Monitoring Plan for the

Cornell Combined Heat and Power Project (CCHPP)

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New York State Energy Research and Development Authority
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Section 1: Introduction

The Cornell Combined Heat and Power Project (CCHPP) involves the construction of a combined heat and power facility based on two new dual fuel Gas Turbine Generators (GTG) and natural gas duct fired Heat Recovery Steam Generators (HRSG) for the purpose of supplying the Cornell University (Ithaca, New York) campus with both electricity and heating steam. The electrical production will displace electricity previously purchased from the local utility company, New York State Electric & Gas (NYSEG) and the heating steam production will displace steam produced by the existing Central Heating Plant (CHP) boilers which are fired with coal, oil and/or natural gas. The CCHPP also has the capability of exporting excess power production to NYSEG. The CCHPP will be wholly developed, owned, and operated by Cornell University. A rendering of the CCHPP and the existing CHP is provided in Appendix A.

The GTGs, HRSGs, and most auxiliaries are located inside the CCHPP Building. The steam condenser equipment is located inside a separate Steam Condenser Building with the steam condenser mounted on top of the building. The emergency diesel generators (EDGs) are located outside, on the north side of the CCHPP Building. The CCHPP Building will be heated and ventilated with filtered air, capable of maintaining positive pressure in the building to keep dust out. The electrical room, CEMs room, and other personnel spaces will be air conditioned using campus chilled water.

The major equipment in the CCHPP will be two dual fuel (natural gas and no.2 ultra low sulfur diesel Solar Titan 130 Gas Turbine Generators (GTGs). Each GTG will be complete with a natural gas duct fired Rentech HRSG which uses the hot exhaust gases of the GTG to generate steam. The nominal output for each gas turbine generator is 15 MW (ISO rating). Each HRSG is capable of providing approximately 46,000 lb/hr of HP steam (400 psig, 600 ^{o}F) and 14,000 lb/hr of LP steam (50 psig nominal, saturated) with no duct firing, and approximately 135,000 lb/hr of HP steam and 18,000 lb/hr of LP steam at the maximum duct firing temperature of 1800 ^{o}F.

When the Cornell power system is isolated from the grid in the event of a grid outage, transformer failure, or other reason, the GTGs will operate in islanded operation to supply power to the campus with automatic load shedding as required. The GTGs will follow the campus load up to their base load capability and control the system frequency. On return to normal parallel operation, the Cornell power system can be synchronized to the grid without having to adjust GTG output or campus loads.

Under all these different operation modes, the HRSG duct firing will be adjusted to meet the campus net steam demand (campus steam demand minus steam production from CHP) until the steam demand is below the HRSG unfired steam production. At that time, if GTG operation is to continue, CHP steam generation will be reduced if possible, or excess steam will be diverted to the steam condenser.

The steam condenser system utilizes a combination of direct air cooled condensing and a closed loop glycol system to condense any excess HRSG steam production due to low campus steam loads, or operating the GTG/HRSG solely for the purpose of exporting power, or during transient condition such as HRSG startup. During these times, all HRSG HP steam production is routed to the steam turbines and then to the steam condensing system as LP steam. Excess LP steam generated in the HRSG is routed directly to the steam condensing system. The steam condensing system is designed to allow both GTG units to operate at full output with the HRSG unfired, while supplying the minimum summer campus steam load. This corresponds to a steam flow of approximately 90,000 lb/hr.

A new ammonia supply system will provide ammonia to the Selective Catalytic Reduction (SCR) units of the two new HRSGs for the control of NOx emissions. The ammonia equipment including unloading skid, 12,000 gallon storage tank, forwarding skid, process control unit, manifold and injection grid are all supplied by the HRSG manufacturer. The ammonia storage tank, unloading station, and underground piping are designed to provide containment in accordance with NYCRR Part 599 requirements.

Two (2) 480 V Emergency Diesel Generators (EDGs) will be located adjacent to the CCHPP Building. The EDGs will be sized to provide sufficient auxiliary power to blackstart both gas turbine generator sets and CCHPP and CHP auxiliary loads. The EDGs will also be capable of operating in a Peak Shaving mode where they can operate in parallel with the normal utility supply. The generator set will have an integral diesel fuel tank built into the frame of the skid, with enough fuel capacity, for a minimum of 2000 US gal of fuel. The fuel tank will be connected to the diesel fuel supply system that will supply the GTGs. An automatic control valve, operated by level switches in the fuel tank, will refill the tank as necessary.

