

555 W23rd

555 West 23rd Street

New York, NY 10011

As-Built December 2019

Submitted to:

Frontier Energy
2695 Bingley Road
Cazanovia, NY 13035

Submitted by:

Tecogen, Inc.
45 First Ave
Waltham, MA 02451
781.466.6400
www.Tecogen.com

Project Team:

Principal Engineer:

Jim Armstrong
DSM Engineering
225 Wireless, Suite 102
Hauppauge, NY 11788
T: 631-360-1208 x101
www.ventrop.com

Developer/Contractor:

Joseph E. Gehret
Director of Operations
Tecogen, Inc.
45 First Avenue
Waltham, MA 02451
T: 781-466-6482
E: joseph.e.gehret@tecogen.com

Site Contact:

Jared Mosery
FS Residential
555 West 23rd Street
T: 212-634-5491
E: jared.mosery@fsresidential.com

Measurement & Verification Plan for CHP System at 555 W23rd

1. Introduction

Tecogen, Inc. (Tecogen) designed and oversaw the installation of a combined heat and power (CHP) system at 555 W23rd Street. The site is receiving an incentive from NYSERDA, of which the first two milestones have been paid out in full. The CHP system includes two (2) INV-e+ 100kW engine generator units. Each inverter-based system is intended to produce a gross output of 100 kW and recover engine jacket water and exhaust heat recovery for:

- i. DHW heating
- ii. Space Heating

The CHP system will provide power in parallel with the existing utility service, as well as the capabilities to operate in island-mode and provide backup power during an outage scenario.

2. Instrumentation

In order to quantify the performance of the CHP system, the CHP system fuel input, net electrical output, and useful thermal output will be measured. To capture that data Tecogen supplied the meters and instrumentation listed in **Table 1 on page 4**.

Data Logger

Readings for the installed instrumentation are recorded by a CHPInsight datalogger provided and installed by Tecogen. The computer samples all sensors approximately once per 30 seconds and records the information. The readings of heat recovery temperatures and flow rates will be used to provide an accurate calculation of heat transfer on the heat recovery loops, which are all continuous flow loops. Based on the number of monitored data points, the logger will have sufficient memory to store 3-days of data if communications with the logger are interrupted.

The data will be downloaded from CHPInsight once per day via an Internet connection provided by the Site. The data will be loaded into a Tecogen database for long term storage and checked for validity.

Onsite Installation

Tecogen installed a CHPInsight panel in each boiler room below each CHP unit. The monitoring system panel is approximately 2 ft x 16 in x 10 in. The panel is supplied with 120 VAC power (it requires 1 amp or less). The panel is located in each tower, with communication tied to the sensors in the other as well as the communications line provided by the site. Each panel will transmit individual reports to DER which in turn will be combined for reporting results.

Communications

The CHPInsight has a connection to the Internet. An IP address has been supplied. The logger uploads data every night to the Tecogen servers, is compiled into a csv file, and then distributed on an annual basis and provided to NYSERDA based on their monitoring requirements.

On Site Support

Measurement & Verification Plan for CHP System at 555 W23rd

The facility has assisted in providing a network connection for the CHPInsight. Tecogen is responsible for providing a complete monitoring installation, as well as any access for return trips to verify sensors or service the monitoring system.

Table 1. Overview of CHP System Monitoring Instrumentation

Data Point	Tecogen Label	Description	Units	Instrument / Sensor	Output Type	Location
P _{NET1}	EM-1	Generator NET Electrical Output	kW/ kWh	Veris E50C2	ModBus	Boiler Room - South Tower
P _{OUT1}	INV1	Generator Gross Electrical Output	kW/ kWh	InVerde	On-Board	Boiler Room Roof - South Tower
P _{NET2}	EM-2	Generator NET Electrical Output	kW/ kWh	Veris E50C2	ModBus	Boiler Room - North Tower
P _{OUT2}	INV2	Generator Gross Electrical Output	kW/ kWh	InVerde	On-Board	Boiler Room Roof - North Tower
G _{IN}	GM-1	Net Generator Fuel Input	CF	3M175TC Roots Meter (or similar)	Pulse	Mechanical Room Roof – South Tower
G _{IN}	GM-2	Net Generator Fuel Input	CF	3M175TC Roots Meter (or similar)	Pulse	Mechanical Room Roof – North Tower
T _{OUT1}	BTU-S1	Engine Heating Module Supply Temperature	°F	Onicon System-10 BTU	ModBus	Boiler Room - South Tower
T _{RET1}	BTU-R1	Engine Heating Module Return Temperature	°F	Onicon System-10 BTU	ModBus	Boiler Room - South Tower
F _{NET1}	BTU-1	Engine Heating Module System Flow	GPM	Onicon System-10 BTU	ModBus	Boiler Room - South Tower
Q _{NET1}	BTU-1	CHP Engine Heat Supplied	BTUh	Onicon System-10 BTU	ModBus	Boiler Room - South Tower
T _{OUT2}	BTU-S2	Engine Heating Module Supply Temperature	°F	Onicon System-10 BTU	ModBus	Boiler Room - North Tower
T _{RET2}	BTU-R2	Engine Heating Module Return Temperature	°F	Onicon System-10 BTU	ModBus	Boiler Room - North Tower
F _{NET2}	BTU-2	Engine Heating Module System Flow	GPM	Onicon System-10 BTU	ModBus	Boiler Room - North Tower
Q _{NET2}	BTU-2	CHP Engine Heat Supplied	BTUh	Onicon System-10 BTU	ModBus	Boiler Room - North Tower

3. Data Analysis

Measurement & Verification Plan for CHP System at 555 W23rd

The collected data listed in Table 1 on page 4 will be used to determine the net power output of the system as well as the fuel conversion efficiency (FCE).

Peak Demand or Peak kW

The peak electric output or demand for each power reading will be taken as the average kW in a fixed 15-minute interval (0:00, 0:15, 0:30, etc.), defined as:

$$kW = \frac{\sum_{15 \text{ min}} kWh}{\Delta T} = \frac{kWh \text{ per interval}}{0.25h}$$

Net Power Output

The power meter will measure the generator power output (P_{OUT}). The internal generator meter will measure the gross output of the engine generator as a check.

The parasitic power (P_{PAR}) is estimated to be 1.5 kW. The net power (P_{NET}) can be determined by subtracting parasitic power (P_{PAR}) from the power output (P_{OUT}).

$$kW_{NET} = P_{OUT} - P_{PAR}$$

Heat Recovery Rates

The heat recovery rates will be calculated based on the 30 second interval data collected. The piping arrangement at this site allows for the total recoverable heat rate to be determined at one location as there is no heat rejection unit included with the installation:

The rate of useful heat recovery in Btu/h is defined as:

$$Q_{NET} = C_p \times \sum (F_{NET} \times (T_{OUT} - T_{RET}) \times n)$$

where: $C_p = \sim 500 \text{ Btu/h-gpm-}^\circ\text{F}$ for pure water;
 n = Number of 1-minute intervals included in period of interest

The heat recovery loop fluid is expected to be pure water.

Any heat recovery measurement can be calculated for an interval sum (Btu) by the following:

Calculated Quantities

The fuel conversion efficiency (FCE) of the CHP system, based on the higher heating value of the fuel, will be defined as:

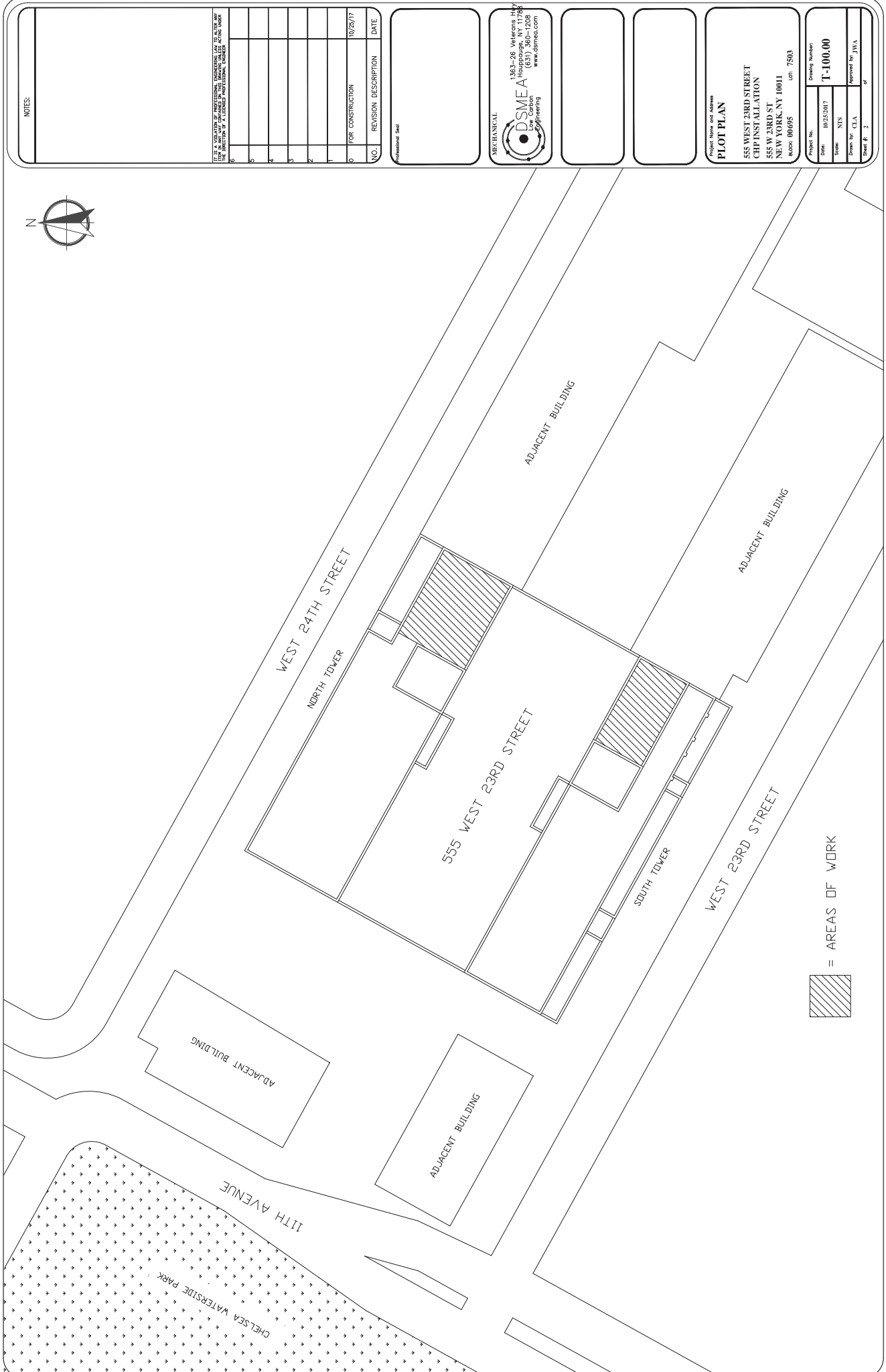
$$FCE = \frac{Q_{NET} + (3413 \times P_{NET})}{G_{IN} \times HHV_{Gas}}$$

