order to make use of this lower temperature heating source, two (2) new 454L indirect fired domestic hot water storage tanks will be provided to preheat the domestic water. The preheated water from these tanks will then be piped to two (2) new 454 L indirect fired domestic hot water storage tanks which will be heated using higher temperature heating water at an approximate temperature of 68 °C. The higher temperature water will be fed from the existing oil-fired boilers. The existing commercial electric domestic hot water heater will be retained and reused.

New water meters will be installed on the domestic cold water and domestic hot water system mains to record, trend, and log water usage within this building.

Heat recovery from coolers/freezers

Energy savings can be realized by using heat rejected from the kitchen freezers and coolers refrigeration system compressors to preheat domestic hot water.

Discharge water temperatures leaving the compressors will be in the range of 37.7°C to 40.5°C allowing for potential heat recovery for preheating domestic hot water from 4.4°C to 32.2°C which represents 50% of the DHW heating requirements. Allowing for differences between DHW usages and operating times of the compressors, it is estimated that 40% of the domestic water heat load could be provided using heat recovered from the refrigeration systems.

The heat recovery system would consist of a closed loop glycol system comprised of water cooled compressors, glycol/domestic water plate heat exchanger, dry cooler, domestic water preheat tanks, circulator, system pumps (one acting as standby), glycol fill tank and pump, air separator and expansion tank. The system pump will recirculate glycol solution through the loop. Heat rejected from the compressors will be used to preheat domestic hot water through a heat exchanger. Excess heat shall be rejected to the outside via the dry cooler.

The existing water cooled service can remain and be reconnected to the glycol system for use as backup.

Residence Complex

Similar as described for the Cabot Building, in order to make use of this lower temperature heating source from the seawater heat pump plant, a new domestic hot water preheat system will be provided in room D112. The system will be comprised of a new domestic hot water heat exchanger and two (2) new 454 L preheat storage tanks. Preheated water from the new system will then be piped to the existing domestic hot water heat exchanger where the water will be heated to its final temperature. This existing heat exchanger shall be fed from the new boiler system in the Cabot Building. Once the domestic hot water is heated to the set point temperature it will be stored in the existing domestic hot water storage tanks in the same fashion as noted above.

New water meters will be installed on the domestic cold water and domestic hot water system mains to record, trend, and log water usage within each of the residence buildings.

4.1.5 Controls

The existing pneumatic control systems that control the existing buildings' mechanical systems shall be replaced with direct digital control (DDC) operated by a new Energy Management Control System (EMCS). The EMCS will perform all monitoring of space conditions, equipment status and control, energy metering, alarm monitoring, and reporting for the HVAC systems as well as interface with the security, lighting control, and fire alarm systems operating on campus.

The DDC system shall consist of supervisory equipment controllers specified to be compatible with BACnet protocols. Controllers shall communicate on a peer-to–peer communication network. The field panels shall operate standalone or networked to perform all complex control, monitoring, and energy management functions without relying on higher level processors.

The system shall include built in energy management application software and DDC programs for complete facility management. Controls shall be with proven program sequences to match equipment control applications. Control algorithms shall have auto adjustments capabilities to compensate for load/seasonal changes. The system shall be of modular design allowing for future expansion.

The system shall be provided with an operator work station (OWS) consisting of a personal computer with sufficient memory and processor capacity to perform functions specified. The OWS shall include control software and graphics packages allowing the building operators to perform all tasks necessary to monitor and operate the facility.

Control software shall include:

- Graphics package to provide operator with visual dynamic displays of each system for monitoring of system conditions, equipment status and control;
- Operator control software shall allow operator to display logging and trending of system information and perform operational task;
- Power monitoring and BTU metering for the plant's primary equipment and services;
- Trend data software shall allow the operator to select and collect data on system points;
- Report modules shall allow the operator to generate and format reports for graphical and numerical displays from real time and stored data;
- Automatic logging of alarm conditions;
- Message handling software to inform operator of status of communications between EMCS devices; and,
- Access control module to provide various levels of password protected access to the EMCS.

Separate stand-alone EMCS shall be provided in the Hopkins, Foster, and Louis S. St. Laurent Buildings, each with local operator interface access. Web based access shall be provided for remote operator access to these buildings and to the EMCS for the main campus.

Where packaged HVAC equipment is provided with internal controls they will be specified to come with a BACnet/IP compatible interface for integration and mapping to the EMCS. This would include equipment such as the existing boilers, the new water-to water heat pump units, the pool dehumidification unit, VSD's and VRF systems operating remotely in the Hopkins and Fosters buildings.

4.1.6 Architectural

The Cabot Building is to have new mezzanines and catwalks constructed to accommodate new mechanical rooms above rooms that currently have dropped ceilings. Where new mechanical rooms are created, fire rated assemblies are to be installed between the existing and new rooms. When new columns are placed for the creation of mezzanines, existing flooring will have to removed and replaced.

The buildings that make up the Residences and Accommodations are to have the ceilings (other than T-bar) removed in their entirety to make way for a new sprinkler system. Where T-bar ceilings exist, they will need to be removed and reinstated. Where radiation systems are upgraded, all adjacent walls are to be repaired and painted. There are to be 12 new mechanical rooms constructed in the attic space of the residences buildings, two per wing, approximately 3.7 m x 3.7

m. The new mechanical rooms will need to be heated and insulated on all sides. A subfloor would be constructed over the existing trusses, with new walls constructed in the truss space and the existing roof would be insulated. Also required would be a folding ceiling access door with integral folding stairway.