The gas turbines have dual fuel capability, operating either with 100% natural gas fuel or 100% Ultra Low Sulfur (ULS) No.2 fuel oil. The No.2 fuel oil serves as back up fuel for the gas turbines during interruption of natural gas supply or during times of high natural gas pricing. The fuel oil supply system allows continuous operation of the two gas turbines at full load at any site ambient temperature with 100% fuel oil firing. The fuel supply system allows for switching of fuel sources to be initiated automatically or manually at any turbine load and running condition. The fuel oil system also supplies fuel to the two new emergency diesel generators.

The existing No.6 fuel oil storage tank which feeds Boilers 6 & 7 in the CHP was converted to store No.2 fuel oil. The burners of Boilers 6 & 7 were converted to fire No.2 oil instead of No.6 fuel oil. The No.2 fuel oil system is equipped with centrifuges and a floating suction in the storage tank to meet the requirements of the gas turbine manufacturer. The centrifuges are located in the basement of the CHP in the area currently occupied by the No.6 fuel oil heaters. A “day” tank is also provided for each gas turbine for increased performance flexibility of the gas turbine liquid fuel forwarding skid.

Section 2: Site and Equipment Details

Presented in this section are site and equipment details regarding the major equipment for the combined heat & power project. In addition, information regarding existing equipment impacted by the CCHPP is provided. Items addressed in this section include:

- Facility Load Details
- Generator Size & Type
- Standby Power Functionality
- Heat Recover
- Displaced Boilers
- Relay Protection
- Electric Utility Details

2.1 Facility Load Details:

Annual Cornell central campus electric consumption is currently 250,000 MWh (approx.) with a peak load of nearly 35,000kW. Cornell central utilities generated approximately 1,200,000 klbs of steam for the campus. Peak steam demand in winter is approximately 360,000 lbs/hr. The building area served by central campus utilities is approximately 13.7 million gross square feet (GSF).

The CCHPP GTGs (one or both) will normally be operating in parallel with the grid to supply power to the campus. When there is a grid outage, the CCHPP can supply power to the campus as an islanded operation.

2.2 Generator Size and Type:

The major equipment in the CCHPP will be two dual fuel (natural gas and no.2 ULSD fuel oil) Solar Titan 130 Gas Turbine Generators (GTGs). The nominal output for each gas turbine generator is 15 MW (ISO rating). The generator is an ABB 13.2 kV 21.5 MVA TEWAC brushless generator complete with generator control, excitation system, and voltage regulator. The GTGs will have duel fuel capability with output of 14.2 MW nominal rating for gas firing and 13.1 MW nominal rating for liquid fuel.

2.3 Standby Power Functionality:

Standby power functionality is provided via (2) 1,000 KW (nominal rating at 0.8 power factor) Emergency Diesel Generators. The generators will allow a “black start” of all major equipment. The EDGs will use ultra low sulfur diesel and are EPA Tier 2 Certified. Each EDG will be equipped with an Allen Bradley Power monitor 3000 Model M6 with display and Ethernet ports.

2.4 Heat Recovery (loads & displaced fuels):

Each GTG will be complete with a Rentech Heat Recovery Steam Generator (HRSG) which uses the hot exhaust gases of the GTG to generate steam. In addition, supplemental natural gas duct firing is provided for each HRSG. Each HRSG is capable of providing approximately 46,000 lb/hr of HP steam (400 psig, 600 ^{o}F) and 14,000 lb/hr of LP steam (50 psig nominal, saturated) with no duct firing, and approximately 135,000 lb/hr of HP steam and 18,000 lb/hr of LP steam at the maximum duct firing temperature of 1800 ^{o}F.

2.5 Boilers displaced by heat recovery operation:

Table 1 provides a list of the boilers located in the central heating plant. The CHPPP will result in the removal of Boiler #2. In addition, ultra-low sulfur diesel will replace #6 fuel oil. Boiler steam production will be displaced by the CHP approximately 50%, reducing coal demand approximately 30,000 tons.

