District of Columbia Courts

H. CARL MOULTRIE COURTHOUSE BUILDING
MECHANICAL ROOM 1000 HEATING AND CHILLED WATER UPGRADE
CPFMD 0001-00-100; 101; 200; 350-2
CPFMD Construction 0012-01-101-7

500 Indiana Ave NW, Washington, DC 20001

July 17, 2020

ELECTRICAL

EXISTING CONDITIONS

The District of Columbia Moultrie Courthouse Building (DC Courts) was initially constructed in 1978. Some of the existing system from the scope of work are not original to the building. Overcurrent protection, disconnecting means, and motor control within the existing motor control center appear to be installed within the last 20 years. Based on discussion with DC Courts on June 19th, 2020, the motor control center was believed to be installed between 2006-2008; however, Eaton was not able to provide factory drawings, leading SmithGroup to believe it was installed prior to 2006. Updated construction documents of the motor control center would provide more insight. In general, most motor connections, conductors, and conduits appear original to the building based on surveys conducted on June 16th, 2020 and June 18th, 2020. Most equipment from the scope of work appear functional and parts are readily available for maintenance per discussion with DC Courts. The following analysis documents the existing conditions.

A. Existing Utility Service Entrance
    a. (3) Potomac Energy Power Company (PEPCO) utility feeders power the Moultrie Building. Utility power enters the building adjacent to Vault 1 located on the Parking Deck Level.
    b. The (3) feeders are labeled 14632, 14636, and 14633. (2) of these (3) feeders, 14636 and 14633, appear active. The inactive feeder may be a spare.
B. Existing Power Distribution
    a. Substation A is located in Vault A. It is comprised of (2)15kV primary switches, (2) 2,000kVA dry-type, step-down transformers, and 480Y/277V distribution switchgear. The switchgear is 3,200A, configured as a main-tie-main with Distribution Bus 1A and 1B in separate line-ups. The switchgear appears to be backed up by generator standby power. The substation appears to be installed in 2016, is in excellent condition and has 1600A frames suitable for use. See Figure 1.A.1a and 1.A.1b for switchgear elevation based on surveyed conditions, below.
    b. Substation B is located in Vault B. It is comprised of (2)15kV primary switches, (2) 2,000kVA dry-type, step-down transformers and 480Y/277V distribution switchgear. The switchgear is a 3,200A, configured as main-tie-main with Distribution Bus 2A and 2B in separate line-ups. The switchgear appears to be backed up by generator standby power. The substation appears to be installed in 2016, is in excellent condition and has 1600A frames suitable for use. See Figure 1.A.2a and 1.A.2b for switchgear elevation based on surveyed conditions, below.
    c. The switchgear overcurrent protection ratings and settings are provided for the observed installation settings by the Engineer of Record (EOR) in Figure 1.A.5.

d. The switchgear metered loads were provided by the Owner and are documented in Figure 1.A.6.
e. From Distribution Bus 2B in Substation B, motor control center “MCCA” is fed from a 1,200A trip setting and 1600A frame power circuit breaker.
f. “MCCA” is located in room “Mechanical P-A”. It is a 1,200A, 8-section motor control center with varying section ratings. See Figure 1.A.3 for elevation of motor control center, “MCCA”, based on surveyed conditions and existing documentation from 1978. “MCCA” appears to house motor starters for pumps original to the building without VFDs. From “MCCA”, motor feeders extend to motor terminations. This motor control center appears to be suitable for reuse and appears to have space available for future expansion. The amount of space available is yet to be confirmed. See Figure 1.A.4 for a table summarizing all the existing electrical connections of mechanical equipment.
g. “LL1S” is in Vault A. It is a 225A, 208Y/120V, panelboard with a 225A main circuit breaker. The panelboard appears to be installed within the last 20 years, is in excellent condition and has available spare branch circuit breakers for future expansion. It houses the existing branch circuit breaker for Pump #5 in the condenser system.
h. “LL1E” is located in room “Mechanical P-A”. It is a 100A, 208Y/120V, panelboard with main lugs only. The panelboard appears to be original to the building, appears operational, but is near the end of its useful life. “LL1E” has available spare branch circuit breakers for future expansion. It houses the existing branch circuit break for Pump #6 in the condenser system.