where: Q_{Net} = Total Useful heat recovery (Btu) (QU)
 P_{Net} = Engine generator net output (kWh)
 G_{in} = Generator gas consumption (Std CF)
 HHV_{gas} = Higher heating value for natural gas ($\sim 1020 \text{ Btu/CF}$)

The FCE can be calculated for any time interval of interest (hourly, daily, monthly, etc.), depending on the resolution available for the gas meter reading.

Appendix A

System Schematics



NOTES

1. IF A VIOLATION OF PROFESSIONAL ENGINEERING LAW IS NOTED BY THE BOARD OF PROFESSIONAL ENGINEERS, THE BOARD OF PROFESSIONAL ENGINEERS SHALL BE NOTIFIED BY THE BOARD OF PROFESSIONAL ENGINEERS.	
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Professional Seal

MECHANICAL



Project Name and Address

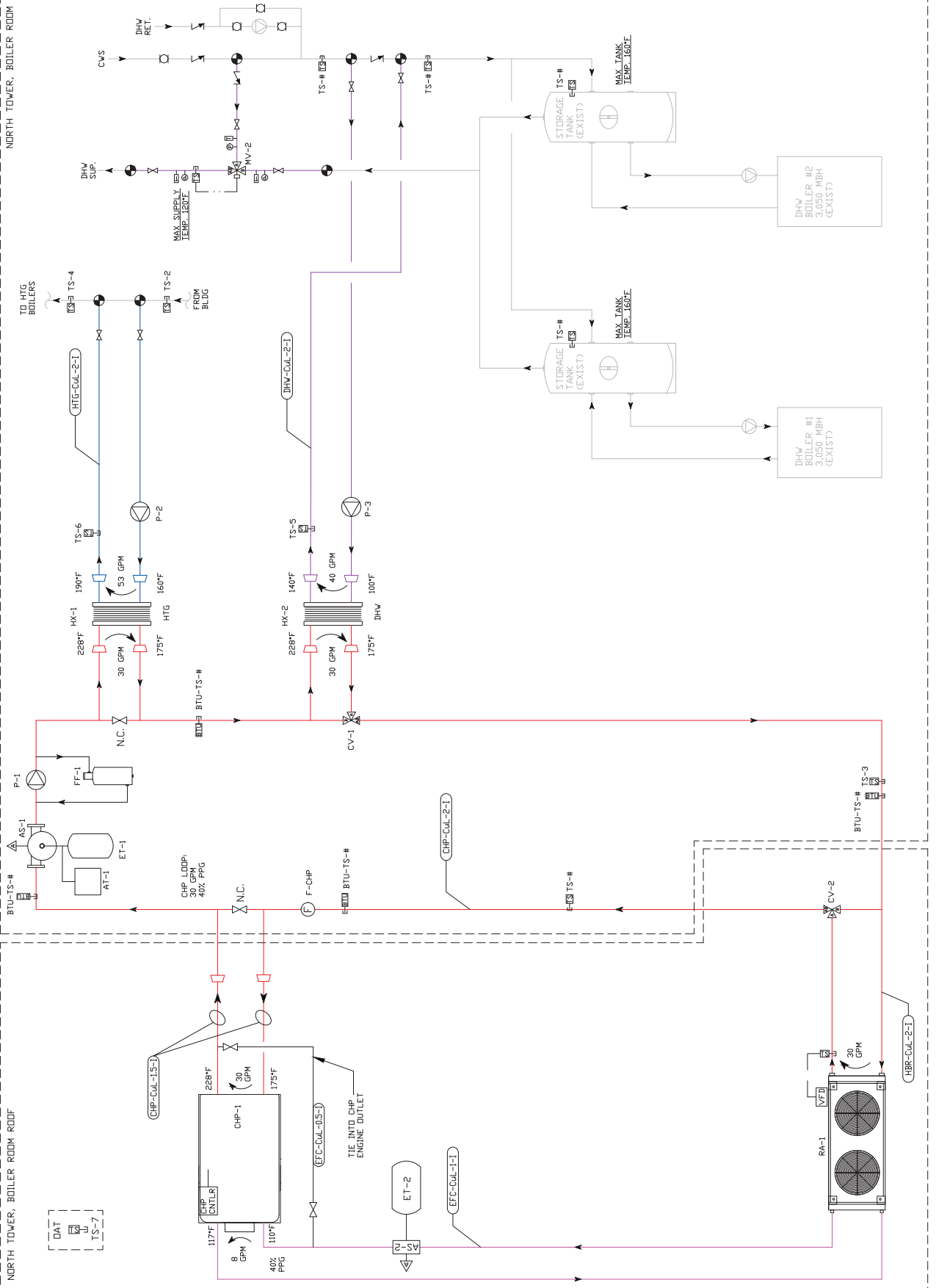
PLOT PLAN

555 WEST 23RD STREET
CHP INSTALLATION
555 W 23RD ST
NEW YORK, NY 10011
BLOCK: 00695 LOT: 7503

Project No.	Drawing Number
Date: 10/25/17	T-100.00
Scale: NYS	
Drawn by: CLJ	Reviewed by: JWA
Sheet # 2	of

NORTH TOWER, BOILER ROOM

NORTH TOWER, BOILER ROOM ROOF



NOTES:
1. REFER TO DWG M-600 FOR TYPICAL DETAILS AND FITTINGS NOT SPECIFIED

NO.	REVISION DESCRIPTION	DATE
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MECHANICAL
1363-26 Veterans Hwy
Hempstead, NY 11550
(516) 461-1208
www.dsmea.com

PROJECT Name and Address
MECHANICAL SCHEMATIC, NORTH
555 WEST 23RD STREET
CHP INSTALLATION
555 W 23RD ST
NEW YORK, NY 10011
BLOCK: 00695 Lot: 7503

Project No.
Date: 10/25/2017
Scale: NYS
Drawn by: JWA
Sheet R of

Drawing Number:
M-300.00



NOTES:

1. EXISTING PIPING SHOWN IN
REFERENCE AND
SCHEMATIC PURPOSES.
CONTRACTOR TO VERIFY ALL
CONNECTIONS AND LOCATIONS IN
FIELD.