Table 1 – CHP Boilers

Boiler No.	Fuel	Capacity (klb/h) Boiler	Type	Year Installed	Outlet Conditions (psig/^{o}F)
1	Coal	90	Spreader Stoker	1981	400/600
2	#6 Fuel Oil	70	Sterling Vibragate	1959	200/550
5	Nat. Gas	100	D Type Package	1965	200/550
6	Nat. Gas or #2 Fuel Oil	107.5 / 109.5	D Type Package	1992	400/640
7	Nat. Gas or #2 Fuel Oil	107.5 / 109.5	D Type Package	1992	400/640
8	Coal	175	Overfeed Stoker	1949	400/600

For the purpose of load assignment of the GTGs and HRSGs, the existing CHP boilers are projected to have the following operating conditions:

- Boiler No. 1 (coal fired) minimum load is 30,000 lb/hr.
- Boiler No. 8 (coal fired) minimum load is 50,000 lb/hr.
- Boiler No. 1 and No. 8 minimum run time is one (1) week, i.e., these boilers will likely not be started unless the forecasted load is sufficient to sustain the operation of these boilers continuously for at least a week. When these boilers are operating, coal firing in these boilers is utilized preferentially over the duct firing in the HRSGs. Therefore, once the coal fired boilers have started, they are loaded to displace HRSG duct firing as much as possible.
- Boilers 5, 6, or 7 (gas fired) are planned not to be placed in service unless the total steam demand exceeds the total steam generating capacity of all operating fully fired

HRSGs and coal fired boilers, or when emergency backup steam is required when there is a GTG/HRSG or coal boiler trip.

2.6 Protective Relay functions and settings:

The CHP includes a sophisticated Electrical Protection and Monitoring System (EPMS)**.** Access to all relay settings and data will be provided via an Electrical Protection and Monitoring System (EPMS). This system will have 2 master stations, one at the Maple Avenue Substation (MAS) and one in the CCHPP electrical room. The workstations and HMIs (human machine interface) will be of utility hardened design, with no moving parts, to minimize the chances of an equipment failure. An interface between the EPMS and the CHP IFIX system will be provided so that EPMS data can be viewed from the CHP control room.

Protective relaying panels complete with HMIs and Ethernet communications will be provided to accommodate line, transformer, generator and bus protection at the MAS and the CCHPP. No transfer tripping from the NYSEG or remote communications to the existing NYSERG line protection will be required for this project. The line, transformer and bus protection relay panels for the MAS will be located in the new 13.2 kV switchgear and control building. Redundant line, transformer and bus relay protection will be provided. Feeder protective relays will be installed on the breaker cell doors in the switchgear line-up. "A" protection, breaker close circuits and breaker "a" trip circuits will be powered from the "A" battery bank while "B"' protection and breaker "B" trip circuits will be powered from the "B" battery bank.

The generator and bus protection relay panels for the CCHPP will be located in the CCHPP electrical room. The Station Service Transformer protective relays will be installed on the breaker cell doors in the generator switchgear line-ups. All generator switchgear control and protection will be powered from the Balance of Plant (BOP) battery bank in the CCHPP Electrical Room. Protective relays will be modern digital multifunction devices powered from the 125 VDC battery systems. The design will be based on the Schweitzer Engineering Laboratories (SEL) product line.

2.7 Electric utility details:

The existing 115 kV NYSEG revenue metering Power Transformers (PTs) on Line 1 will remain in their current location and three new revenue metering PTs will be installed on the new T3 steel A-frame structure. The existing revenue metering Current Transformers (CTs) will be replaced with new units that will be located on the T3 and T1 steel A-frame structures so as to maintain two (2) revenue metering points after T3 has been installed. A new Remote Terminal Unit (RTU) will be installed to report the required breaker statuses, bus voltages and generation output to NYSEG. The specific I/O required will be defined by NYSEG.

Section 3: Monitoring Objectives

The monitoring objectives are the following:

a) *Quantify the variation of the CCHPP system power output, fuel consumption, and efficiency over wide range of annual operating conditions.*

b) *Quantify external parasitic loads (e.g. gas compressors, pumps, etc.)*

c) *Quantify the daily, weekly, monthly, and annual variation of total facility power use (or power purchased from the utility) so that actual utility costs can be determined*

d) *Determine the thermal loads imposed on the CHP system by the facility (or the useful thermal output supplied to the facility) to measure the total CHP efficiency of the system on a daily, monthly and annual basis; quantify the variation of these loads with ambient conditions and operating schedules so the results from this site can be extended to other climates*

e) *Quantify the displaced fuel use on auxiliary equipment and systems to confirm the benefit of heat recovery*

f) *Quantify the amount of available thermal energy that is unused or "dumped" by the CHP system in order to demonstrate a system heat balance.*

g) *Determine environmental emissions from CHPP equipment and components to quantify net emissions impacts of the system.*

h) *Increase the effectiveness/efficiency of any operation and maintenance (O&M) activities*

i) *Satisfy air permit reporting requirements under the University's Title V Air Permit administered by the New York State Department of Environmental Conservation Division of Air Resources.*

Please note that this monitoring plan is focused on satisfying the monitoring / reporting needs for NYSERDA; however, many of the recorded elements are also utilized by the facilities' emissions monitoring system.