C. The existing BAS managed generator load-shed and load-add sequence is summarized.
   a. Failure of a Unit to Start of Synchronize:
      i. If a unit fails to start, after the fail to start time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound. A failure to start signal shall be relayed to the Building Automation System to allow for shedding low priority fan systems. The priority override controls on the OPERATOR INTERFACE PANEL may be used by an operator to manually add low priority loads to the bus, if the system determines that generator capacity is available to serve the loads. Bus overload monitoring shall protect the first priority loads in the event that the bus is inadvertently overloaded due to operator error.
      ii. If a unit fails to synchronize, after a preset time delay, an alarm will sound, but the unit will continue to attempt to synchronize until signaled to stop by manual operation of the control switches on the generator set. A failure to synchronize signal shall be relayed to the Building Automation System to allow for shedding low priority fan systems.
   b. Bus Overload
      If a bus overload occurs for any reason, a signal shall be relayed to the Building Automation System to allow for shedding low priority fan systems. If the bus does

not return to proper frequency within a predetermined period of time (adjustable via the OPERATOR INTERFACE PANEL), additional load shed signals will be generated until the generator set bus returns to normal frequency.

The following list prioritizes loads to be shed during bus overload condition, with i indicating the first load to be shed and viii being the last load shed.

i. Chiller No. 1, affecting the entire building, 676kW
ii. Chiller No. 2 affecting the entire building, 676kW
iii. AHU-19, affecting the 4th and 5th floor, 24HP and 3.7HP
iv. AHU-2, affecting the 3rd, 4th, 5th and 6th floor, 54HP and 10.8HP
v. AHU-18, affecting the 3rd, 4th, 5th and 6th floor, 53HP and 12HP
vi. AH-15, affecting the 3rd, 4th, 5th and 6th floor, 46HP and 9.5HP
vii. AHU-16, affecting the 3rd, 4th, 5th and 6th floor, 54HP and 10HP

D. The existing SCADA power system sequence of operations for Substation A, B, C Main-Gen-Tie-Main low voltage switchgear
   a. NORMAL CONDITIONS
      i. The utility A MAIN breaker (52-U1) is closed.
      ii. Tie (50-T) breaker is open.
      iii. The utility B MAIN breaker (52-U2) is closed.
      iv. The GEN breaker (52-G) is open.
      v. The Auto/Man switch is in the “AUTO” position.
      vi. The Auto Retransfer switch is in the “ON” position.
   b. NORMAL POWER FAILURE ON MAIN “52-U1” (OR “52-U2”)
      i. Voltage failure is detected by device 27/47-1 or –2 Voltage relay.
      ii. After an adjustable Source Loss time delay (factory set at three seconds), Main breaker “52-U1” (or “52-U2”) opens.
      iii. After an adjustable Breaker Open to Breaker Close time delay (factory set at two seconds), the Tie breaker “52-T” closes.
   c. NORMAL POWER RETURNS (AUTO RETRANSFER – OPEN TRANSITION)
      i. Normal voltage is detected by device 27/47-1 or -2 Voltage relay.
      ii. Auto Retransfer switch must be in “ON” position.
      iii. After an adjustable Source Stabilization adjustable time delay (factory set at ten seconds), Tie breaker “50-T” opens.
      iv. After an adjustable Breaker Open to Breaker Close time delay (factory set at two seconds), Main “52-U1” (or “52-U2”) closes.
   d. NORMAL POWER RETURNS (MANUAL RETRANSFER – OPEN TRANSITION)
      i. Normal voltage is detected by device 27/47-1 or -2 Voltage relay.
      ii. Auto Retransfer switch must be in the “OFF” position.
      iii. Turn the Auto/Man switch to the “MAN” position.

iv. After an adjustable Source Stabilization time delay (factory set at ten seconds), Tie breaker “50-T” may be opened via the manual open pushbutton on the touchscreen.
v. After an adjustable Breaker Open to Breaker Close time delay (factory set at two seconds), Main “52-U1” (or “52-U2”) may be closed via the manual close pushbutton on the touchscreen.
vi. Return the Auto/Manual switch to the “AUTO” position to resume normal operation.

e. GENERATOR FAILURE
i. The PLC program monitors the Generator breaker status. If the generator should fail, the generator breaker will open after a three (3) second source loss delay.
ii. If the generator breaker opens three times within a 15 minute interval, a generator failure is assumed and the generator breaker is then locked out.
iii. The “AUTO FAIL” pilot light will illuminate to indicate a system problem.
iv. If the utility source returns, the utility MAIN breaker (52-U1 or 52-U2) will close after a one (1) second delay. (Utility source stabilization delay has been overridden.)
v. The fault indication can be reset by moving the Auto/Manual switch to the “MAN” position and then back to “AUTO”. If the utility source returns, the Auto-Fail condition will be reset and the system will transfer back to the utility.