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FURTHER ACTION SHALL BE THE RESPONSIBILITY OF THE ENGINEER.
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Professional Seal

MECHANICAL



Project Name and Address

MECHANICAL LAYOUT
NORTH TOWER BOILER ROOM

555 WEST 23RD STREET
CHP INSTALLATION

555 W 23RD ST
NEW YORK, NY 10011

Block: 00695 Lot: 7503

Project No.
Drawing Number:
M-406.00

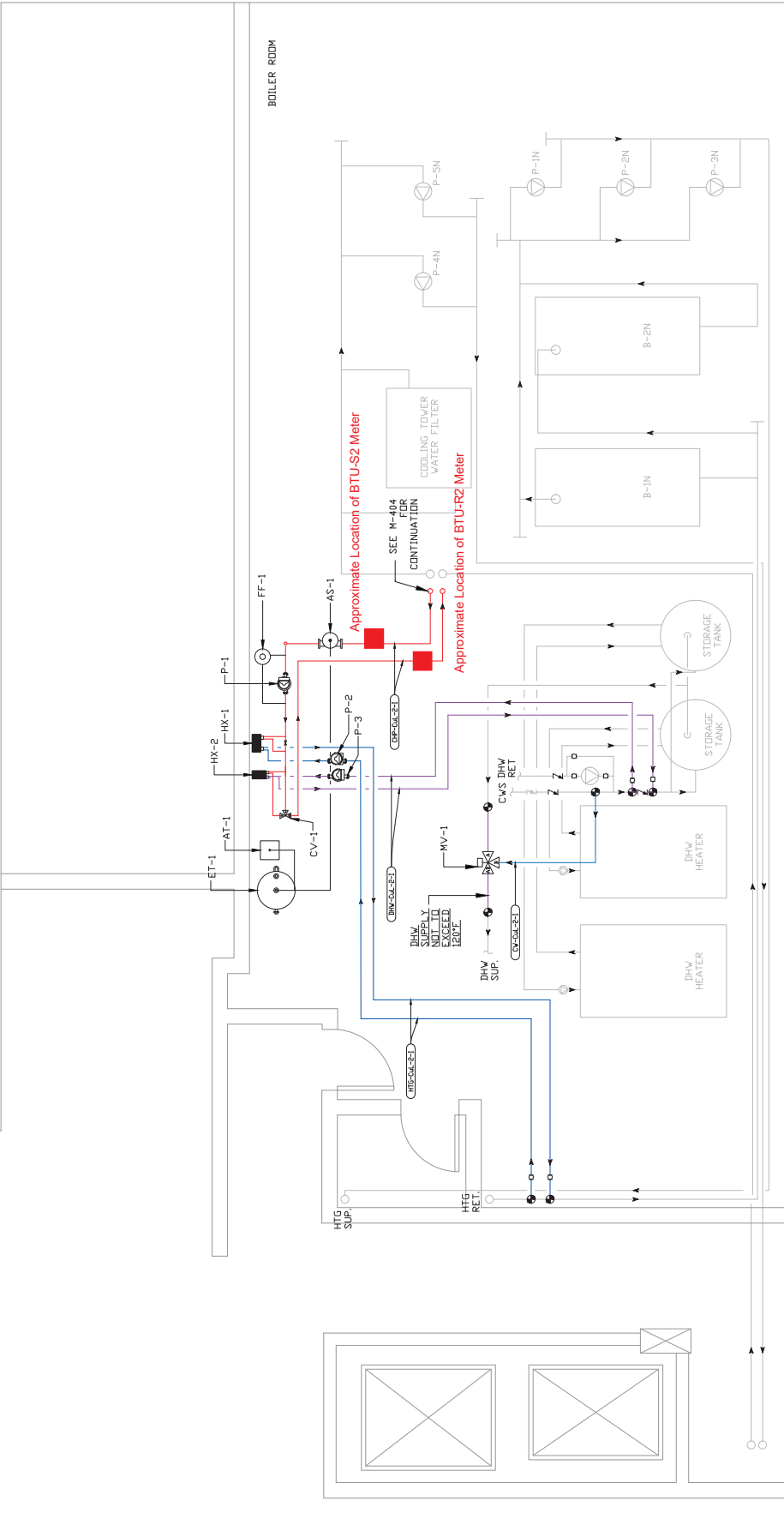
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01/25/2017

Scale:
3/8" = 1'-0"

Drawn by:
CLA

Reviewed by:
JWA

Sheet:
R of

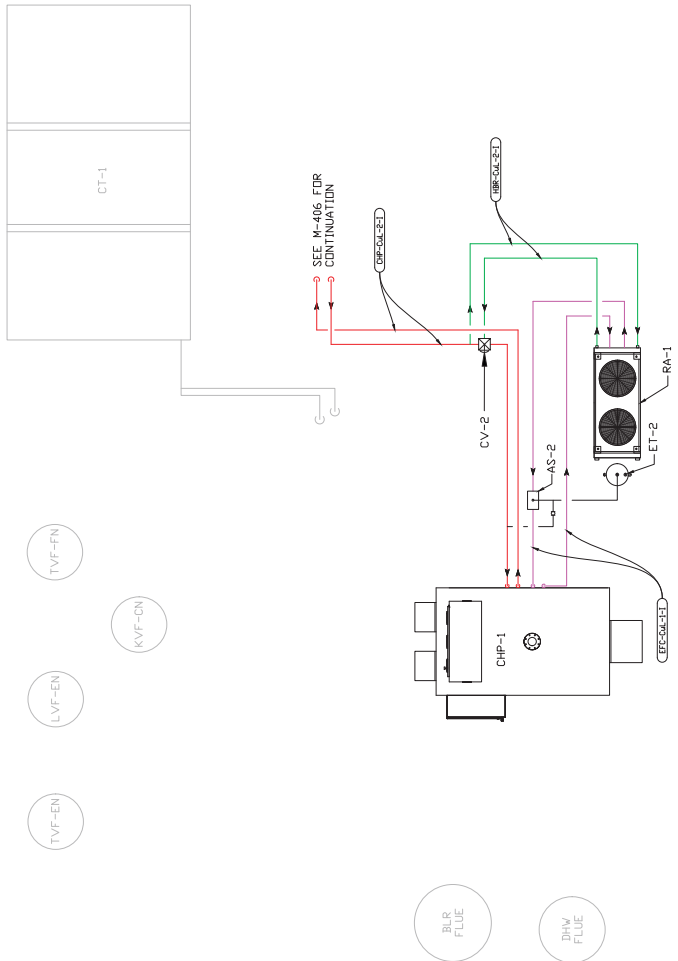


COURTYARD



ELEVATOR
MACHINE ROOM

BOILER ROOM
ROOF



COURTYARD

NOTES

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Professional Seal

MECHANICAL



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Hempstead, NY 11550
(516) 466-1208
www.dsme.com

Project Name and Address
MECHANICAL LAYOUT
NORTH TOWER ROOF

555 WEST 23RD STREET
CHP INSTALLATION
555 W 23RD ST
NEW YORK, NY 10011
BLOCK: 00695 LOT: 7503

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Drawing Number:
M-404.00

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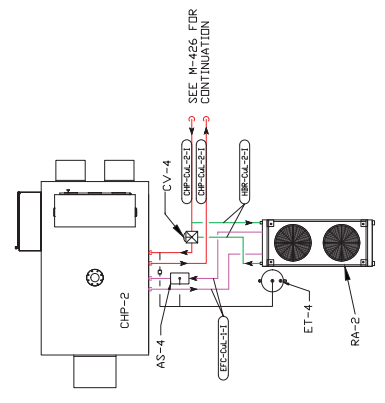
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Reviewed by: JWA
Sheet **R** of



COURTYARD

BOILER ROOM
ROOF

ELEVATOR MACHINE
ROOM



LVF-ES

TVF-ES

KVF-CS

TVF-DS

NOTES

1. IT IS THE OBLIGATION OF THE PROFESSIONAL ENGINEER TO SIGN AND SEAL ANY DRAWING OR SPECIFICATION FOR THE CONSTRUCTION OF ANY BUILDING OR STRUCTURE.

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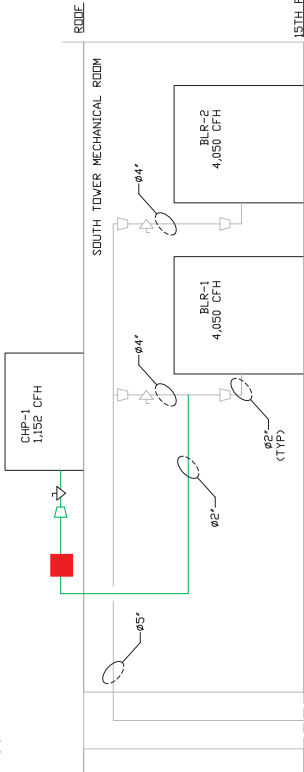
MECHANICAL
DSMECA
1363-26 Veterans Hwy
Hempstead, NY 11550
(516) 466-1208
www.dsmecc.com

MECHANICAL LAYOUT
SOUTH TOWER ROOF
555 WEST 23RD STREET
CHP INSTALLATION
555 W 23RD ST
NEW YORK, NY 10011
BLOCK: 00695 LOT: 7503

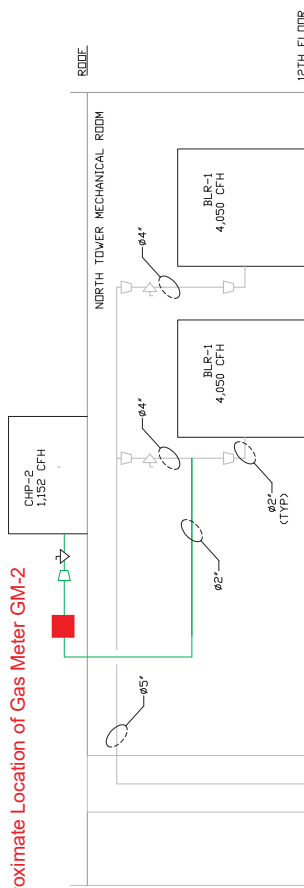
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Checked by	JWA
Sheet	R