Section 4: Monitoring Parameters & Reporting:

4.1: Parameters

It is the intent of the monitoring plan to provide monitoring information in a format that satisfies the monitoring objectives listed in Section 3 and provides for required reporting via the NYSERDA data integration website. The data needs are focused on obtaining data elements to calculate energy consumption, and useful energy production (i.e. electric and steam) at 15-minute intervals and transfer the required elements at least once per day to the NYSERDA data integration website located at http://chp.nyserda.org.

A summary P&ID of the combined heat & power system and the existing central utilities plant is provided in **Drawing No. 6113-1FD2**, (See Appendix B). This drawing identifies the monitor types, locations and tag numbers.

A. Cornell Combined Heat & Power Major Equipment & Monitoring Parameters

The major existing Cornell Central Utilities equipment includes the following:

1. Solar Titan combustion gas turbines (CTG #1 & CTG #2),
2. Heat Recovery Steam Generators (HRSG) (HRSG #1 & HRSG #2)
3. Emergency Diesel Generators (EDG #1 & EDG #2)
4. Steam Condenser

The monitoring parameters associated with the respective equipment are provided below.

1) Solar Titan combustion gas turbines (CTG #1 & CTG #2)
Generating Capacity 15,000 KW each

- *Natural gas consumption.*
- *Fuel oil consumption*
- *Electric production by both combustion turbines*

2) Heat Recovery Steam Generators (HRSG) (HRSG #1 & HRSG #2)
Steam Production: 136,000 lbs/hour high pressure steam &
22,500 lbs/hour low pressure steam for each HRSG

- *Natural gas consumption by Duct Burner*
- *Steam Production by both HRSGs,*
- *Steam Production (both high & low pressure steam out)*
- *Steam Pressure (high pressure)*
- *Steam Temperature (both high & low pressure steam out)*
- *Flow Rate (feed water IN)*

3) **Emergency Diesel Generators (EDG #1 & EDG #2)**
Electrical Generation 1,000 KW each
- *Fuel oil consumption*
- *Electric Power Output*

4) **Steam Condenser**
Capacity: 90,000 lbs of steam / hour
- *Steam Pressure (low pressure steam IN)*
- *Steam Temperature (low pressure steam IN)*
- *Flow Rate (low pressure steam IN)*

B. Cornell Central Utilities Existing Major Equipment & Monitoring Parameters

The major existing Cornell Central Utilities equipment includes the following:

1. Coal Boiler No. 1,
2. Coal Boiler No. 8,
3. Natural Gas Boiler No. 5,
4. Natural Gas / Fuel Oil Boiler No. 6,
5. Natural Gas / Fuel Oil Boiler No. 7,
6. Back Pressure Steam Turbine Generator #1,
7. Back Pressure Steam Turbine Generator #2; and,
8. Cornell Hydroelectric Facility.

The monitoring parameters associated with the respective equipment are provided below.

1) **Coal Boiler No. 1, Steam Production 90,000 lbs/hour:**
- *Steam Production (high pressure steam out)*
- *Steam Pressure*
- *Steam Temperature*
- *Flow Rate (feed water IN)*

2) **Coal Boiler No. 8, Steam Production 90,000 lbs/hour:**
- *Steam Production (high pressure steam out)*
- *Steam Pressure*
- *Steam Temperature*
- *Flow Rate (feed water IN)*

Note: coal is not directly measured but calculated based on steam production. The methodology is accepted by the New York Department of Environmental Conservation for reporting consumption under our Title V Air Permit

3) **Natural Gas Boiler No. 5, Steam Production 100,000 lbs/hour:**
   - *Natural gas consumption*
   - *Steam Production (high pressure steam out)*
   - *Steam Pressure*
   - *Steam Temperature*
   - *Flow Rate (feed water IN)*

4) **Natural Gas / Fuel Oil Boiler No. 6, Steam Production 108,000 lbs/hour:**

   - *Natural gas/oil consumption*
   - *Run Hours for boiler.*
   - *Steam Production (high pressure steam out)*
   - *Steam Pressure*
   - *Steam Temperature*
   - *Flow Rate (feed water IN)*