All the buildings will be in operation by staff and students during the construction period. Hoarding will be required to separate the students and staff from areas under construction while still allowing use of the remainder of the building not under construction. Emergency egress will need to be maintained at all times during construction. Temporary weather protection will be required where the building envelope is opened for the removal and installation of new mechanical equipment.

There will be the requirement for exterior concrete pads to hold mechanical equipment. The concrete pads will be screened on four sides with wood slat walls complete with gates for accessibility.

4.1.7 Electrical

Cabot Building

The existing electrical distribution equipment associated with mechanical equipment upgrades within the Cabot building shall be replaced. Where existing motor starters serving mechanical equipment are to be replaced and controlled by new variable speed drives and/or integral control panels the existing motor control centres shall be replaced with the following:

- New feeder from Cabot Main Electrical Room.
- New Splitter and Fusible Disconnect Switches (where room contains four (4) or fewer pieces of mechanical equipment).
- 600 V, 3-Phase, 4-wire distribution panelboards (where room contains more than four (4) pieces of mechanical equipment).

Where new mechanical rooms are created they shall be served in a similar manner with the aforementioned equipment. Lighting and emergency lighting shall be adjusted in existing mechanical rooms to suit equipment revisions where required. The new mechanical spaces shall also be outfitted with new lighting, emergency lighting and convenience receptacles for maintenance purposes.

New fan coil units distributed throughout the Cabot building shall be fed from one (1) of two (2) new 120/208 V branch circuit panelboards. The following equipment shall be added to accommodate these panelboards:

- Two (2) 3P, 40 A, 600 V breakers installed in HVAC switchboard.
- Two (2) 30 kVA, 600 V-120/208 V Dry-Type transformer.
- Two (2) 125 A, 120/208 V, 3-Phase, 4-wire branch circuit panelboards.
- Primary and Secondary Feeders associated with new transformers and panelboards.

The Dry-Type transformers shall be added in the Main Electrical Room and 120/208 V panelboards, one (1) each located centrally within the each wing of the Cabot Building.

Residence Complex

The following revisions shall be made to the electrical equipment in room FF120 to support the mechanical upgrades throughout the Alert Building and Residence Buildings:

- Replace existing 3P, 400 A breaker in HVAC switchboard feeding panel "RVP" to be 3P, 600 A.
- Replace existing feeder serving panel "RVP" from the Cabot Main Electrical Room to Alert FF120.
- New 600 A, 347/600 V, 3-Phase, 4-wire distribution panelboard.
- New 15 kVA, 600 V-120/208 V Dry-Type transformer.
- New 125 A, 120/208 V, 3-Phase, 4-wire branch circuit panelboard.
- Primary and Secondary Feeders associated with new transformer and panelboard.
- Breakers and feeders installed to serve each wing of the residence buildings from panel "RVP".

Similar to the Cabot building, the 600 V system shall be used to feed new mechanical ERVs and Humidifiers. The dry type transformer and panelboard shall be used to serve 120 V & 208 V fan coil units throughout the Alert Building.
The following equipment shall be installed in existing and new Mechanical Attic spaces, one (1) per each wing of the each residence building. Their feeders shall originate from the Alert Building Room FF120:

- 100 A, 600 V, 3-Phase, 3-wire splitter.
- Fusible Disconnect Switches to serve new ERV unit and Humidifier (where applicable).
- 15 kVA, 600 V-120/208 V Dry-Type transformer.
- New 125 A, 120/208 V, 3-Phase, 4-wire branch circuit panelboard to power fan coil units throughout resident wing.
- Primary and Secondary Feeders associated with new transformer and panelboard.

New lighting shall incorporate the use of energy efficient L.E.D. fixtures where new Mechanical Attic Spaces have been created. Occupancy sensors shall be utilized where appropriate to reduce energy costs in addition to new emergency lighting and convenience receptacles for maintenance purposes.

4.1.8 Fire Alarm System

<u>New Seawater Mechanical Building</u>

The following devices shall be added to the new Seawater Mechanical Building and tied back into the Main Fire Alarm Panel located in the Cabot Building:

- Smoke Detectors in new Mechanical building.
- Manual Pull Stations in new Mechanical building.
- Horn/Strobe Stations in new Mechanical building.

<u>Cabot Building</u>

The following devices shall be added to Cabot Building, tied-in to local initiating and annunciating loops as required:

- Smoke Detectors in new Mechanical rooms.
- Manual Pull Stations in new Mechanical rooms.
- Horn/Strobe Stations in new Mechanical rooms.
- Duct Detectors in new ERV units.
- Existing smoke detectors, horn/strobes and pull stations shall be re-located and re-used where appropriate

<u>Alert and Residence Complex</u>

The following devices shall be added to the Alert Building to suit the new mechanical systems:

- Duct Detector in new ERV unit

The following devices shall be added to each of the new and existing Attic Mechanical Spaces:

- Smoke Detectors in new Mechanical rooms.
- Manual Pull Stations in new Mechanical rooms.
- Horn/Strobe Stations in new Mechanical rooms.
- Duct Detectors in new ERV units.