f. NORMAL POWER FAILURE ON BOTH MAINS “52-U1” AND “52-U2”
i. Voltage failure is detected by device 27/47-1 and –2 Voltage relay.
ii. After an adjustable Source Loss time delay (factory set at three seconds), Main breaker “52-U1” and “52-U2” open.
iii. A generator start signal will then be sent to the standby generator.
iv. Once the acceptable voltage level and frequency have been detected by the 27/47, 59, and 81 relays, the generator breaker “52-G”then closes.
v. After an a two second time delay the Tie breaker “50-T” closes.

g. NORMAL POWER RETURNS – SINGLE SOURCE (AUTO RETRANSFER – OPEN TRANSITION)
i. Normal voltage is detected by device 27/47-1 or -2 Voltage relay.
ii. Auto Retransfer switch must be in “ON” position.
iii. After an adjustable Source Stabilization adjustable time delay (factory set at ten seconds), Main breaker “52-U1” closes.

h. NORMAL POWER RETURNS – BOTH SOURCES(AUTO RETRANSFER – OPEN TRANSITION)
i. Normal voltage is detected by device 27/47-1 and -2 Voltage relay.
ii. Auto Retransfer switch must be in “ON” position.

iii. After an adjustable Source Stabilization adjustable time delay (factory set at ten seconds), Tie breaker “50-T” opens.
iv. After an adjustable Breaker Open to Breaker Close time delay (factory set at two seconds), Mains “52-U1” and “52-U2” close.

