CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☐ Commercial Buildings	☐ New	☐ Existing or	☐ EBCx	
Institutional Buildings:				
☐ Educational Facilities	☐ New	☐ Existing or	☐ EBCx	
☐ Other Institutional	☐ New	☐ Existing or	☐ EBCx	
■ Health Care Facilities	☐ New	■ Existing or	☐ EBCx	
☐ Industrial Facilities or Processes	☐ New	☐ Existing or	☐ EBCx	
☐ Public Assembly	☐ New	☐ Existing or	☐ EBCx	
☐ Residential (Single and Multi-Family)				

2. Name of building or project: John H. Stroger, Jr. Hospital Energy Efficiency Upgrades

City/State: Chicago, Illinois

3. Project Description: Installation of a boiler flue gas waste heat recovery system.

Project Study/Design Period: 07/2013 (Begin date (mm/yyyy)) to 11/2013 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Vidri, Rina (Last / First / Middle)

Membership Number: 8276816

Chapter: Illinois

Region: VI

b. Address (including country): 100 South Wacker Drive, Suite 700

Chicago (City) | Illinois (State) | 60606 (Zip) | USA (Country)

c. Telephone: (O) 312-242-6336 d. Email: rvidri@primeraeng.com

e. Member's Role in Project: Lead Mechanical Engineer

f. Member's Signature: R. Vidri

5. Engineer of Record: Michael Belczak, PE, CPD, LEED AP BD+C

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

Primera

ASHRAE Illinois Chapter
2016 Excellence in Engineering Awards

PROJECT John H. Stroger Jr. Hospital of
Cook County Energy Efficiency Upgrades
Chicago, Illinois

OWNER Cook County

PREPARED FOR American Society of Heating Refrigerating
and Air Conditioning Engineers

PREPARED BY Primera Engineers, Ltd.
100 South Wacker Drive, Suite 700
Chicago, Illinois 60606
312/606.0910

About the Project

Project Description

John G. Stroger, Jr. Hospital is located on the near west side of Chicago and is the flagship facility of the Cook County Health and Hospitals System (CCHHS). The hospital has over 450 beds, nearly 100 outpatient clinics and a Level 1 Trauma Center. It is the primary provider of comprehensive medical services for the Chicagoland population, caring for all patients with no regard to their financial status. It replaced the iconic Cook County Hospital in 2002.

The scope of the entire project required the identification and implementation of energy conservation measures (ECMs) across Stroger Hospital's campus. These improvements were designed to ensure a consistent level of comfort and safety, contribute to a more sustainable campus, and enhance operability while significantly reducing energy consumption and cost. The system described herein is one of those ECMs.

Primera was contracted by Johnson Controls (JCI) to design a heat recovery system to capture the maximum amount of available waste heat from the Stroger campus steam boiler plant flue gases and return that heat to campus systems. Three (3) campus systems were selected to receive the recovered heat: 1) Preheating the boiler feed water before entering the boilers; 2) Preheating city domestic water to be used as makeup water for the steam boiler system; and 3) Preheating city domestic water before sending it to the domestic hot water (DHW) heaters. The system was installed under JCI as a performance contract.

Existing Mechanical Description

The existing steam plant serves the heating and domestic water needs of the entire Stroger Hospital complex. The steam plant consists of six (6) high-pressure steam boilers. The total plant is capable of producing 60,000 lb./hr. of steam at up to 125 psi. In addition to the six main boilers, the steam plant included condensate return tanks and pumps, deaerator tanks, feedwater pumps, and standard steam boiler controls and fill controls.

Existing energy recovery measures included hydronic economizers on two of the six boilers flues (B-2 and B-6). Each of the hydronic economizer was dedicated to a single boiler, capturing flue gas heat and transferring it back to itself without affecting the other boilers, and were only capable of capturing a fraction of the potential heat available, and only sensible heat, while discharging the rest.

The average boiler flue gas temperature is approximately 370°F. Previously, this hot air was exhausted directly outside via the boiler flue stack. The existing burners on the boilers are original and in fair operating condition.