4.1.9 Structural

In the Cabot Building, new mezzanine platforms will be provided adjacent to existing floors to create additional space for new mechanical equipment.

The structural framing for the Cabot mezzanines will consist of structural steel beams connected to existing beams and columns, steel floor purlins, and corrugated steel deck with concrete topping reinforced with welded wire mesh. The existing steel beams, columns, and connections will be reinforced as required to support the increase in load.

New structural steel columns and reinforced concrete foundations will be required for the mezzanine in Block A (Cabot West). The steel columns will be complete with steel base plates and anchor bolts, and will be supported on reinforced concrete spread footings complete with pedestals. Two spread footings, adjacent to existing strip footing foundations, will be cast on top of and adjacent to the existing foundation.

One new structural steel column (complete with base plates and anchor bolts) will be required for the mezzanine in Block B (Cabot East). The column will be attached to the existing concrete slab with post-installed anchor bolts. This new column is located above an existing reinforced concrete column, thus no slab reinforcing is required.

The floors of the attic spaces in the residence buildings in which new mechanical rooms are to be provided are typically wood framed. Where required, the wood joists of the attic floor will be reinforced by adding additional floor joists parallel to the existing joists (sistering).

For the exterior mechanical equipment, reinforced concrete pads will be provided. The pads will consist of 250 mm thick high-strength reinforced concrete, constructed with air-entrained concrete for added durability. A 600 mm thick layer of compacted granular material will be placed below the pad. The perimeter of the granular material will extend 600 mm out from the perimeter of the concrete pads. Where applicable, galvanized cast-in-place plates will be provided on which to fasten visual enclosures. The perimeter of the concrete pads will be extended to provide room for the enclosures.

4.1.10 Civil

Excavation, trenching, and backfilling will be required for the HXGS & R piping run from the Seawater Pumphouse to the Cabot Building. After the piping run has been installed, the road and any other disturbed features will be reinstated to match original condition.

4.1.11 Maintenance impact

All options shall require maintenance over the HVAC equipment life, including planned and preventive, as well as the unplanned or reactive maintenance required to provide a safe, healthful, and comfortable environment at the College. Maintenance tasks related specifically to the seawater option, as described below and in the life cycle analysis, are based on the existing seawater heat pump plant installed at the NSPI Headquarters in Halifax, NS.

To service the seawater system, including the intake located in Sydney Harbour, regular maintenance tasks shall include:

- An annual inspection should be performed by a qualified diver of the intake and the cathodic protection system to ensure that it is in good condition and that no mussels are growing on the intake or inside the pipe.
- At the outlet of each seawater pump, there will be a stainless steel strainer to catch and prevent material from entering the heat exchanger. This strainer shall need to be cleaned on a weekly basis to ensure proper operation of the system.
- A yearly flushing and cleaning of the seawater heat exchangers will be required to prevent fouling.

With a central cooling system, if the seawater plant is required to be taken offline for maintenance, the campus cooling system serving Cabot, the residences, and D'Iberville, with the exception of the dedicated split systems, will be inoperable for the duration of the maintenance.

The Cabot boiler system shall be able to provide back-up heating capability to the seawater heat pump plant during maintenance work. Regular boiler service shall be required in all options.

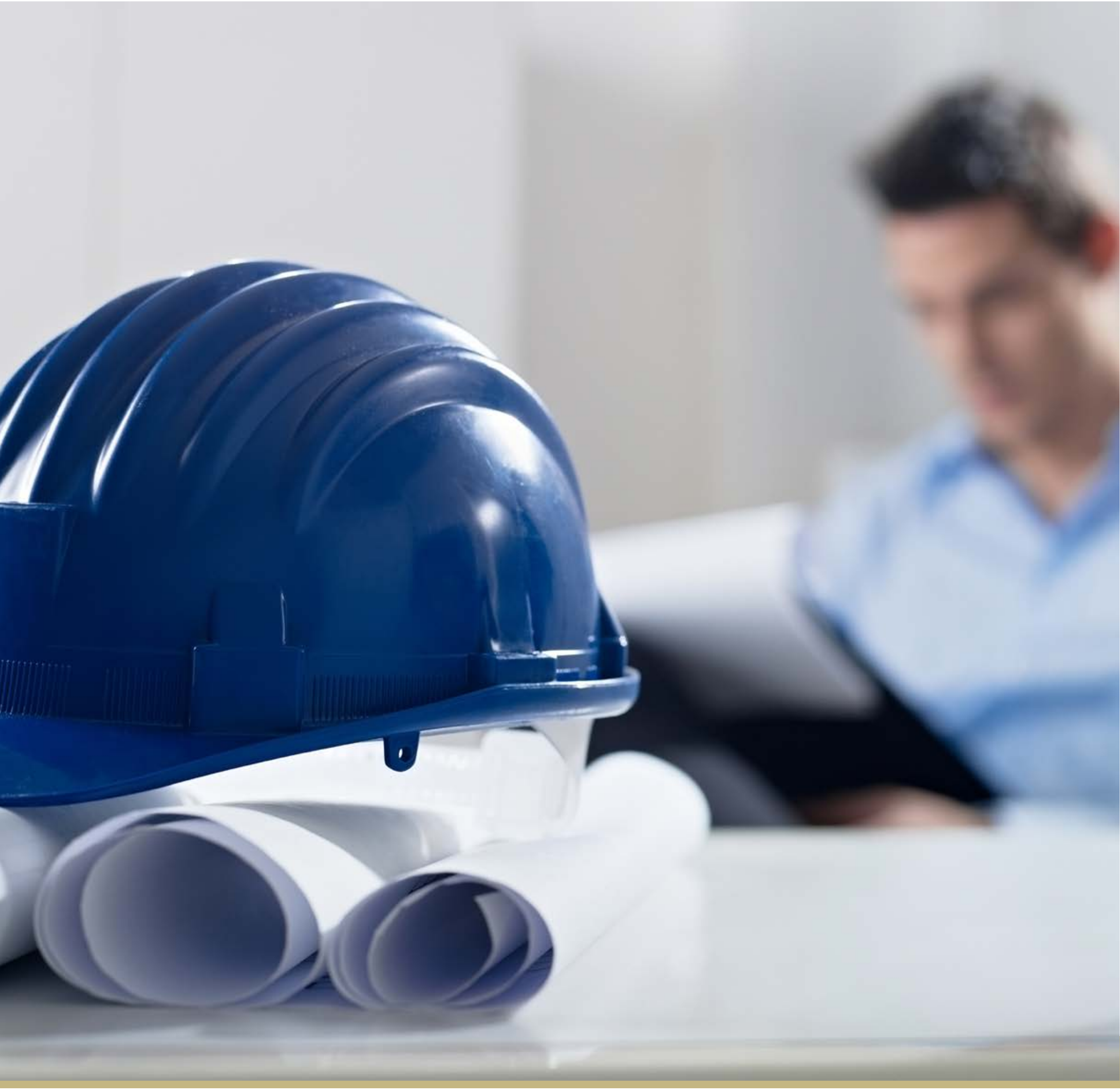
HVAC equipment maintenance tasks will be required. Table 1 below shows a list of typical maintenance tasks and an estimated frequency (Quarterly (Q), Semi-Annually (S), or Annually (A)). Note that the frequency of maintenance shall vary depending on the equipment being serviced.