5) **Natural Gas / Fuel Oil Boiler No. 7, Steam Production 108,000 lbs/hour:**
   - *Natural gas/oil consumption*
   - *Run Hours for boiler.*
   - *Steam Production (high pressure steam out)*
   - *Steam Pressure*
   - *Steam Temperature*
   - *Flow Rate (feed water IN)*

6) **Back Pressure Steam Turbo Generator #1, Generating Capacity 1692KW:**
   - *Electric Out*

7) **Back Pressure Steam Turbo Generator #2, Generating Capacity 5,778KW:**
   - *Electric Out*

8) **Cornell Hydroelectric Generating Facility, Generating Capacity 1,100KW Peak**
   - *Electric Out*

C. **Electric In Grid Purchased Electric (NYSEG)**
   - *Electric IN*

4.3: Emissions Monitoring

Two new exhaust stacks are provided (one for each GTG/HRSG system). The air emissions from the exhaust stacks are regulated by the New York Department of Environmental Conservation under the Title V Program and include comprehensive emissions monitoring. Applicable emissions output from the data acquisition system (DAS) is summarized in Table 2 below.

Table 2: Summary of DAS Emissions Related Outputs

Input Name	Connection Type (hard-wired or serial)	Measurement Range	Measurement Unit
Inlet NOx ppmvd @15% O2 on CT/HRSG-1	hard wired	0-200	ppmvd
Inlet NOx ppmvd @15% O2 on CT/HRSG-2	hard wired	0-200	ppmvd
Stack NOx ppmvd @15% O2 on CT/HRSG-1	hard wired	0-200	ppmvd
Stack NOx ppmvd @15% O2 on CT/HRSG-2	hard wired	0-200	ppmvd
Stack O2 on CT/HRSG-1	hard wired	0-25%	%O2
Stack O2 on CT/HRSG-2	hard wired	0-25%	%O2
Low CO ppmvd @15% O2 on CT/HRSG-1	ethernet	0-50	ppmvd
Low CO ppmvd @15% O2 on CT/HRSG-2	ethernet	0-50	ppmvd
High CO ppmvd @15% O2 on CT/HRSG-1	ethernet	0-10,000	ppmvd
High CO ppmvd @15% O2 on CT/HRSG-2	ethernet	0-10,000	ppmvd
NH3 ppmvd @15% O2 on CT/HRSG-1	hard wired	0-200	ppmvd
NH3 ppmvd @15% O2 on CT/HRSG-2	hard wired	0-200	ppmvd
CEMS in calibration for unit 1	hard wired	on/off signal	
CEMS in calibration for unit 2	hard wired	on/off signal	
CEMS in alarm for unit 1	hard wired	on/off signal	
CEMS in alarm for unit 2	hard wired	on/off signal	
NOx and NH3 system CEMS data valid for unit 1	hard wired	on/off signal	
NOx and NH3 system CEMS data valid for unit 2	hard wired	on/off signal	
CO CEMS data valid for unit 1	ethernet	on/off signal	
CO CEMS data valid for unit 2	ethernet	on/off signal	
CO catalyst 4-hour average temperature	ethernet	0-1200	degrees F

4.4: Energy Cost Reporting

Energy costs, including grid standby/contract demand costs will be reported annually in the Metrics Letter report and in the project Final Report. O&M activities and associated costs will be reported monthly via the NYSERDA CHP website

Section 5: Plant Control / Monitoring System Details

The CCHPP Plant Control System is intended to be a fully functional, state of the art microprocessor based, distributed control system (DCS) or programmable logic controller (PLC) control system. The control system will coordinate the control and monitoring of the CCHPP combustion Gas Turbines (GTGs), Heat Recovery Steam Generators (HRSGs) and plant auxiliary systems. The control system shall utilize current processing technology and be of a modular design comprised of individual control processors, I/O modules, power system modules and peripherals connected by means of Ethernet links in a redundant communications network. Each part of the system shall have options for redundant capability. The control system shall be a real time operating system, consisting of a global database with programmable functions. It is intended that the system shall be an open system and fully capable of interfacing to other systems for operator, system manager and enterprise management functions without special keys, licenses or other devices intended to restrict access to the control system other than for security functions.