Drawing Number: **M-424.00**

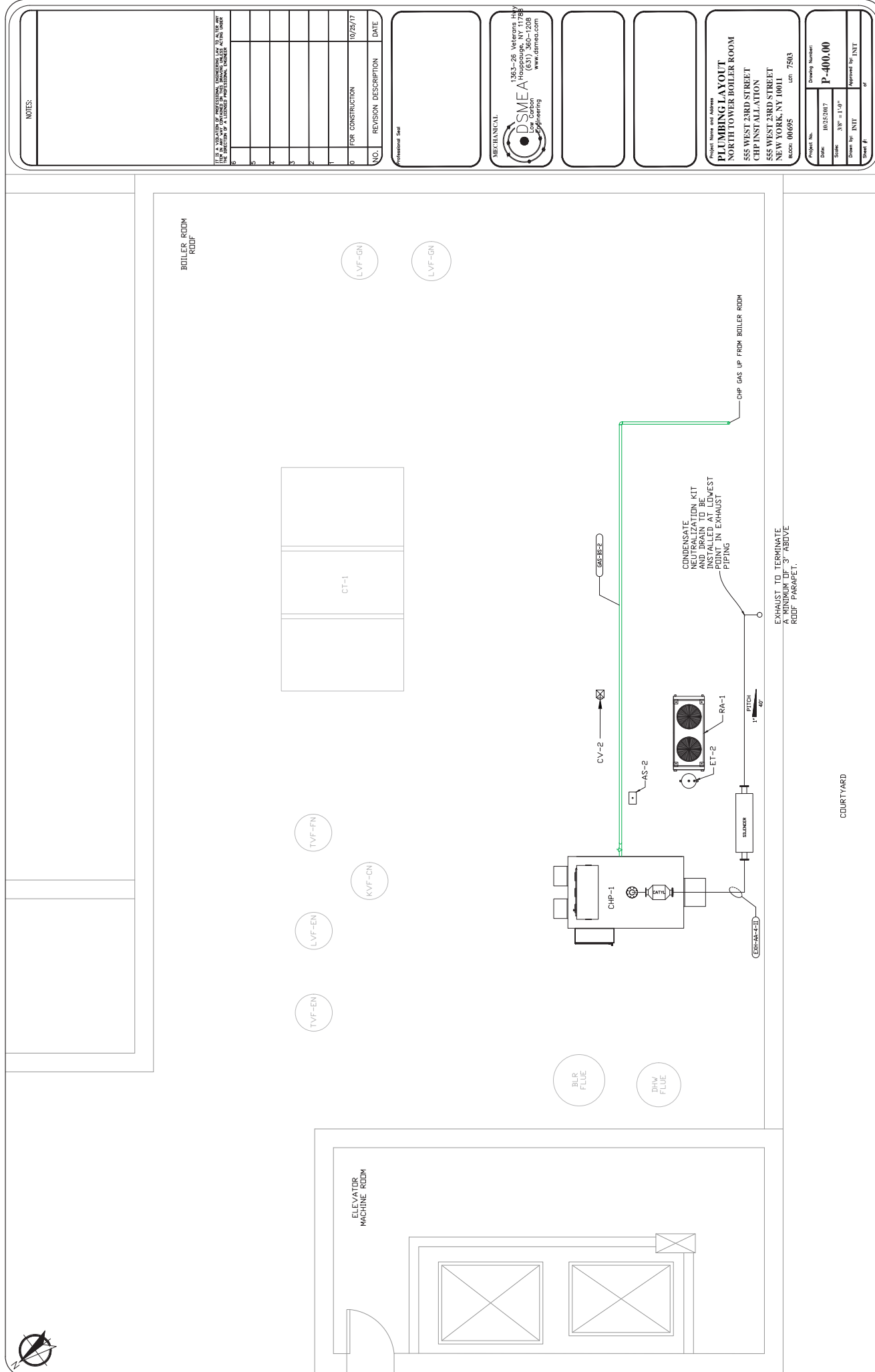
Approximate Location of Gas Meter GM-1



Approximate Location of Gas Meter GM-2



NOTES:		
1.	REFER TO DWG M-600 FOR TYPICAL DETAILS AND FITTINGS NOT SPECIFIED	
15. A VIOLATION OF PROFESSIONAL ENGINEERING LAW TO NOT USE ANY INFORMATION FROM THIS DRAWING FOR ANY OTHER PROJECT WITHOUT THE WRITTEN PERMISSION OF THE ENGINEER.		
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CONDENSATE
NEUTRALIZATION KIT
AND DRAIN TO BE
INSTALLED AT LOWEST
POINT IN EXHAUST
PIPING

CHP GAS UP FROM BOILER ROOM

EXHAUST TO TERMINATE
CONDENSATE IN 3" ABOVE
ROOF PARAPET.

EXP-2A-1-B

BOILER ROOM
ROOF

BLR
FLUE

DHW
FLUE

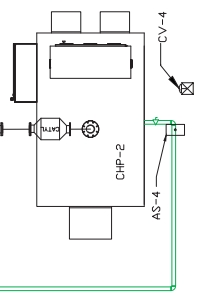
ELEVATOR MACHINE
ROOM

KVF-CS

TVF-DS

LVF-ES

TVF-ES



NOTES

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Professional Seal

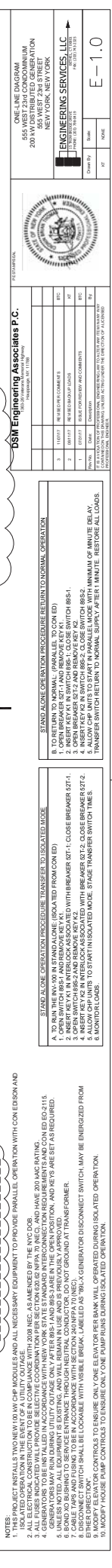
MECHANICAL

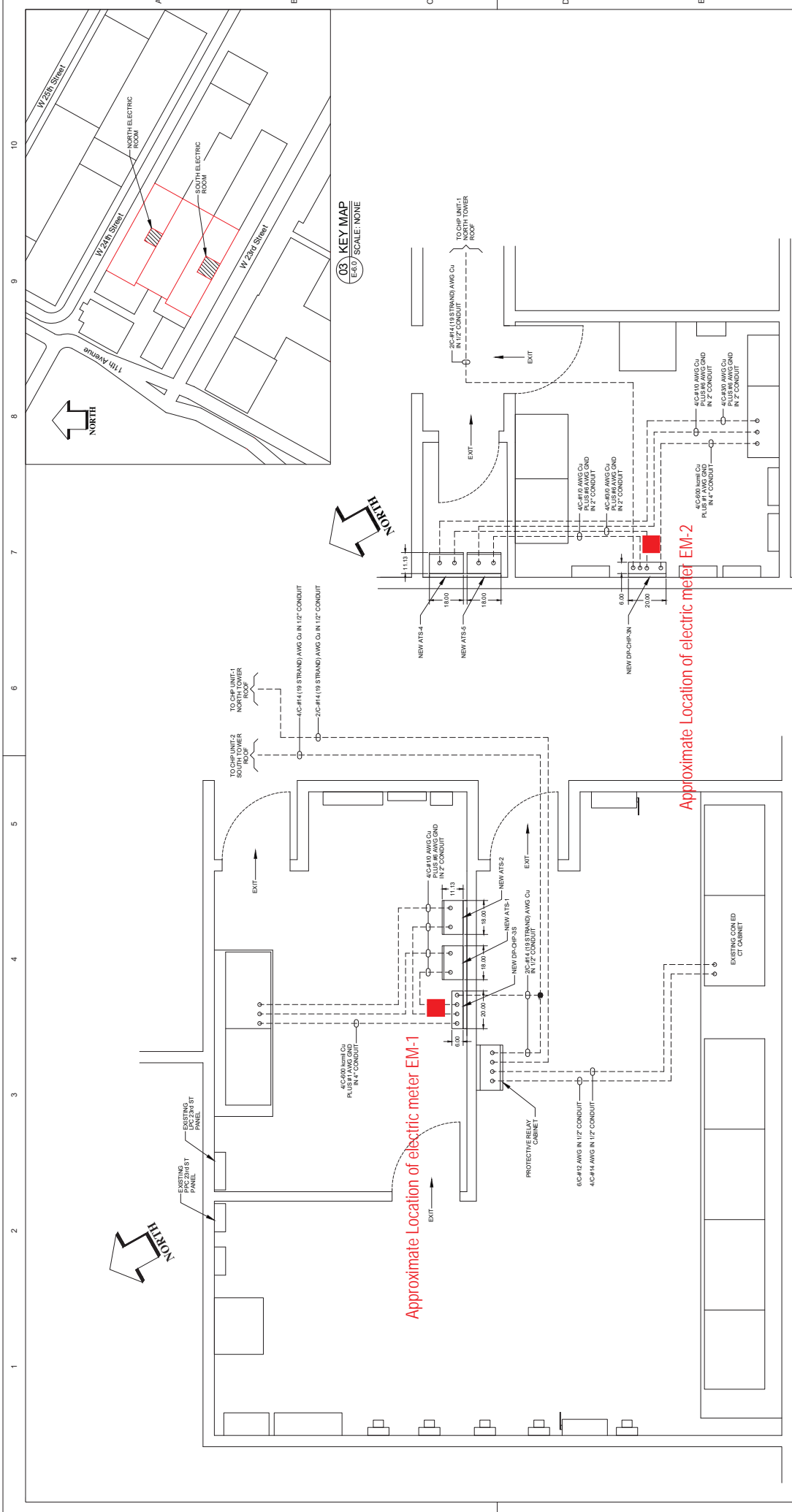


Project Name and Address

PLUMBING LAYOUT
SOUTH TOWER BOILER ROOM
555 WEST 23RD STREET
CHP INSTALLATION
555 WEST 23RD STREET
NEW YORK, NY 10011
BLOCK: 00695 Lot: 7503