Typical maintenance tasks for HVAC Equipment	Frequency		
	Q	S	A
Check equipment for proper operation	X	X	X
Visual inspection for leaks and damaged insulation		X	X
Lubrication of motor bearings	X	X	X
Check valves for proper operation			X
Check and clean strainers and traps			X
Check refrigerant charge level			X
Visual inspection for rust and corrosion	X	X	X
Clean equipment and surrounding area	X	X	X
Replace filters	X	X	X
Check oil level and top up as required			X

Table 1: Frequency of typical maintenance tasks for HVAC equipment

MARITECH
COMMISSIONING WORKS

77 VAUGHAN HARVEY BLVD., SUITE 210
MONCTON, NEW BRUNSWICK
E1C 0K2



MARITECH
COMMISSIONING WORKS

77 VAUGHAN HARVEY BLVD., SUITE 210
MONCTON, NEW BRUNSWICK
E1C 0K2

Public Works and Government Services Canada

Project # R.065476.700
Mechanical & Sprinkler Upgrade Project
Canadian Coast Guard College, Sydney, NS

June, 2018

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APPENDICES

1. OVERVIEW

This Commissioning Plan has been specifically developed for this project to aid the building design, construction and operations team in verifying that the project will meet the Owner's Project Requirements. It sets out the process and methodology for the successful commissioning of the project during the design and construction phases. The Commissioning Plan also acts as a communication tool to facilitate each team member's understanding of their roles and responsibilities in the commissioning process.

It is important to understand that the Commissioning Plan is a living document in that information is added and modified to it as the project progresses.

The Commissioning Plan **does not** relieve the project team from contractual requirements outlined in the project documents. The project specifications may include special testing requirements for equipment. These tests are mutually exclusive of the verification and functional procedures outlined in the Commissioning Plan.

2. COMMISSIONING OBJECTIVES

Commissioning (Cx) is a systematic and quality focused process for verifying and documenting that all building systems perform interactively according to the design intent in order to meet the Owner’s Project Requirements. This is achieved through a complete commissioning process; beginning at the design phase with documented design and operating intent and continuing through construction and acceptance phases, with actual verification of performance.

Commissioning activities during the design and pre-construction phases are intended to achieve the following specific objectives:

- Ensure that the Owner’s Project Requirements are documented and clearly understood by the Design Team.
- Ensure that the Basis of Design and construction documents reflect the Owner’s Project Requirements.
- Provide a plan for the implementation of the commissioning process, including the initial scope of systems to be commissioned for the project.
- Ensure that commissioning for the construction phase is adequately reflected in the bid documents.

Commissioning activities during the construction phase are intended to achieve the following specific objectives:

- Clearly communicate to the various members of the commissioning team their roles and responsibilities in the commissioning process.
- Verify that the design and operational intent are adhered to during the construction phase.
- Verify the applicable equipment and systems are installed properly and receive adequate pre-operational checkout.
- Verify and document proper performance of mechanical an electrical equipment and systems.
- Review the operation and maintenance documentation provided for the continued management of the facility to ensure completeness.
- Document the proper training of Owner’s building management personnel.