The CCHPP control system will consist of a Balance of Plant (BOP) Control System and two Gas Turbine Generator (GTG) Control System complete with communications hardware, local and remote operator stations and alarm/logging printers connected in separate control architectures to an existing central control room located in the CHP. The existing CHP control room will be expanded to contain the Human Machine Interface (HMI) and auxiliary devices required to control and monitor the two control systems. The GTG Control System will control and monitor the gas turbine generators as well as integrate with a campus utility Load Management System (LMS) located in the Maple Ave. Substation (MAS). The BOP Control System will supervisory control and monitor two Heat Recovery Steam Generator (HRSG) PLCs, two Burner Management System (BMS) PLCs, two Emergency Diesel Generator (EDG) PLCs, a Continuous Emissions Monitoring System (CEMS), plant auxiliary system I/O and selected MAS I/O as required. The GTGs will be interconnected via a redundant Controlnet network, which will provide communications to local and remote HMI interfaces (local to the GTG equipment and remote at the CCHPP electrical room and or MAS electrical room). Ethernet connections will provide connection of each GTG to the CHP control room HMIs provided for the CHP operator. The BOP Control System will interface with the various local PLC systems (HRSG/BMS/EDG) via data highway plus (DH+) connections. The GTG and BOP Control Systems will interface with the existing CHP operator interfaces located in the

existing CHP control room. The existing CHP operator interfaces will provide the operator, through display, trend, and alarm screens, with control and monitoring access for the operation of the CCHPP Plant. All data accumulation, report generation and alarming takes place within the GTG and BOP Control Systems and is available to the plant operators and engineering staff as required. To the extent practical, the system will be organized so that the program within a processing unit will stand alone without dependence upon another processing unit or loop communications. Each processing unit will be backed up by a redundant fully capable processing unit on a separate power supply, operating in a "hot standby" mode, with automatic transfer of function to the standby unit in the event of a failure of the operating processing unit.

A CCHPP data logging room is located in the electrical room to house the Balance of Plant (BOP) Control System panels, BOP HMI , (Human Machine Interface) and GTG HMIs for control and monitoring of the CCHPP and the electrical interconnections. The CCHPP Plant will normally be monitored and operated, including startup, normal operation, and shutdown, by the CHP Operator to be stationed at the expanded Control Room in the CHP. During normal operation there is no operator stationed at the CCHPP. During plant startup and shutdown, or if the plant is experiencing upset conditions, a plant operator may be dispatched to the CCHPP Building to carry out local monitoring, inspection, and provide assistance to the plant operator located in the control room. Alternatively, the complete CCHPP can also be controlled and monitored at the data logging room. The GTG PLCs and HMIs shall be installed at the GTG equipment for local control and monitoring. Secondary control will be provided by remote GTG HMIs located in the CCHPP electrical room with primary supervisory control and monitoring from the CHP control room. The BOP Control System PLCs shall be installed in the CCHPP electrical equipment room. Primary operator control stations (P-HMIs) shall be located in a continuously manned central control room in the existing CHP plant with secondary operator control (S-HMI) from the CCHPP electrical room.

A Load Management System (LMS) will be provided in the Maple Ave. Substation (MAS). The LMS will provide load shed control, synchronizing control, import/export control, data logging and alarms, device control and monitoring, and event logging. The LMS will connect to the GTG Control System for control and monitoring at the CHP and the CCHPP.

A Substation Management System (SMS) will be provided in the MAS for control and monitoring of the substation equipment. The SMS will connect to both the HMI and printer located in the CCHPP electrical room and to the CHP HMIs for operator control and monitoring.