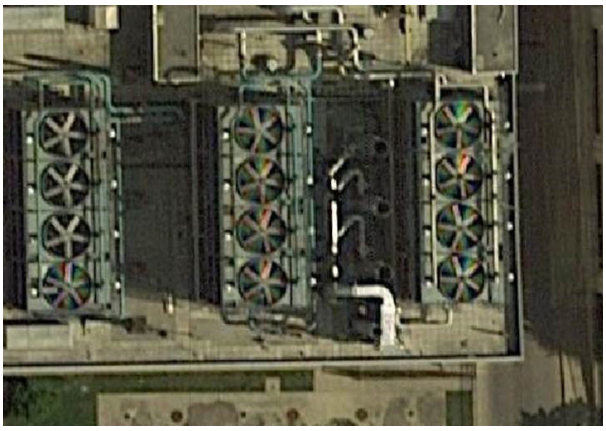
New Mechanical System Description

The new heat recovery system was design to lower the flue gas temperature below its dew point to capture the maximum amount of heat possible. The new heat recovery system, therefore, captures not only sensible but also latent heat of the boiler flue gas. Flue gases are drawn off from the existing boilers' stacks by a 23,000 CFM energy recovery fan. Control dampers in the flue gas takeoffs modulate

About the Project

position, and the energy recovery fan VFD modulates speed, in response to temperature sensors in the main stacks and the takeoffs to draw the precise amount of flue gas that the boiler is generating.

Boiler flue gas heat is captured first by the feedwater heat exchanger (HX). In this "flue gas-to-water" HX, flue gases have their temperatures reduced from 370°F to 238°F, while 70 GPM of boiler feedwater enters the heat exchanger at 230°F and leaves at 265°F, recovering 1,266,000 BTUh of sensible heat. Excess feedwater in the system is bypassed around the flue gas-to-water HX.



Next the "process water" heat exchanger captures flue gas heat. Process water is used to both preheat the city make up water to the boiler plant and preheat the domestic city water for use in the campus DHW system. In this flue gas-to-water heat exchanger, flue gases have their temperatures reduced from 238°F to 69°F, while 250 GPM of process water enters the heat exchanger at 50°F and leaves at 91°F, recovering a 5,173,000 BTUh of total heat at peak capacity. Of the total heat recovered, 70% is latent heat from the flue gas, which has a dew point 134°F.

A pair of redundant process water pumps move water between the process flue gas-to-water HX and a pair of water-to-water HXs, one to preheat makeup condensate and one to preheat DHW. Process pump speed is controlled to maintain specified delta-t's across the load side of the two water-to-water HXs.

Energy Efficiency

The heat recovery system is capable of recovering a total of 6,439,000 BTUh at peak capacity, 3,620,000 BTUh (56%) of which is latent heat in the flue gas. The operating energy of the system consists of a 23,000 CFM, 40 HP energy recovery fan operating at peak power of 34.1 brake HP, and a 250 GPM, 15 HP pump operating at peak power of 12.1 brake HP.

The system has been in operation for one year. At the time of this submission, total measured energy savings had not yet been processed. The projected annual savings based on a design year and current electric and gas contracts held by Stroger Hospital are as follows: $307,955 savings in gas consumption, $6,684 additional electrical usage for the energy recovery fan and pumps. Total estimated operating savings is $301,271.

Indoor Air Quality

Not Applicable

About the Project

Innovation

Latent flue gas heat is the key to the energy savings. The heat recovery system has been engineered to lower the flue gas temperature below the dew point in order to capture latent heat. The recovered heat is 1,000 BTUs for every pound of water that is condensed and equals the heat that is in one cubit foot of natural gas.

The existing boiler controls were retained. The heat recovery system did not change the quantities of flue gases produced by the boilers. If the energy recovery fan draws less flue gases than the boilers are producing, potential energy savings are lost. If the energy recovery fan draws more than the boilers are producing, the additional air is drawn from the outside down the existing flue stacks, sub-cooling the flue gases and reducing the effectiveness of the flue gas-to-water heat exchangers. To capture the maximum amount of heat, flue gas temperatures were measured in the flue stack before the energy recovery takeoff and also in the flue gas takeoff. Control dampers modulated to maintain the takeoff flue gas temperature at 2°F greater than the stack temperature before the takeoff, resulting in drawing all available flue gases while mixing in less than 2% of OA in the energy recovery flue gas.

Operation & Maintenance

Since all of the mechanical equipment is located in the boiler room, roof, or basement of the Power House, it was accessible without disturbing the Hospital's schedule. The heat recovery heat exchangers, low temperature loop heat exchangers, and pumps all utilize modern and sophisticated controls to improve overall operation, maintenance, and reliability. Sensors and alarms were programmed to notify maintenance staff before any systems need maintenance or immediately when the system fails.