3. GENERAL BUILDING INFORMATION

Project:	Mechanical and Sprinkler Upgrades to Canadian Coast Guard College
Location:	Sydney, NS
Description:	The Canadian Coast Guard College will undergo a midlife mechanical systems upgrade including the replacement of the original HVAC and Controls Systems, the replacement of the dry sprinkler system in the residences, and the introduction of green technologies like a seawater heating and cooling exchange system. The aim is to reduce overall energy consumption and GHG emissions, increase comfort, indoor environmental quality and safety in the campus.

4. ABBREVIATIONS AND DEFINITIONS

The following are common abbreviations used in this document.

ABBREVIATIONS	DEFINITIONS
A/E	Design Team Consultants
BOD	Basis of Design
CC	Controls Contractor
Cx	Commissioning
CxA	Commissioning Agent / Authority
EC	Electrical Contractor
FAC	Fire Alarm Contractor
FPT	Functional Performance Test / Testing
FPTF	Functional Performance Test Form
GC	General Contractor / Construction Manager
MC	Mechanical Contractor
Mfr	Manufacturer
OPR	Owner’s Project Requirements
PC	Plumbing Contractor
PF/SU	Pre-Functional/Start-Up Verification
RFI	Request for Information
SC	Sprinkler System Contractor
SUF	Start-Up Form
SV	Static Verification
SVF	Static Verification Form
TAB	Test and Balance Contractor

5. COMMISSIONED EQUIPMENT AND SYSTEMS

Commissioning and training of the following systems and equipment will be verified in this project. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy.

Please note: Note that the final list of commissioned equipment and systems for each building will be provided in the final commissioning plan. The list below is a sample only.

SYSTEMS AND EQUIPMENT	SV	PF / SU	FPT
Mechanical			
Air Handling Units	100%	100%	100%
Energy Recovery Ventilators	100%	100%	100%
Water to Water Heat Pumps	100%	100%	100%
Boiler Plant and Hydronic Pumps, Heat Exchangers, Loops and Accessories	100%	100%	100%
Solar wall	100%	100%	100%
Panel Radiators, Hydronic Pumps, Loops and Accessories	100%	100%	20%
Convector Radiators, Hydronic, Loops and Accessories	100%	100%	20%
Wall Fin Radiation, Hydronic Pumps, Loops and Accessories	100%	100%	20%
Cabinet and Unit Heaters, Hydronic Pumps, Loops and Accessories	100%	100%	20%
Heating and Cooling Coils, Hydronic Pumps, Loops and Accessories	100%	100%	20%
Fan Coil Units, Hydronic Pumps, Loops and Accessories	100%	100%	20%
Variable Air Volume Boxes	100%	100%	20%
Wall and Floor Mounted A/C Units Hydronic Pumps, Loops and Accessories	100%	100%	20%
Split Systems Fan Coils and Condensers	100%	100%	20%
Computer Room Conditioning Units	100%	100%	100%
Infrared Radiant Heaters	100%	100%	20%
Electric Heating Coils and Unit Heaters	100%	100%	20%
Sea Water Pumps	100%	100%	100%
HVAC Zones	100%	100%	20%
Humidifiers	100%	100%	100%
Return and Exhaust Fans	100%	100%	100%

SYSTEMS AND EQUIPMENT	SV	PF / SU	FPT
TAB Work	100%	100%	20%
Energy Management Control System / Building Automation System	100%	100%	20%
DHW Systems (tanks, pre-heat tanks, heaters, pumps, heat exchangers and accessories)	100%	100%	100%
Sump Pumps	100%	100%	100%
Trap Primers	100%	-	20%
Energy and Water Meters	100%	100%	100%
Variable Frequency Drives	100%	100%	100%
Wet Sprinkler Systems	100%	100%	100%
Pre-Action Sprinkler Systems	100%	100%	100%
Dry Pipe Sprinkler Systems	100%	100%	100%
Wet Chemical Fire Extinguishing Systems	100%	100%	100%
Fire Extinguishers	100%	100%	100%
Electrical Systems			
Electrical Panel Boards and Breakers (inc. modifications to existing panels)	100%	100%	100%
Transformers	100%	100%	100%
Wiring Devices	100%	100%	20%
Interior Lighting (modifications and additions)	100%	100%	100%
Exit and emergency lighting	100%	100%	100%
Fire alarm system	-	100%	100%

6. COMMISSIONING TEAM

In order to ensure a successful commissioning process, lines of communication must be defined between all parties involved in the project. To aid in improved communication, each contractor must assign one person the responsibility of being their representative on the commissioning team. This individual will be accountable to the team for his or her assigned role and activities as it relates to the commissioning process.

TEAM MEMBER	COMPANY & CONTACT NAME	TELEPHONE AND E-MAIL
Owner		
Owner Representative		
User Representative		
Commissioning Authority		
Prime Consultant		
Mechanical Engineering		
Electrical Engineering		
Structural Engineering		
Civil Engineering		
Architect		
Project Manager		
Construction Manager		
Mechanical Contractor		
Electrical Contractor		
Controls Contractor		
Fire Protection Systems Contractor		
Fire Alarm Systems Contractor		
TAB Contractor		

7. ROLES AND RESPONSIBILITIES

7.1 TEAM MEMBERS

The members of the Commissioning Team consist of the Owner, Owner's Representatives, User Representatives, A/E, CxA, GC, MC, EC, PC, CC, TAB, FAC and SC. Other participants may include other installing subcontractors or equipment manufacturers, as required.