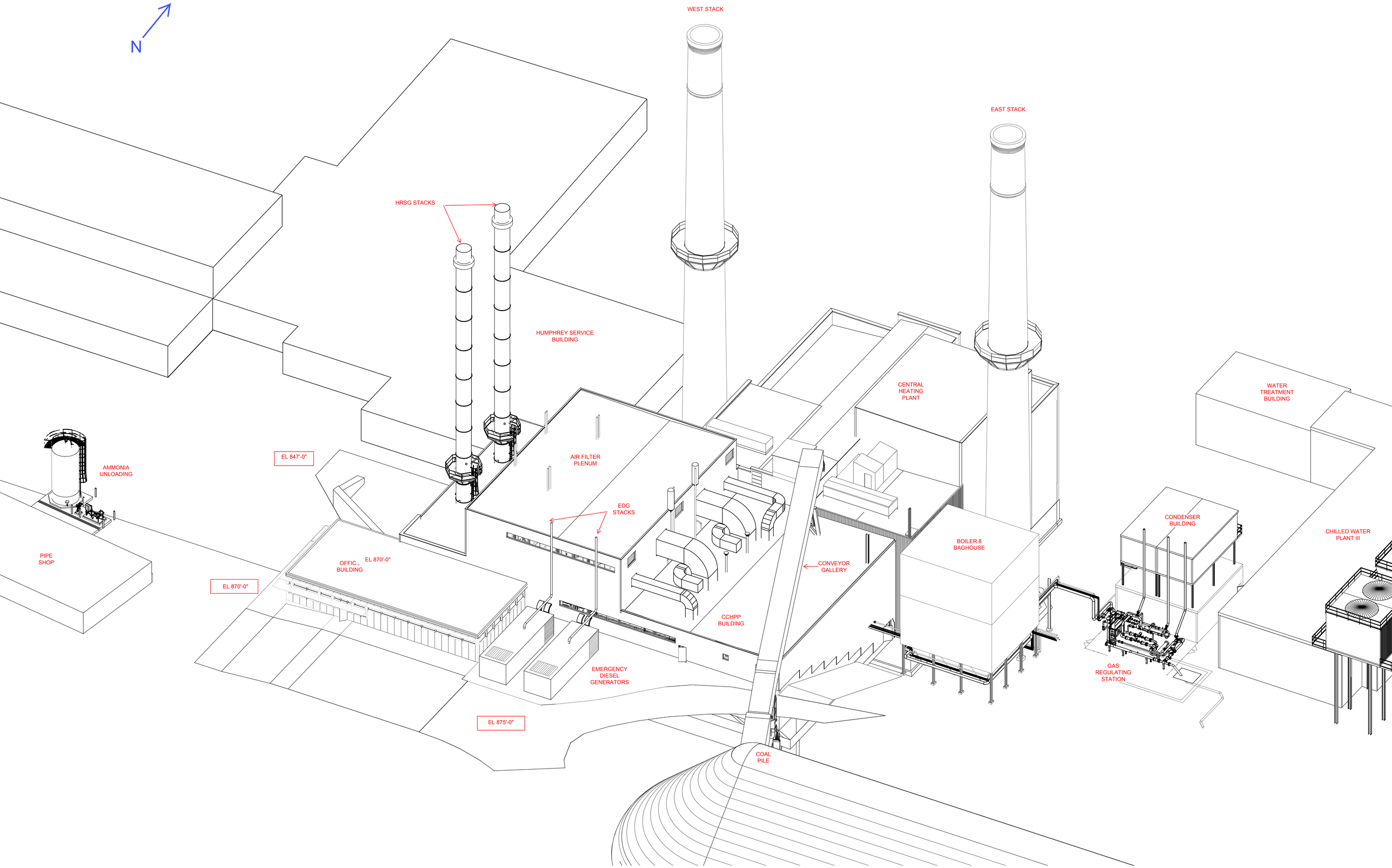
A Continuous Emissions Monitoring System (CEMS) will be provided. The CEMS will connect to the BOP Control System for control and monitoring at the CHP and the CCHPP.

Section 6: QA / QC

After start-up of all CHP systems is completed, commissioning will be initiated by operating all systems and equipment installed. CHP System emissions will be monitored during the commissioning period in order to validate the manufacturer's performance specifications. Commissioning will be considered completed when continuous and reliable operation of the complete plant with the new equipment has been demonstrated. The Contractor for the CCHPP will provide all services, labor and equipment required to modify systems and equipment and rectify problems to enable the plant to operate safely and continuously to achieve full load operation.

Periodic calibration will be performed as needed. The objectives of the calibration are to ensure proper meter/monitoring operations such that externally reported data is accurate and complete.

A copy of the commissioning report will be submitted to NYSERDA.