Project No.	Drawing Number:
Date: 10/25/2017	P-420.00
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01 SOUTH ELECTRIC ROOM PLAN
E-6.0 SCALE: 1/2" = 1'-0"

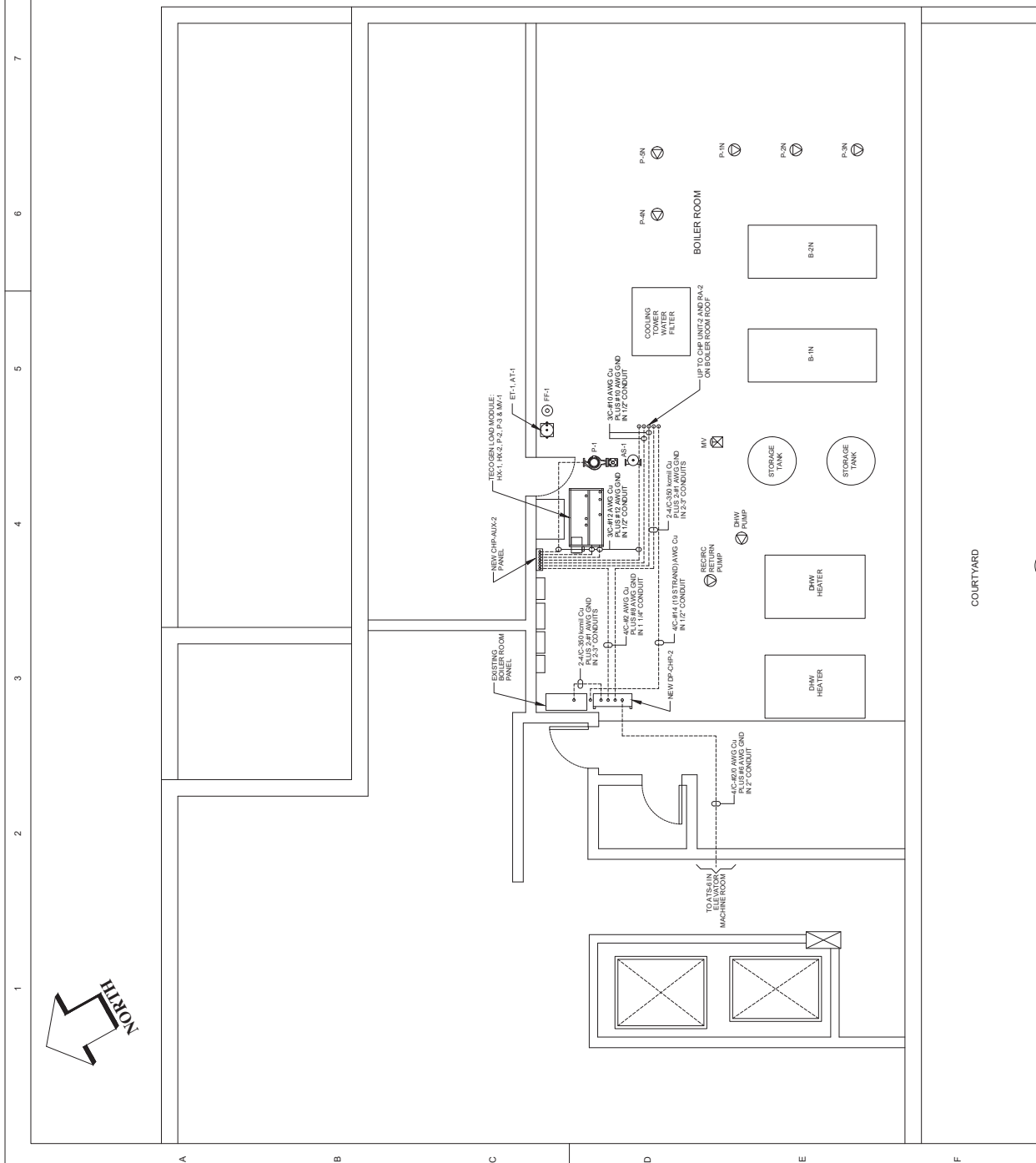
02 NORTH ELECTRIC ROOM PLAN
E-6.0 SCALE: 1/2" = 1'-0"

03 KEY MAP
E-6.0 SCALE: NONE

PROJECT INFORMATION		REVISIONS		DATE	
NORTH & SOUTH ELECTRIC ROOM LAYOUT 555 WEST 23RD CONDOMINIUM 200 HARTFORD STREET 55 WEST 23RD STREET NEW YORK, NY		CSA Engineering Services, LLC 110 WEST 23RD STREET NEW YORK, NY 10011-3602 TEL: 212.244.1234 WWW.CSAENGINEERING.COM		E-6.0	

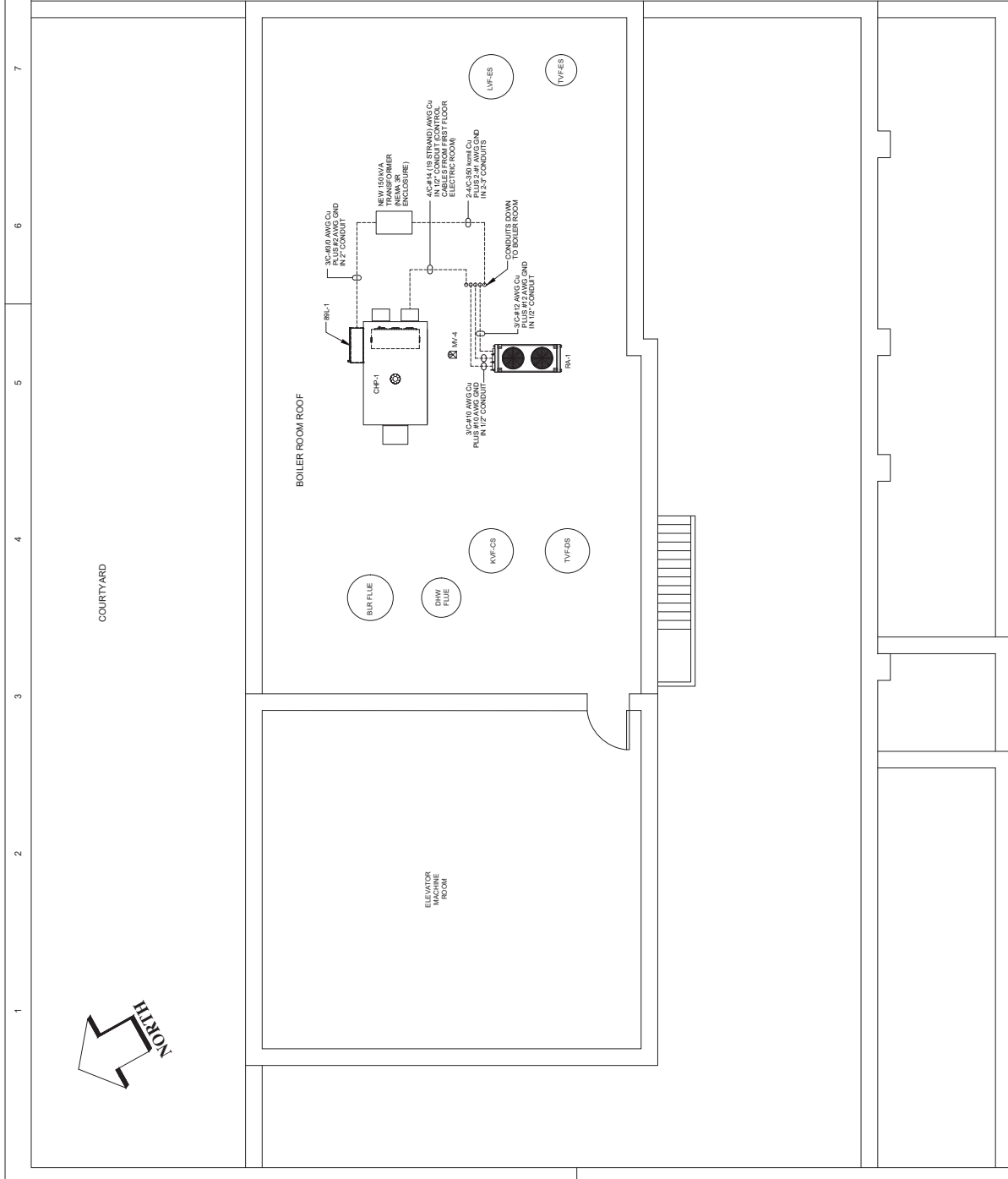
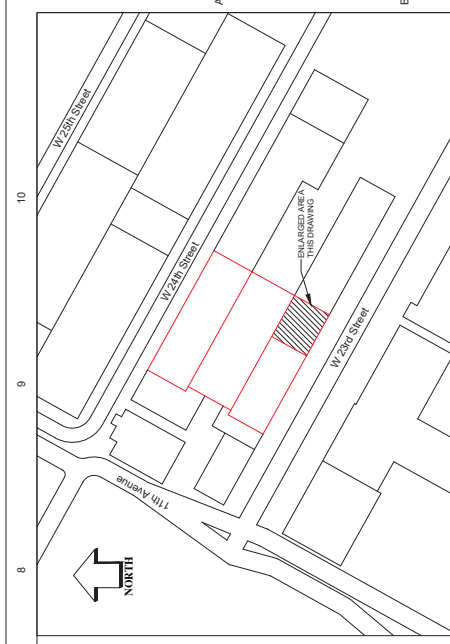
NO.	DESCRIPTION	DATE	BY	CHKD.
1	ISSUED FOR PERMIT	08/01/2023	CSA	CSA