7.2 GENERAL MANAGEMENT PLAN

In general, the CxA coordinates the commissioning activities and reports to the Owner's Representative. The CxA's responsibilities, along with all other Contractors' commissioning responsibilities are detailed in the project specifications. All members work together to fulfill their respective roles, as summarized in the section below.

7.3 GENERAL DESCRIPTIONS OF ROLES

A general description of the commissioning roles is as follows

CxA:

- Reviews the OPR, BOD and design documents
- Develops and updates the Commissioning Plan.
- Coordinates the Commissioning Process.
- Reviews commissioning documentation and other test reports for compliance with the Contract Documents. Commissioning documentation includes, but is not limited to SVF, SUF and FPTF forms.
- Prepares, oversees and documents Functional Performance Tests.
- Verifies that the systems are performing in accordance with Contract Documents.
- Reviews General Training Plan
- Prepares a final Commissioning Report, with the assistance of the Commissioning Team.

GC:

- Facilitates and supports the Commissioning Process.
- Coordinates the response to RFIs throughout the commissioning process.
- Ensures that all subcontractors fulfill their commissioning responsibilities.
- Integrates Commissioning into the Construction Process and Schedule.
- Coordinates and provides Training.
- Includes the CxA on the distribution lists for project documents such as shop drawings and start-up reports.

Subcontractors (MC, EC, PC, CC, TAB, FAC, SC and others):

- Completes all required start-up and testing activities, as outlined in the project specifications, prior to commencement of the FPT by the CxA.

- Demonstrates proper system performance and perform the actual testing as designated by the Commissioning Team.
- Coordinates with manufacturers and suppliers to provide documentation requested by the Commissioning Team.
- Completes commissioning documentation as outlined in the Commissioning Plan.
- Participates in all commissioning activities related to equipment and systems associated with their scope of work and as directed by the CxA.
- Conducts training and coordinates with Manufacturers.

A/E:

- Develops Basis of Design document, project specifications and drawings.
- Provides clarification on the design intent to the Cx Team, as required.
- Responds to RFIs relating to the commissioning process.
- Reviews or inspects installed equipment and systems for compliance with the project specifications prior to commencement of the FPT by the CxA.
- Participates in the training process, as required.

Owner and Owner's Representative:

- Develops the Owner's Project Requirements.
- Gives final approval of the Commissioning work.
- Coordinates the involvement of user representatives in the commissioning and training process.

8. COMMUNICATIONS MANAGEMENT PROTOCOLS

The following communications management protocols will apply to this project:

ITEM	PROTOCOL
Commissioning related documentation	CxA will forward to GC who will distribute to subcontractors. Subcontractors will send all documentation to GC who will forward to CxA.
Minor or verbal information and clarifications	CxA will communicate directly with appropriate party.
Formal RFI or documentation requests	CxA will communicate directly with Owner's Rep., A/E or GC, as appropriate.
Scheduling of Cx meetings	CxA will communicate with Owner's Rep. and GC
Scheduling of Functional Performance Testing and Re-Testing	CxA will communicate with the GC. Direct communication with subcontractor if acceptable to GC.
Notification of Issues through Issues Log	CxA will forward to GC who will distribute to subcontractors. Subcontractors will confirm resolution by returning signed Issues Log to GC who will forward to CxA.
Request for changes	CxA, GC, subcontractors to request with A/E. CxA has no authority to issue change orders or to direct GC or sub-contractors.
Disagreements	Parties to try and resolve directly at lowest possible level. Owner's Rep. will have final decision.

9. COMMISSIONING PROCESS

This section sequentially details the Commissioning Process by task or activity.

9.1 COMMISSIONING PROCESS SUMMARY

TASK / ACTIVITY	PROJECT MILESTONE
OPR Development	
Design documents reviews during the design phase	
Incorporate Cx documentation into construction documents (specifications and preliminary Commissioning Plan)	
Review mechanical and electrical contractor submittals and shop drawings	
Development of Final Commissioning Plan	
Static Verification Forms	
Start-Up Forms	
Functional Performance Test Forms	
Commissioning Meetings	
Introduce Issues Log	
Mechanical and Electrical Site Observations	
Execution of Functional Performance Tests	
Test Failure and Re-testing	
Deferred, Phased or Seasonal Testing	
Facility Staff Participation	
Operations & Maintenance Manuals	
Training and Orientation of Owner Personnel	
10 - month post occupancy review	
Prepare final commissioning report	

9.2 OPR REVIEW

The CxA reviewed the OPR document provided by the Owner for clarity and completeness.

9.3 DESIGN DOCUMENT REVIEW AND BACK-CHECK

The CxA has reviewed a design documents submission for clarity, completeness and conformance with the OPR.

9.4 COMMISSIONING DOCUMENTATION

The CxA develops commissioning specifications and a Preliminary Commissioning Plan for inclusion into the Construction Documents. The commissioning specifications describe the commissioning process and activities as part of the project. The Commissioning Planning is a supporting document which outlines the organization, schedule, resources and documentation requirements of the commissioning process.

9.5 SUBMITTALS AND SHOP DRAWINGS

The CxA requests from the GC all the documentation required for the systems, assemblies and equipment being commissioned. The GC will coordinate appropriately with the subcontractors. This data request typically coincides with the normal A/E submittal process. At minimum, this equipment data includes shop drawings, installation and start-up procedures, O & M data, performance data, material data sheets and control drawings. The CxA reviews the submissions relative to commissioning issues as expressed in the contract documents, not for general contract compliance, which is the A/E's responsibility.