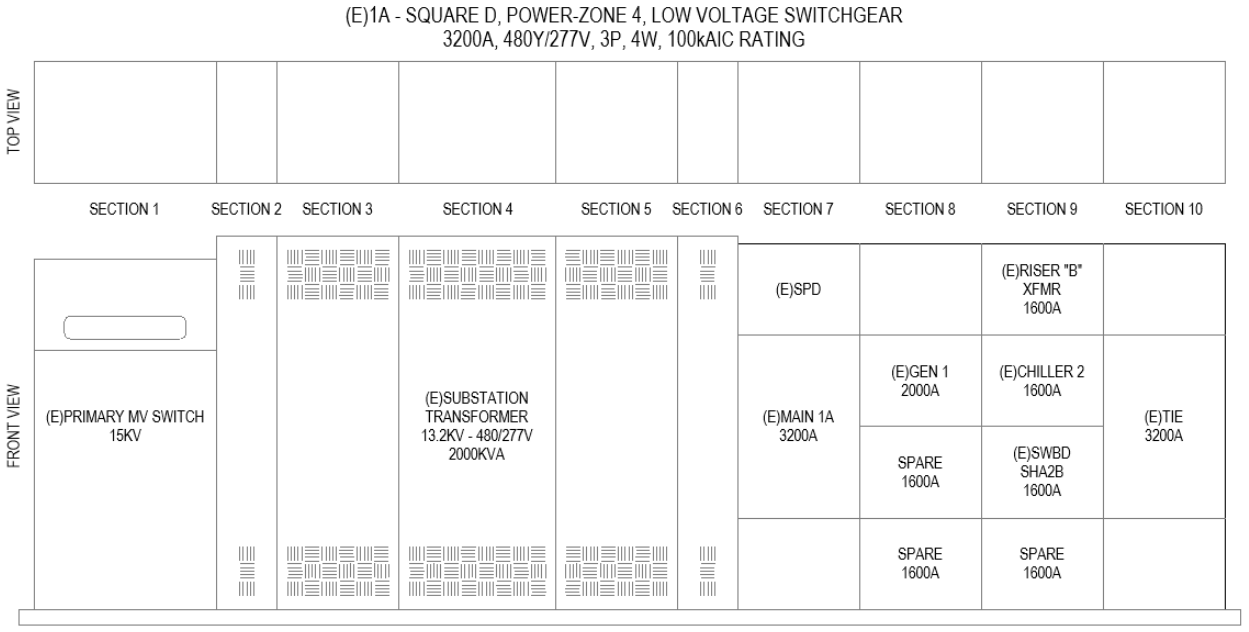

Figure 1.A.1a
Existing Substation 1A Elevation

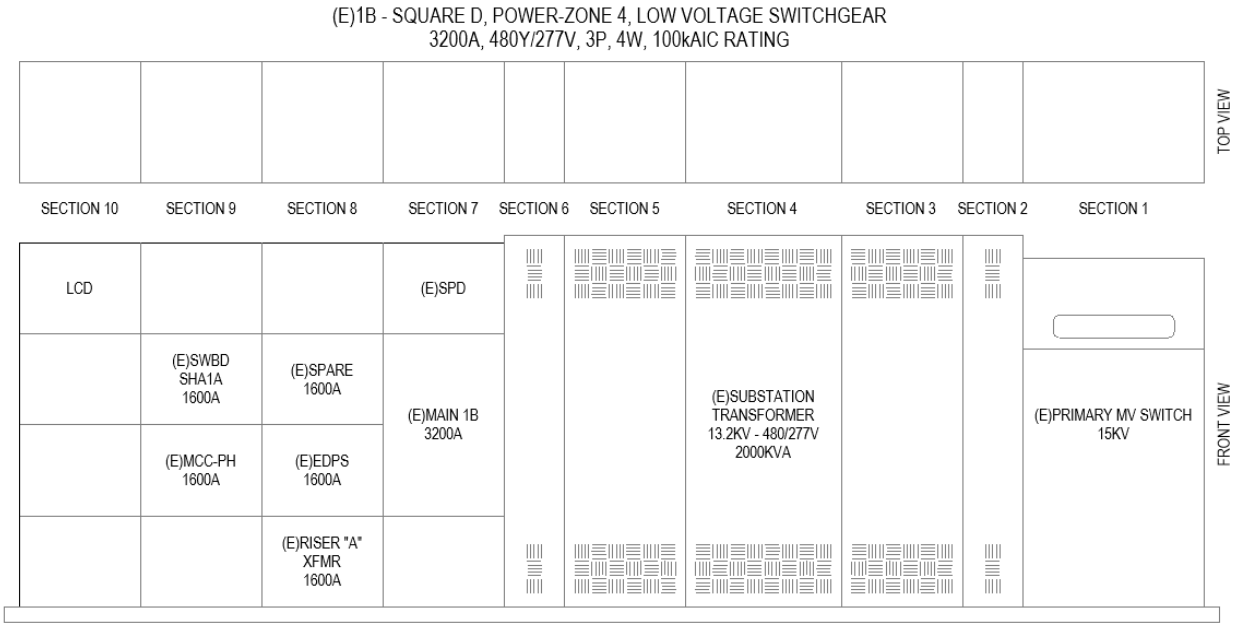

Figure 1.A.1b

Existing Substation 1B Elevation

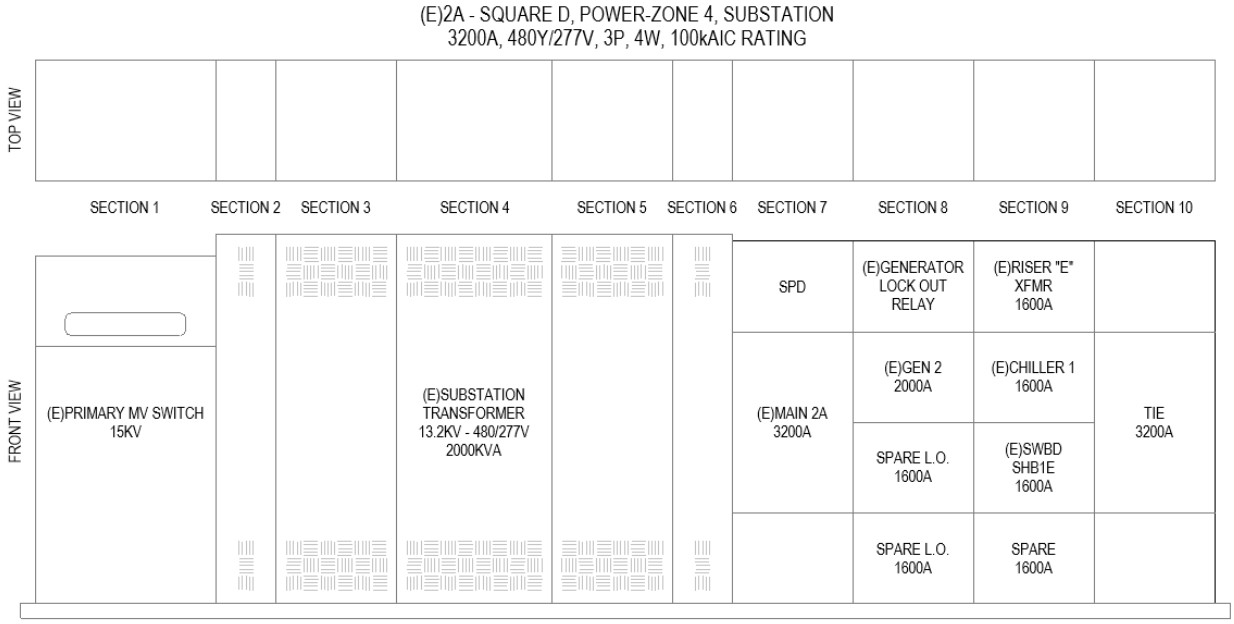

Figure 1.A.2a
Existing Substation 2A Elevation

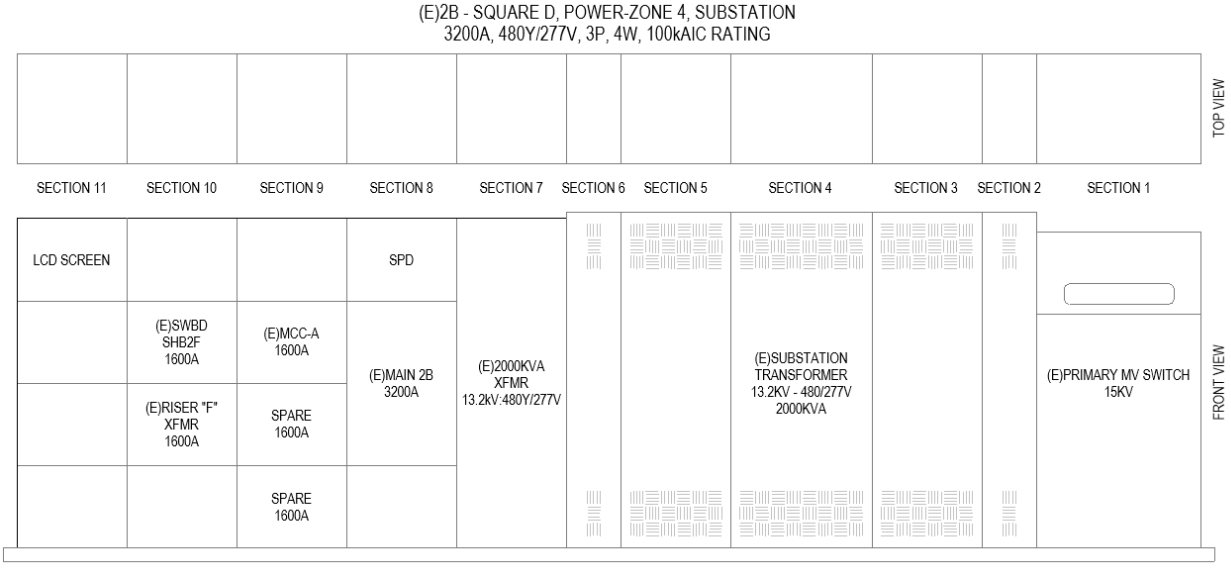

Figure 1.A.2b
Existing Substation 2B Elevation

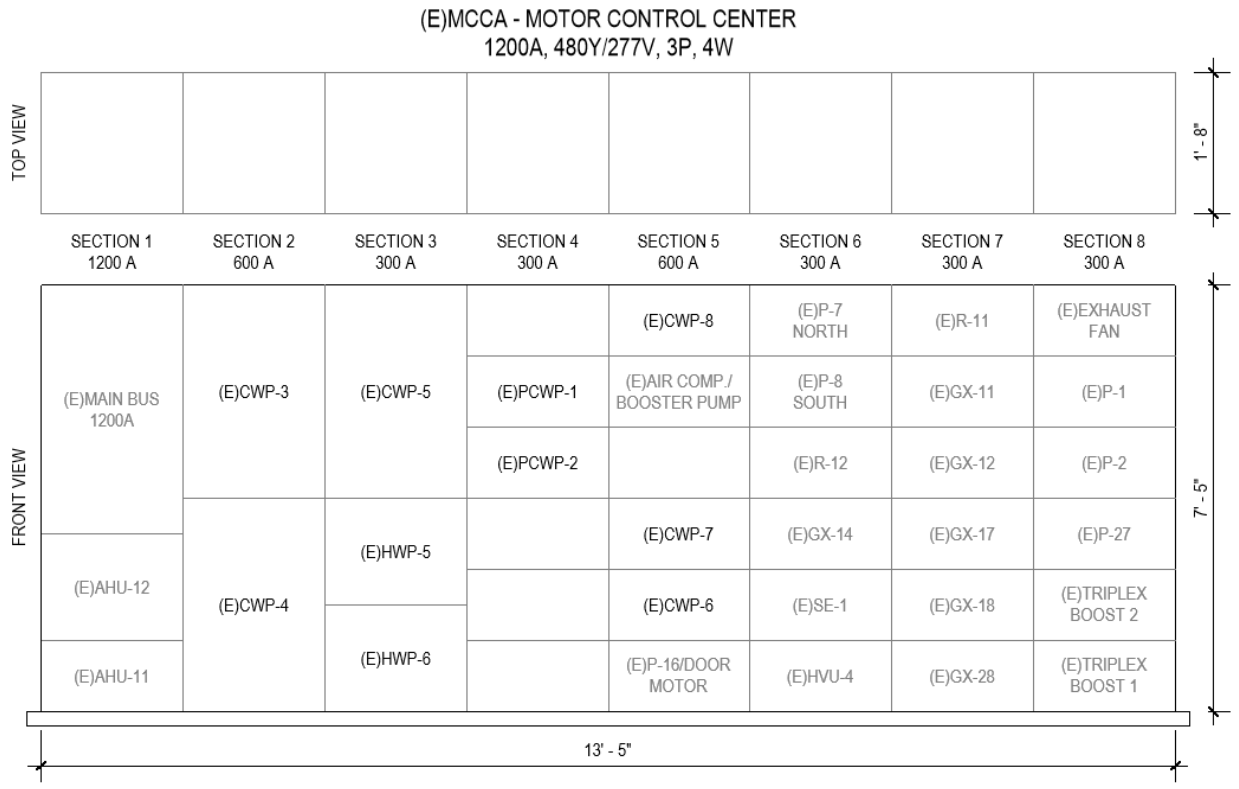

Figure 1.A.3
Existing Motor Control Center – MCCA Elevation