110 WEST 23RD STREET, NEW YORK, NY 10011-3602
TEL: 212.244.1234
WWW.CSAENGINEERING.COM





01 PLAN VIEW
E-62
SCALE: 1/4" = 1'-0"

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01 PLAN VIEW
E-6.3
SCALE: 1/4" = 1'-0"

DSM Engineering Associates, P.C. 1000 Westchester Avenue, Suite 110 Westchester, New York 10590		FIELD LOCATION SOUTH TOWER BOILER ROOM ROOF LAYOUT 555 WEST 23RD CONDOMINIUM LLC 205 WEST 23RD STREET 555 WEST 23RD STREET NEW YORK, NEW YORK	
			
Date Rec'd: _____ Date Issued: _____ Date Revised: _____	Description: _____ Scale: 1" = 10'-0"	Title: _____ Drawn By: _____ Checked By: _____ Date: _____	Date: _____ Drawn By: _____ Checked By: _____ Date: _____
This drawing was prepared by the undersigned in accordance with the provisions of the Professional Engineering Law of the State of New York.		E-6.3	

Appendix B

Cut Sheets for Key Sensors and Instruments



ONICON
Flow and Energy Measurement

System-10 BTU Meter

ONICON's
SYSTEM-10
BTU METER is the
premier platform
for accurately
measuring and
reporting the
thermal energy
usage, flow and
temperatures
required by today's
High Performance
Buildings.



• Chilled Water • Hot Water • Condenser Water •



DESCRIPTION

The System-10 BTU Meter provides highly accurate thermal energy measurement in chilled water, hot water and condenser water systems based on signal inputs from two matched temperature sensors (included) and any of ONICON's insertion or inline flow meters which are ordered separately. The basic model provides a local indication of energy, flow and temperature data through an alphanumeric display. An isolated solid state dry contact is provided for energy total. Optional analog outputs and network communications are also available.

Whether it's used for chiller plant optimization, CEP monitoring and control, or sub-metering the hydronic energy use across a campus, the System-10 has the versatility and functionality required to integrate seamlessly with your BMS/EMS.

APPLICATIONS

Chilled water, hot water and condenser water systems for:

- Commercial office tenant billing
- Central plant monitoring
- University campus monitoring
- Institutional energy cost allocation
- Performance/efficiency evaluations
- Performance contracting energy monitoring

CALIBRATION

Flow meters and temperature sensors are individually calibrated followed by a complete system calibration.

Field commissioning is also available.

FEATURES

Simple Installation and Commissioning - Factory programmed and ready for use upon delivery. All process data and programming functions are accessible via front panel display and keypad.

Single Source Responsibility - One manufacturer is responsible for every aspect of the energy measurement process ensuring component compatibility and overall system accuracy.

NIST* Traceable Calibration with Certification - Each BTU measurement system is individually calibrated using application specific flow and temperature data and is provided with a certificate of calibration.

Precision Solid State Temperature Sensors - Custom calibrated and matched to an accuracy better than $\pm 0.15^\circ\text{F}$ over the calibrated range.

Highly Accurate Flow Meters - ONICON offers a wide variety of insertion and inline type flow measurement technologies including turbine, electromagnetic and ultrasonic sensing. Each type offers unique advantages depending on the application. All ONICON flow meters are individually wet calibrated and designed to operate over a wide flow velocity range with accuracies ranging from $\pm 0.2\%$ to $\pm 2.0\%$ of rate depending on the model.

Complete Installation Package - All mechanical installation hardware, color coded interconnecting cabling and installation instructions are provided to ensure error-free installation and accurate system performance.

Serial Communications - Optional: Provides complete energy, flow and temperature data to the control system through a single network connection, reducing installation costs.



Smart button technology simplifies menu page navigation

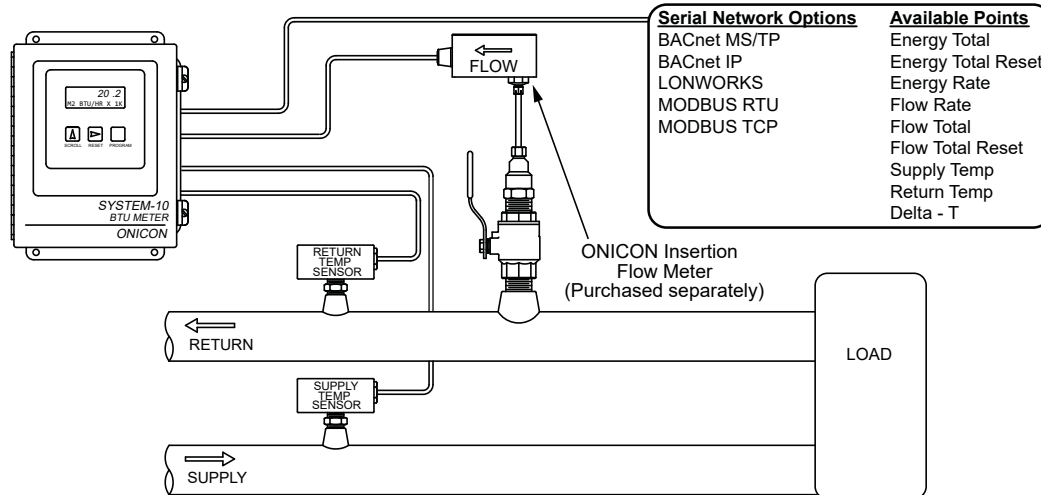
*National Institute of Standards and Technology

SPECIFICATIONS*

TEMPERATURE	Overall differential temperature measurement uncertainty of $\leq \pm 0.15^{\circ}\text{F}$ over the stated range (Includes uncertainty associated with the sensors, transmitters, cabling and calculator input circuitry) Temperature sensors meet EN1434/CSA C900.1 accuracy requirements for 1K sensors for cooling applications, 32°F to 77°F . Temperature sensors meet EN1434/CSA C900.1 accuracy requirements for 2K sensors for heating applications, 140°F to 212°F .
CALCULATOR	Computing nonlinearity within $\pm 0.05\%$ Calculator meets EN1434 / CSA C900.1 class 1 accuracy requirements for 2K sensors for all applications.
PROGRAMMING	Factory programmed for specific application Field programmable via front panel interface
MEMORY	Non-volatile EEPROM memory retains all program parameters and totalized values in the event of power loss.
DISPLAY	Alphanumeric LCD displays total energy, total flow, energy rate, flow rate, supply temperature, return temperature, serial number and alarm status Alpha: 16 character, 0.2" high Numeric: 8 digit, 0.4" high Rate Display Range: 0 - 9,999,999 Total Display Range: 0 - 9,999,999
OUTPUT SIGNALS	Isolated solid state dry contact for energy total Contact rating: 100 mA, 50 V Contact duration: 0.5, 1, 2, or 6 sec Analog Output(s) (4-20 mA, 0-10 V or 0-5 V): One or four analog output(s) available for flow rate, energy rate, supply/return temps, or delta-T
SERIAL COMMUNICATIONS	BACnet® IP or MS/TP, MODBUS® RTU RS485 or TCP/IP, LONWORKS - TP/FT-10F, Siemens Apogee - P1, Johnson Controls Metasys - N2
TEMPERATURE SENSORS	Solid state sensors are custom calibrated using NIST traceable temperature standards. Current based signal (mA) is unaffected by wire length.
TEMPERATURE RANGE	Liquid temperature ranges based on application. See Meter Ordering Information on next page. Ambient temperature range: -20°F to 140°F
LIQUID FLOW SIGNAL INPUT	Pulse (frequency) or 4-20 mA input
MECHANICAL	Available Electronics Enclosures: Steel NEMA 13, wall mount, 8"x10"x4" NEMA 4 Approximate weight: 12 lbs Temperature Sensor Thermowell Kits: Thermowells and other kit components vary by fluid type, fluid temperature, pipe material and pipe size. Commonly used kits are listed on the previous page. Contact ONICON for additional thermowell kit options, including Hot Tap Installation Kits for retrofit installations.
ELECTRICAL	Input Power: Based on BTU meters configured for network connection without the analog outputs: 24 VAC, 50/60 Hz, 500 mA 120 VAC, 50/60 Hz, 200 mA 240 VAC, 50 Hz, 150 mA Internal Supply: Provides 24 VDC at 200 mA to electronics and select flow meters Wiring: Temperature signals: Use 18-22 ga twisted shielded pair Flow signals: Use 18-22 ga - see flow meter specification sheet for number of conductors.