The A/E and GC will notify the CxA of any new design intent or operating parameter changes, added control strategies and sequences of operation or other Change Orders that may affect commissioned systems. As the phases of the TAB are completed, the draft TAB report is provided to the CxA with full explanations of approach, methods, results, data table legends, etc. The final TAB report is provided to the CxA upon completion.

These submittals to the CxA do not constitute compliance for submittals for the O & M Manuals.

9.6 DEVELOPMENT OF FINAL COMMISSIONING PLAN

Upon receipt of the required submittals, shop drawings and other documentation, the CxA will finalize the Commissioning Plan. This consists of the development of Static Verification Forms, Start-Up Forms and Functional Performance Test Forms as they relate to this specific project. These forms will form the basis of the Final Commissioning Report.

9.7 STATIC VERIFICATION FORMS

The Static Verification Forms are intended to verify that the equipment received on site is consistent with the design documents and submitted shop drawings. The CxA is responsible for developing these forms. The GC and subcontractors are responsible for the timely execution of the activities required to complete the forms.

It is highly recommended that these forms be completed as the equipment arrives on site. This will allow the subcontractors sufficient time to address any issues related to non-conformance such as: missing equipment, incorrect voltage, capacity, orientation, etc.

These documents are to be completed and submitted to the CxA for review before installation and start-up.

9.8 START-UP FORMS

Upon completion and review of the Static Verification Forms, the Subcontractors and Mfr can proceed with the start-up of equipment and systems. The Subcontractors and Mfr schedule the start-up and initial checkout with the GC and CxA. The start-up and initial checkout are directed and executed by the Subcontractors and/or Mfr. During the start-up process, the Subcontractors and Mfr will complete the Start-Up Forms provided and all other required documentation for warranty purposes. Only individuals having direct knowledge of the equipment and its operation shall complete the forms.

The Start-Up Form will consist of documentation provided by the Mfr. If this documentation is not available, the Subcontractors will request a form be developed by the CxA. The Subcontractors must clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully at the bottom of the procedure form or on an attached sheet. The installing Subcontractors and/or Mfr correct all areas that are deficient or incomplete according to the checklists and tests.

The Start-Up Forms are to be completed and submitted to the CxA for review before the functional performance testing can begin.

9.9 FUNCTIONAL PERFORMANCE TEST FORMS

Upon receipt of the required submittals, shop drawings and other documentation, the CxA will develop the Functional Performance Tests based on the sequence of operations outlined in the design documents. These forms are intended to ensure that the equipment and system installation meet the design intent and the Owner's Project Requirements.

Prior to execution, the CxA will provide the Functional Performance Tests to the installing Subcontractor (via the GC) who will review the tests for feasibility, safety, warranty and equipment protection. Blank copies of the forms are included in the Commissioning Report and System Manual for later use by Operations Staff.

The CxA oversees, witnesses and documents the functional performance testing of all equipment and systems according to the requirement of the Commissioning Plan.

9.10 COMMISSIONING MEETINGS

Early on in the construction process, the CxA will plan and conduct a commissioning meeting to present and review the Commissioning Plan. The respective representatives of the commissioning team, as defined above, shall all be in attendance. The following items will be discussed at the meeting: reporting lines, flow of documents, project schedule and a primary contacts / contact information for each company represented. The outcome of the meeting is an increased understanding of the commissioning process and the respective responsibilities of each team member. During the meeting, the CxA will request any additional information required to finalize the Commissioning Plan. The CxA is responsible for producing meeting minutes.

The CxA will schedule regular commissioning coordination meetings throughout the construction process. The commissioning representative from each company will attend these meetings. The frequency of meetings will vary, with meetings occurring more frequently as construction progresses. During the meetings, the CxA will review the Issues Log. The CxA may attend construction meetings to stay abreast of construction issues.

9.11 ISSUES LOG

The Issues Log will document any discrepancies, non-conformance or test failures that are identified during the commissioning process. The Log will be used to manage the resolution of all issues and will be included in the Final Commissioning Report.

9.12 SITE OBSERVATIONS

The CxA may make periodic visits to the site, as necessary, to witness equipment and system installation during construction. The GC is to facilitate this process.

9.13 EXECUTION OF FUNCTIONAL PERFORMANCE TESTS

Functional performance testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as maximum/minimum cooling and heating loads, component failures, scheduled events, varying outside air temperatures, fire alarm, power failure, etc. The systems are operated through all of the sequences of operation and component functionality is verified. The CxA develops the Functional Performance Tests in a sequential, written form, and coordinates, oversees and documents the actual testing, which is performed by the appropriate commissioning team member.

These Functional Performance Tests do not relieve the project team from contractual requirements outlined in the project documents. The project specifications may include special testing requirements for equipment. These tests are mutually exclusive of the verification and functional procedures outlined in the Commissioning Plan.

Once the Static Verification and Start-Up Forms are submitted and reviewed, The CxA schedules functional tests through the GC, A/E and affected Subcontractors. Functional testing will not begin until the systems have been inspected by the A/E and that the GC and subcontractors confirm that they are ready for Functional Testing. The CxA may require written confirmation of a systems readiness for Functional Testing. The subcontractors will execute the tests. Air balancing and water balancing must be completed and debugged before functional performance testing of air or water-related equipment or systems. The EMCS must be operational and debugged before functional performance testing is conducted on components or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems.