SYSTEM TYPE	RFP TAG	EXISTING OBSERVED TAG	EXISTING MOTOR CONTROL	EXISTING ESTIMATED LOAD (HP)	EXISTING POWER SOURCE
Condensate	Pump #5	None	FVNR	-	LL1S
Condensate	Pump #6	None	FVNR	-	LL1E
Heating Hot Water	P-5	HWP-5	FVNR	30	MCCA
Heating Hot Water	P-6	HWP-6	FVNR	30	MCCA
Chilled Water (CH-1)	P-1	PCWP-1	FVNR	10	MCCA
Chilled Water (CH-2)	P-2	PCWP-2	FVNR	10	MCCA
Condenser Water	P-3	CWP-3	FVNR	125	MCCA
Condenser Water	P-4	CWP-4	FVNR	125	MCCA
Condenser Water	P-5	CWP-5	FVNR	125	MCCA
Chilled Water (Secondary Loop)	P-6	CWP-6	VFD[1]	100	MCCA
Chilled Water (Secondary Loop)	P-7	CWP-7	VFD[1]	100	MCCA
Chilled Water (HX)	P-8	CWP-8	FVNR	10	MCCA

Notes:
[1]Motor control is not installed original to the building; can be maintained and reused.
[2]This is estimated based on mechanical existing surveyed conditions or listed as TBD in cases where ratings will be determined in a future survey.