* SPECIFICATIONS subject to change without notice.

TYPICAL INSERTION METER INSTALLATION



COMPATIBLE FLOW METERS

AVAILABLE OUTPUTS



METER ORDERING INFORMATION

Meter Model Number Coding = **SYS-10-ABCD-EFGG**

A = Electronics Enclosure

- 1 = NEMA 13 enclosure with LCD display
- 2 = NEMA 4 enclosure with LCD display

B = Input Power

- 1 = 24 VAC, 12 VA
- 2 = 120 VAC, 15 VA
- 3 = 240 VAC, 17.5 VA

C = Serial Communications

- 0 = No serial communications provided
- 1 = RS485, BACnet MS/TP
- 2 = RS485, MODBUS RTU
- 3 = BACnet IP
- 4 = MODBUS TCP/IP
- 5 = DualNet serial communications, IP and RS485
- 8 = LonWorks

D = Analog Output

- 0 = No analog output
- 1 = Single (1) isolated analog output
- 2 = Four (4) isolated analog outputs (Not available when C=5)

E = Auxiliary Pulse Inputs

- 0 = (1) Directional pulse input only
- 1 = (1) Directional pulse and auxiliary pulse input

F = Auxiliary Pulse Outputs

- 1 = Three (3) pulse outputs, dry contact

GG = Temperature Sensor

- 01 = Matched pair of current (mA) based sensors, CHW/CW range
- 02 = Matched pair of current (mA) based sensors, HHW range
- S1 = Matched pair of current (mA) based sensors, 122°F to 302°F range
- S4 = Matched pair of current (mA) based sensors, 80°F to 400°F range

E5X SERIES

Versatile Energy Monitoring Solution



The E5x Series DIN Rail Meter combines exceptional performance and easy installation to deliver a cost-effective solution for power monitoring applications. The E5x can be installed on standard DIN rail or surface mounted as needed. The Modbus, LON, and BACnet output models offer added flexibility for system integration. The data logging capability (E5xC3 and E5xx5) protects data in the event of a communications or power failure elsewhere in the system. Combinations of serial communication, pulse output, and phase alarms are provided to suit a wide variety of applications. Additional pulse inputs on E5xHx and E50Fx provide an easy way to incorporate simple flow sensors to track gas, water, steam, or other energy forms using a BACnet or LON system.

The E51 models add a bi-directional monitoring feature designed expressly for renewable energy applications, allowing measurement of power imported from the utility grid as well as power exported from the renewable energy source (e.g. solar panels). In this way, a facility administrator can track all energy data, ensuring accuracy in billing and crediting. They are also useful for monitoring loads that use regenerative braking.

SPECIFICATIONS

INPUTS

Control Power, AC	50/60 Hz; 5 VA max.; 90 V min.; UL Maximums: 600 V _{L-L} (347 V _{L-N}); CE Maximum: 300 V _{L-N}
Control Power, DC	3W max.; UL and CE: 125 to 300 Vdc (external DC current limiting required)
Voltage Input	UL: 90 V _{L-N} to 600 V _{L-L} ; CE: 90 V _{L-N} to 300 V _{L-N}

CURRENT INPUT

Scaling	5 A to 32,000 A
Input Range	0 to 0.333 V or 0 to 1 V (selectable) CTs must be rated for use with Class 1 voltage inputs
Pulse Inputs E5xHx & E50Fx only	Contact inputs to pulse accumulators (one set with E5xH2 and E50F2; two sets with E5xH5 and E51F5)*

ACCURACY

Real Power & Energy	0.2% (ANSI C12.20, IEC 62053-22 Class 0.2S)
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OUTPUTS

E50B1 & E5xCx	Real Energy Pulse: N.O. static**; Alarm contacts: N.C. static**
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Revenue grade measurements

Meets ANSI C12.20 Class 0.2 standards

High reliability

ANSI C12.20 0.2% accuracy, IEC 62053-22 Class 0.2S on E5xxx

Easy installation

DIN rail or screw mounting options

Multiple applications

Real energy output and phase loss alarm output on E50Bx and E5xCx models...one device serves multiple applications

Data logging

Ensures long term data retrieval and safeguards during power failures (E5xC3 and E5xx5)

Wide CT compatibility

Compatible with CTs from 5 A to 32000 A

APPLICATIONS

- Energy monitoring in building automation systems
- Renewable energy
- Energy management
- Commercial sub-metering
- Industrial monitoring
- Cost allocation

E50Bx	Reactive energy pulse 30 Vac**
E5xCx	RS-485 2-wire Modbus RTU (1200 baud to 38.4 kbaud)
E5xHx	RS-485 2-wire BACnet MS/TP (9600 baud to 115.2 kbaud)
E50Fx	2-wire LON FT

MECHANICAL

Mounting	DIN Rail or 3-point screw mount
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ENVIRONMENTAL

Altitude of Operation	3000 m
Operating Temp Range	-30 to 70 °C (-22 to 158 °F)
Storage Temp Range	-40 to 85 °C (-40 to 185 °F)
Humidity Range	<95% RH non-condensing
Mounting Location	Not suitable for wet locations. For indoor use only.

WARRANTY

Limited Warranty	5 years
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AGENCY APPROVALS

Agency Approvals	UL 508 (Open Type Device), IEC/EN 61010-1, California CSI Solar, ANSI C12.20, Cat III, Pollution Degree 2
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*10 kΩ Vac/dc to 4 to 10 Vdc.

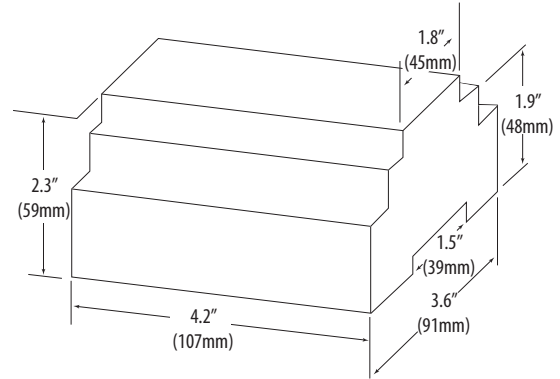
**30 Vac/dc, 100 mA max. (AC: 50/60Hz).



ORDERING INFORMATION

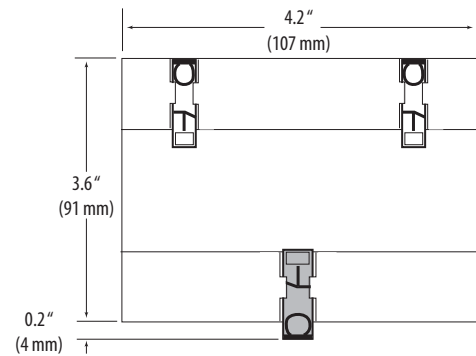
	E50B1	E50C2	E50C3	E50F2	E50F5	E50H2	E50H5	E51C2	E51C3	E51H2	E51H5
MEASUREMENT CAPABILITY - FULL DATA SET											
Bi-directional Energy Measurements											
Power (3-phase total and per phase): Real (kW) Reactive (kVAR), and Apparent (kVA)											
Power Factor: 3-phase average & per phase											
Present Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)											
Import and Export totals of Present Power Demand: Real (kW), Reactive (kVAR), & Apparent (kVA)											
Peak Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)											
Current (3-phase average and per phase)											
Voltage: Line-Line and Line-Neutral (3-phase average and per phase)											
Frequency											
ANSI C12.20 0.2% accuracy, IEC 62053-22 Class 0.2S											
Accumulated Net Energy: Real (kWh), Reactive (kVARh), and Apparent (kVAh)											
Accumulated Real Energy by phase (kWh)											
Import and Export Accumulators of Real and Apparent Energy											
Reactive Energy Accumulators by Quadrant (3-phase total & per phase)											
Demand Interval Configuration: Fixed or Rolling Block											
Demand Interval Configuration: External Sync to Comms											
DATA LOGGING											
Data Logging: 10 16-Bit Configurable (can include Date/Time) Data Buffers											
Data Logging: 3 Timestamped 32-Bit Configurable Data Buffers											
Store up to 60 days of readings at 15-minute intervals											
OUTPUTS											
Alarm Output (N.C.)											
1 Pulse Output (N.O.)											
2 Pulse Outputs (N.O.)											
RS-485 Serial (Modbus RTU Protocol)											
RS-485 Serial (BACnet MS/TP Protocol)											
LON FT Serial (LonTalk Protocol)											
INPUTS											
2 Pulse Contact Accumulator Inputs											
1 Pulse Contact Accumulator Input											