6113
CORNELL COMBINED HEAT & POWER PROJECT
PROGRESS SET - FOR INFORMATION ONLY
MAY 16, 2008

ATTEMPERATOR
FIT 190
PIT 100
TIT 100
FIT 100
TIT 100LP
FIT 100LP
FIT 586
FIT 332
FIT 234
OIL
GAS
AIR
GAS
HP
LP
HRSG # 1
136,000 PPH – HP
22,500 PPH – LP
RENTECH 2009
15,000 KW
SOLAR TITAN
GAS TURBINE
2009
EM
FIT 250
FIT 250LP
PIT 0134
TIT 0134
FIT 0134
TO MAPLEWOOD
& PIPE SHOP
ATTEMPERATOR
FIT 190
PIT 100
TIT 100
FIT 100
TIT 100LP
FIT 100LP
FIT 586
FIT 332
FIT 234
OIL
GAS
AIR
GAS
HP
LP
HRSG # 2
136,000 PPH – HP
22,500 PPH – LP
RENTECH 2009
15,000 KW
SOLAR TITAN
GAS TURBINE
2009
EM
FIT 250
FIT 250LP
HIGH PRESSURE STEAM LOOP HEADER 400 PSIG/600°F
LOW PRESSURE STEAM HEADER 200 PSIG/550°F
SH02
FIT21
PIT xxx
TIT xxx
WEST
STACK
(EP #2)
STACK
(EP #3)
FIT xxx
PIT xxx
TIT xxx
PRV
F
PRV
B
PRV
D & E
FIT xxx
COAL
BOILER NO. 1
90,000 PPH
ZURN 1981
BAGHOUSE
ASH
BOILER NO. 5
100,000 PPH
B & W 1965
GAS
WF17
FITxx
WFxx
FITxx
HIGH PRESSURE STEAM LOOP HEADER 400 PSIG/600°F
SH01
FIT20
PIT xxx
TIT xxx
EAST
STACK
(EP #1)
SH21
FIT01
PIT xxx
TIT 621
SH20
FIT01
PIT xxx
TIT 721
FIT xxx
FIT xxx
GAS
OIL
PRV
A & C
FIT xxx
FIT xxx
GAS
OIL
COAL
BOILER NO. 8
175,000 PPH
RILEY 1949
BAGHOUSE
ASH
BOILER NO. 6
107,500 PPH GAS
109,500 PPH OIL
FWEC 1992
BOILER NO. 7
107,500 PPH GAS
109,500 PPH OIL
FWEC 1992
WF09
FITxx
WF30
FIT01
WF28
FIT01
DSH
HEATING &
PROCESS
STEAM
DSH
180,000 PPH
BACK PRESSURE STEAM
TURBO–GENERATOR #2
TURBODYNE
1986
5778 KW
EM
60 psig
77,000 PPH
BACK PRESSURE STEAM
TURBO–GENERATOR #1
TURBODYNE
1986
1692 KW
EM
60 psig
PIT 0102
FIT 0102
TIT 0102
STEAM
CONDENSER
90,000 PPH
2009
MAKEUP
CONDENSATE/
TREATED WATER
STORAGE
CAMPUS
BUILDINGS &
FACILITIES
DEAERATOR
TIT xxx
BOILER FEED PUMPS
FI 0220
OIL
EMERGENCY
DIESEL
GENERATOR
#1
2009
1000 KW
EM
EM
SST1
FI 0221
OIL
EMERGENCY
DIESEL
GENERATOR
#2
2009
1000 KW
EM
480 KV
LOADS
EM
SST2
EM
EM
ELECTRICAL
POWER–OUTSIDE
SOURCES
(NYSEG)
HYDROELECTRIC
GENERATING FACILITY
(850 KW & 1100 KW UNITS
WITH PEAK CAPABILITY OF
1100 KW)

LEGEND

STEAM, FEEDWATER & CONDENSATE PIPING (NEW)

ELECTRICAL POWER (NEW)

STEAM, FEEDWATER & CONDENSATE PIPING (EXISTING)

ELECTRICAL POWER (EXISTING)

PRV – PRESSURE REDUCING STATION
DSH – DESUPERHEATING STATION
PIT – PRESSURE TRANSMITTER
TIT – TEMPERATURE TRANSMITTER
FIT – FLOW TRANSMITTER
EM – ELECTRIC POWER METER

REV.	APPROVED	CHECKED	DRAWN	DATE	ISSUED FOR REVIEW
PA			RM	JAN 08/08	
PB			SR	SEPT 12/08	ISSUED FOR INFORMATION

APPROVED

DRAFT. SUPER
CIVIL
I. & C.
ELECTRICAL
MECHANICAL
PROJECT

CORNELL COMBINED HEAT AND POWER

CORNELL UNIVERSITY
ITHACA, NEW YORK

P&ID
CHP WITH CCHPP
ELECTRIC & STEAM SUMMARY

GIE NIAGARA ENGINEERING INC., PC

DRAWN R MADSEN | CHECKED
DATE NOV 07
SCALE: NTS
IN REFERENCE TO "D" SIZE DWG. (36"×24")
SHEET 1 OF 1
DRAWING No. 6113–1FD2 | REV. PB

PA, PB, PC... ISSUED FOR REVIEW AND COMMENTS. BA, BB, BC... ISSUED FOR BID PURPOSES. DA, DB, DC... ISSUED FOR DESIGN RELEASE. 00, 01, 02... ISSUED AND REVISED FOR CONSTRUCTION PURPOSES.