Figure 1.A.4

Electrical Connections of Mechanical Equipment Within Scope of Work

Line-up	OCP	Frame (A)	Sensor (A)	Plug (A)	LTPU	LTD	STPU	STD	IPU	GFPU	GTD
A1	1B MCB 1A	3200	3200	3200	1	4	4	0.2	OFF	B	0.4
	2B Gen-1	2000	2000	2000	1	4	4	0	8	A	0.3
	2C SPARE	1600	1600	800	1	0.5	1.5	OFF	2	A	0.3
	2D SPARE	1600	1600	800	1	0.5	1.5	OFF	2	A	0.3
	3A RISER "A" XFMR	1600	1600	800	1	4	6	0.2	10	A	0.3
	3B CHILLER 1	1600	1600	1600	0.88	4	5	OFF	8	A	0.3
	3C SHA1A	1600	1600	1600	1	4	4	0.1	8	A	0.3
	3D SPARE	1600	1600	In 800	1	0.5	1.5	0.1	2	A	0.3
	4B TIE	3200	3200	3200	1	2	3	0.1	OFF	A	0.3
A2	6B SHA2B	1600	1600	1600	1	0.5	1.5	0.1	2	A	0.3
	6C MCC-PH1	1600	1600	800	0.8	4	6	OFF	2	A	0.3
	7B S SPARE	2000	2000	2000	0.7	8	5	0.1	6	A	0.3
	7C EDPS	1600	1600	800	0.88	20	10	0.1	8	A	0.3
	7D RISER "B" XFMR	1600	1600	800	1	0.5	1.5	0.1	2	A	0.3
	8B MCB 1B	3200	3200	3200	1	4	4	0.2	OFF	B	0.4

Figure 1.A.5
Substation A Low Voltage Switchgear Overcurrent Protection Ratings and Settings

Substation	Metering Point	Max. Load (kVA)	Max Load (A)	Date Range
A	1A	716.2	862.5	6/23 – 7/10
A	1B	534.8	644.0	6/23 – 7/10
B	2A	104.9	1264.3	7/9 – 7/10
B	2B	0	0	7/9 – 7/10

Figure 1.A.6
Substation A & B Metering Data

ANALYSIS

DESIGN WORK – ANALYSIS

The following outlines new mechanical equipment coordination.

A. Figure 2.A.1 estimates the maximum inrush current should all motors attempt to start on a full voltage (across the line start). The calculation shows that should the variable speed control bypass be equipped with full voltage starter, and all pumps were to start at once, the main circuit breaker of the panelboard is required to be sized at 800A.
B. Figure 2.A.2 estimates the maximum inrush current should all motors attempt to start on a full voltage (across the line start). The calculation shows that should the variable speed control bypass be equipped with full voltage starter, and all pumps were to start at once, the main circuit breaker of the panelboard is required to be sized at 1,200A.
C. Figure 2.A.2 compares the metered load, existing design load, and new substation loads.

It is recommended to feed a new panelboard to Mechanical Room P-A from Substation A to provide a second Utility source power to the space. The new panelboard and existing MCCA (fed from Substation A and B respectively) are recommended to each serve separate motors in redundant systems for when power is lost, partial operation is possible. The chiller system sequence of operations needs to consider pump flow availability and react accordingly. The new panelboard is sized at 800A to support the new design and allow for worst case multiple motor starting inrush current.

MECHANICAL EQUIPMENT	HP	FLA	OCP MULTIPLIER	MAXIMUM INRUSH (A)
CWP-5	150	180	2.5	784
SCWP-7	125	156	1	
HHWP-5	60	77	1	
HHWP-8	15	21	1	
PCWP-1	30	40	1	
PCWP-1A	30	40	1	

Figure 2.A.1
DP-A-1 Maximum Inrush Current Analysis

MECHANICAL EQUIPMENT	HP	FLA	INRUSH MULTIPLIER	MAXIMUM INRUSH (A)
(E)AHU-12	40	52	1	1113
(E)AHU-11	25	34	1	
CWP-3	150	180	2.5	
CWP-4	150	180	1	
HHWP-6	60	77	1	
CWF-1	15	21	1	
PCWP-2	30	40	1	
HHWP-7	15	21	1	
(E)AIR COMP/BOOSTER PUMP	5	7.6	1	
SCWP-6	125	156	1	
(E)P-16/DOOR MOTOR	3	4.8	1	
(E)R-12	7.5	11	1	
(E)GX-11	1.5	3	1	
(E)GX-12	1	2.1	1	
(E)GX-17	1.5	3	1	
(E)GX-18	1	2.1	1	
(E)GX-28	1.5	3	1	
(E)EXHAUST FAN	5	7.6	1	
(E)P-1	5	7.6	1	
(E)P-2	5	7.6	1	
(E)P-27	5	7.6	1	
(E)TRIPLEX BOOST 2	5	7.6	1	
(E)TRIPLEX BOOST 1	5	7.6	1	