DIMENSIONAL DRAWING



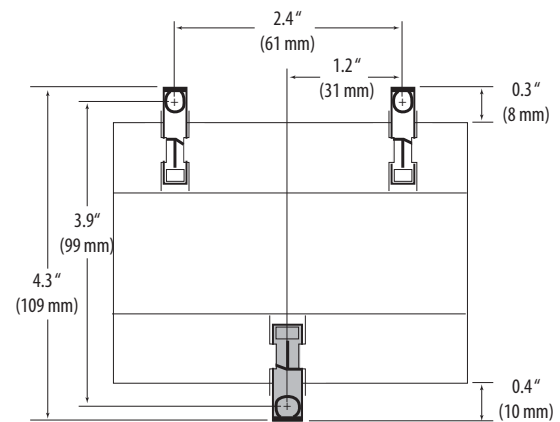
DIN MOUNT CONFIGURATION

Mounting Diagram



SCREW MOUNT CONFIGURATION

Mounting Diagram





ROOTS® Meters & Instruments

DATA SHEET

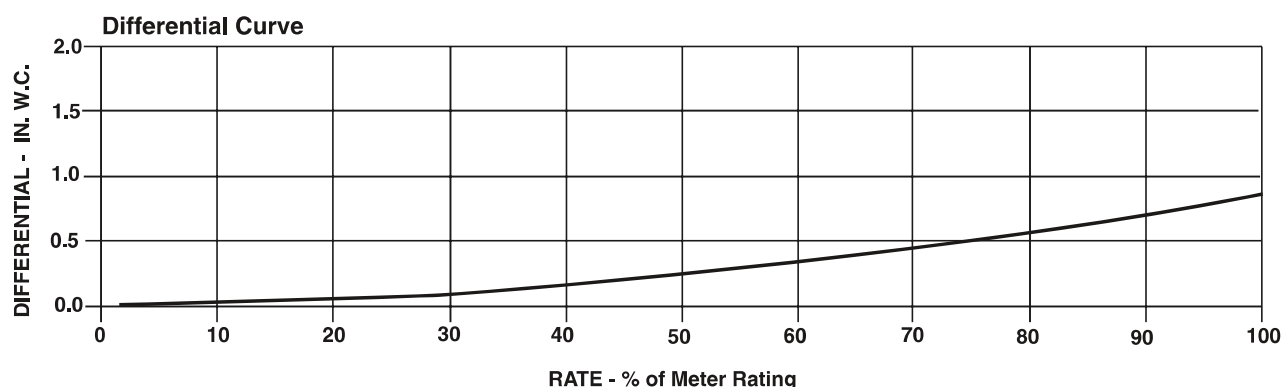
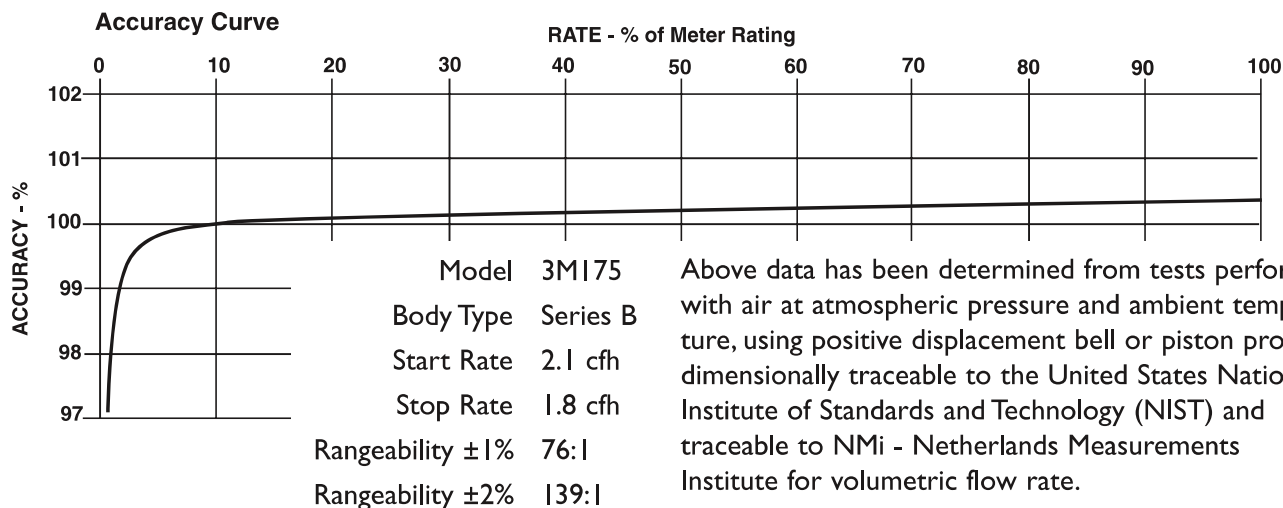
SERIES B3: 3M175 ROOTS® Meter

	UNITS	Imperial	UNITS	Metric
Temperature Range	deg. F	-40 to +140	deg. C	-40 to +60
Base Rating (Q Max.)	acfh	3000	m ³ /h	85
Max. Operating Pressure (MAOP)	psig	175	kPa	1200
Leak Test (125% MAOP)	psig	219	kPa	1510
Static Test (2 x MAOP)	psig	350	kPa	2400
Rangeability +/- 1%	ratio	76:1	ratio	76:1
Rangeability +/- 2%	ratio	139:1	ratio	139:1
Start Rate	cfh	2.1	m ³ /h	0,0595
Stop Rate	cfh	1.8	m ³ /h	0,0510
Flow Rate @ 0.5" w.c., Gas	cfh	2580	m ³ /h	73,1
Avg. Differential, 100% Flow	in. w.c.	1.1	mbar	2,6
Max. Pressurization Rate	psig/sec	5	kPa/sec	35
Max. Operating Speed	rpm	2000	rpm	2000
Gear Ratio	ratio	400:1	ratio	141,1764:1
Displaced Volume/Revolution	cf	0.025	m ³	0,000708
Drive Rate, CD	cf/rev	10	m ³ /rev	0,1
Drive Rate, TD	cf/rev	100	m ³ /rev	1
Temp. Compensating Range (TC,TD)	deg. F	-20 to +120	deg. C	-29 to +49
Min. Odometer Reading	cf	0.2	m ³	0,002
Odometer Turnover	yrs.	3.8	yrs.	1,34
Nominal Pipe Size	in.	2	mm	50,8
Flange-to-Flange	in.	6-3/4	mm	172
Flange Connection	ANSI	125#FF	ANSI	125#FF
Bolts per Flange	qty.	4	qty.	4
Bolt Size ¹	in.	5/8 - 11	in.	5/8 - 11
Flange Bolt Hole Depth	in.	15/16	mm	23,8
Bolt Torque: Lubricated/Non-Lub.	ft.-lb.	55/60	N-m	74/81
Restricting Orifice (120%)	in.	17/32	mm	9,525
Oil Capacity – Side Inlet	oz.	1.25	ml	37
Oil Capacity – Top Inlet	oz.	7.65	ml	226
Counter Version (CTR) ²				
Net Weight	lbs.	29	kg	13,2
Shipping Weight	lbs.	31	kg	14,1
Carton Size	in.	27 x 11 x 9	cm	69 x 28 x 23
Counter with Instrument Drive (CD) ²				
Net Weight	lbs.	33	kg	15,0
Shipping Weight	lbs.	38	kg	17,2
Carton Size	in.	31 x 15 x 13	cm	79 x 38 x 33

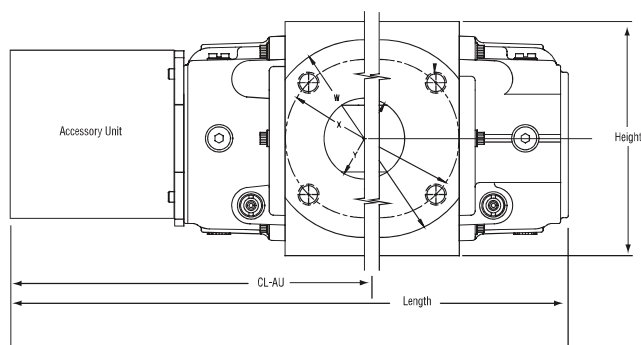
NOTES:

¹ Bolt Length varies by application.

² Weights and dimensions available for CPS, TC, TD, TPS upon request.



3M175 Series B3	Overall Length		Overall Height		Width (Flange/Flange)		Centerline to Accessory End (CL-AU)		Request Detailed Drawing Number
	inches	mm	inches	mm	inches	mm	inches	mm	
CTR / TC	17-1/8	435	6-31/32	177	6-3/4	172	10-7/8	276	D054517-000
CD / TD	20-31/32	533	6-31/32	177	6-3/4	172	14-23/32	374	D054431-000
CPS / TPS	9-1/4	489	6-31/32	177	6-3/4	172	13	330	D054670-000
IMC/C	20-5/8	524	6-31/32	177	6-3/4	172	14-3/8	365	D056486-000
IMC/W	21-5/8	549	6-31/32	177	6-3/4	172	15-3/8	391	D056702-000



To order

Specify: Meter Series, Size and Type
 (i.e., ROOTS Meter Series B3 3M175 CD).

For CD or TD, specify Inlet (Top or Side) and
 ID Rotation (CW-B or CCW-A).

For Pulser, specify Single or Dual Connectors and
 Connector Type (MS Circular, Conduit or Cable Gland).

For more specific ordering information on the
 electronic products, request: TS:SSP, TS:IMC/C or S:IMC/W.

Contact the factory for other available information,
 options, or special requests.



Process Valve & Equipment Co. | Manufacturer's Rep. & Stocking Distributor

7205 Chagrin Road
 Chagrin Falls, Ohio 44023
<http://www.processvalve.com>

Ph: 1-800-922-8897 Fax: 1-440-247-7305
sales@processvalve.com