Functional Testing and Verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA follows the specifications, when provided, and uses judgment where needed to determine which method is most appropriate. According to the specifications, identical piece of equipment may undergo random sampling for functional testing, as outlined in Section 5. The CxA reviews Owner-contracted, factory or required Owner acceptance tests and determines what further testing may be required.

9.14 TEST FAILURE AND RE-TESTING

The CxA documents the results of the Functional Performance Tests. Corrections for minor test failures can be made during the tests at his discretion. A failure of more than 10% of the selected equipment in the functional test shall be considered a failure of the particular test item. In this case, the equipment failure shall be corrected and retested and an additional number of items of equipment shall be tested. This shall continue until the particular functional test is successful i.e. less than 10% failure.

Failures are noted in the Issues Log and reported to the GC. The CxA schedules re-testing through the GC. Decisions regarding failures and corrections are made between the Owner, GC, CxA, A/E and the Subcontractor. For areas in dispute, final authority resides with the A/E and the Owner. The CxA recommends acceptance of each test.

9.15 DEFERRED, PHASED OR SEASONAL TESTING

Deferred, phased or seasonal testing is performing Functional Performance Tests after substantial completion. Systems performance testing should occur prior to the owner accepting the systems from the contractors, however, there are some instances where testing at the end of construction is either impractical or not meaningful due to uncontrollable factors. If any check or functional test cannot be completed during the scheduled commissioning timeline, execution of checklists and functional performance testing may be delayed upon approval of the A/E. These tests will be conducted in the same manner and as soon as possible.

9.16 FACILITY STAFF PARTICIPATION

The Owner's facilities operating staff are recommended to attend and participate in the testing process. The CxA will notify the GC who will then notify the Facility Staff when the commissioning events will occur.

9.17 OPERATIONS & MAINTENANCE MANUALS

The CxA receives from A/E, for review, the O & M Manuals for systems that were commissioned. The CxA reviews approval of these sections of the O & M Manuals and provides comments to the A/E and the Owner.

9.18 TRAINING AND ORIENTATION OF OWNER PERSONNEL

Owner training and orientation on equipment and systems is the responsibility of the GC. The CxA, A/E and Owner will review the training outlines for completeness. The GC will provide a list of participant's and a location for the training as required. The training agendas and attendance reports will be incorporated into the final commissioning report by the CxA.

The GC will coordinate all training activities in accordance with this document and the specifications. The GC will provide the CxA with a training schedule in accordance with

Commissioning Training Plan. The schedule is to include training location, equipment and systems to be covered, material to be covered and a timeline for each session. Information on the trainer shall also be provided including qualifications.

The person providing training for each piece of equipment shall be factory trained and fully knowledgeable on the operation and maintenance of the equipment.

9.19 10-MONTH POST OCCUPANCY REVIEW

The CxA will review the operation of the building with the General Contractor, Owner, Owner's Representative and User Representatives after 10 months of occupancy. A plan for resolving any outstanding commissioning related issues will be developed. The plan will be included in the Final Commissioning Report.

9.20 FINAL COMMISSIONING REPORT

The CxA will provide a Final Commissioning Report to the Owner and Owner's Representative. The Report shall include:

- Executive Summary
- Summary of commissioning activities
- Completed version of the final commissioning plan, including all Static Verification, Start-up and Functional Performance Test forms
- Issues Log itemizing all issues identified during the process, those resolved and those outstanding
- Copies of Meeting Minutes
- Copies of Site Reports
- Training and orientation documentation, if applicable.

10. TESTING EQUIPMENT

All standard testing equipment required to perform start-up and installation verification and required functional performance testing shall be provided by the division Contractor for the equipment being tested. The same equipment shall be used for the duration of the project.

Special test equipment, tools or instruments required by the Contract documents shall be provided for commissioning and shall be left on site.

All testing equipment shall have had a certified calibration, traceable to a national standard, performed within the past year. If not otherwise noted, temperature sensors and digital thermometers shall have an accuracy of ± 0.1°F, pressure sensors shall have an accuracy of ± 1.0% for each range available on the instrument (not the full range of the meter). All equipment shall be re-calibrated when dropped or damaged.

Appendix A

Mechanical Static Verification Forms

Note: Final list of Static Verification Forms will be provided in the Final Commissioning Plan

Appendix B

Mechanical Start-Up Forms

Note: Final list of Start-Up Forms will be provided in the Final Commissioning Plan

Appendix C

Mechanical Functional Performance Test Forms

Note: Mechanical Functional Performance Tests will be provided in final commissioning plan and will be based on the sequence of operations provided by the designer.

Appendix D

Electrical Static Verification Forms

Note: Final list of Static Verification Forms will be provided in the Final Commissioning Plan

Appendix E

Electrical Start-Up Forms

Note: Final list of Start-Up Forms will be provided in the Final Commissioning Plan

Appendix F

Electrical Functional Performance Test Forms

Note: Electrical Functional Performance Tests will be provided in final commissioning plan.

Appendix G

Training Plan

Note: Training Plan will be provided in final commissioning plan.

MARITECH
COMMISSIONING WORKS

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