Figure 2.A.2
MCCA Maximum Inrush Current Analysis

Name	7/10/2020 Meter Data		2015 Design		New Design	
	Max. Load (kVA)	Max Load (A)	Max. Load (kVA)	Max Load (A)	Max. Load (kVA)	Max Load (A)
A_1A-MCB	716.2	862.5	2754.4	3313.0	3164.1	3805.8
A_1B-MCB	534.8	644.0	2245.2	2700.6	2245.2	2700.6
B_2A-MCB	1049.9	1264.3	1932.5	2324.5	1932.5	2324.5
B_2B-MCB	0	0	2826.9	3400.3	2682.2	3226.2

Figure 2.A.3
Substation Load Analysis

PROPOSED WORK

DESIGN WORK – PROPOSED

Electrical power phasing will support mechanical work phasing and minimize interruption to existing equipment. The following lists the proposed work:

A. Provide a 480Y/277V panelboard fed from Substation A as there appears to be more clear pathways to the area of scope as compared to Substation B. Feeding from Substation A allows for additional reliability in power sources to Mechanical Room P-A in the Substation B utility feeders are interrupted.
B. Provide VFD's and feeders to each pump in the heating hot water system, chilled water system and new steam pump.
C. Provide FVNR (Across the line) starter for CWF-1, chilled water filtration motor.
D. Provide FVNR (Across the line) starter for the steam condensate pumps.
E. Reuse and maintain motor control center, "MCCA", throughout construction.
F. Provide new motor overcurrent protection, feeders, conduit, and motor control for motors.
G. Contractor will be required to provide a coordination study during Construction for the following:
    a. Selective Coordination shall be achieved between the main switchgear main in Vault 1 and the new panelboard's overcurrent protection.
    b. Motor and feeder protection.
H. Contractor will be required to provide a short circuit study during Construction for the new panelboard.
I. Contractor will be required to provide an arc flash study during Construction for the new panelboard.
J. Select demolition will be required for systems not suitable for reuse. Demolition will minimize power interruption and be required to maintain existing to remain and out of scope items.

Existing feeders, conduits, and overcurrent protection will be reused where suitable for reuse.

A phased approach will be provided to support pump replacement. Construction phasing will maintain power to existing systems. Minor disruptions will be required for any new terminations in existing Substation A and MCCA. One twenty-four-hour power interruption outside of normal business hours (on Sundays), to Substation A is acceptable to DC Courts based on a Coordination Call on 7/8/2020. Whether one-for-one pump replacement, or new pumps are installed prior to demolition of existing pumps, a new panelboard can be utilized to minimize disruptions required to existing MCCA. The phased approach is documented in the Construction Documents.

The existing BAS managed generator load shed scheme is not functioning properly according to discussions with DC Courts. The proposed design shares pumps between both chillers. It does not appear the BAS Load Shed scheme accounts for chilled water loads. It is recommended, that should Chiller 1 and 2 remain on separate priorities, the BAS and controls be configured to maintain supporting pump operation during a generator overload. Should both Chillers be shed, it is recommended the associated pumps are also shed.

Coordinate for the new pumps to be on the same existing generator load add scheme as the previous existing pumps.

Testing for existing Substation A switchgear and existing generator standby systems is required. Testing will be to exercise the switchgear and generators with the new load on Substation A located in Vault A to ensure that the new loads do not impact the Substation A operation and to inform DC courts of any standby systems operational issues, and to inform the future standby system solutions task order.

SYSTEM REQUIREMENTS

A. System requirements are included in the following Division 26 specifications:

260413 COMMON SUBMITTAL REQUIREMENTS FOR ELECTRICAL
260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260523 CONTROL-VOLTAGE ELECTRICAL POWER CABLES
260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573.13 SHORT-CIRCUIT STUDIES
260573.16 COORDINATION STUDIES
260573.19 ARC-FLASH HAZARD ANALYSIS
260800 COMMISSIONING OF ELECTRICAL SYSTEMS
262416 PANELBOARDS
262726 WIRING DEVICES
262813 FUSES
262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
262913.03 MANUAL AND MAGNETIC MOTOR CONTROLLERS
262923 VARIABLE-FREQUENCY MOTOR CONTROLLERS
264313 SURGE PROTECTION FOR LOW-VOTAGE ELECTRICAL POWER CIRCUITS