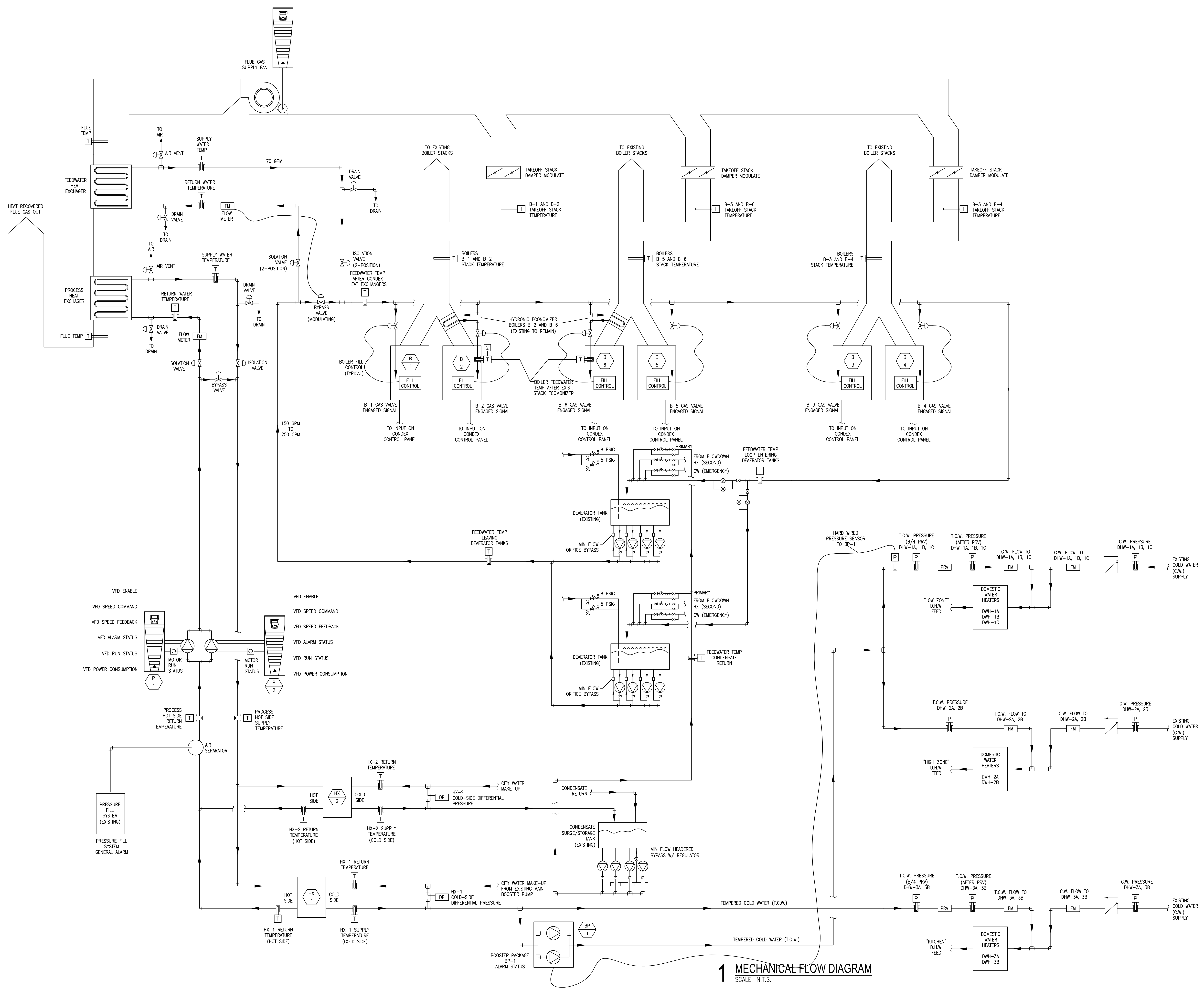
After project completion, Johnson Control staff provided testing, balancing, commissioning, training, and start-up of new system.

Cost Effectiveness

The estimated overall energy savings is over $300,000. Based on the construction costs, the system payback is estimated at less than five years.

Environmental Impact

Utilizing a high-efficiency, condensing heat recovery system improves boiler efficiency and provides the Hospital with significant energy savings, reducing its overall impact on the environment. Total annual estimated reduction in gas usage is 750,000 therms. The total annual reduction in carbon footprint is 8,775,000 (assuming 117 lbs.-CO2 per 1 million BTUs of natural gas, and assuming 100,000 BTUs of heat content per therm of natural gas).



FLUE GAS SUPPLY FAN
FLUE TEMP
TO AIR
AIR VENT
SUPPLY WATER TEMP
70 GPM
FEEDWATER HEAT EXCHAGER
RETURN WATER TEMPERATURE
FLOW METER
DRAIN VALVE
TO DRAIN
HEAT RECOVERED FLUE GAS OUT
ISOLATION VALVE (2-POSITION)
FEEDWATER TEMP AFTER CONDEX HEAT EXCHANGERS
PROCESS HEAT EXCHAGER
BYPASS VALVE (MODULATING)
TO EXISTING BOILER STACKS
TAKEOFF STACK DAMPER MODULATE
B-1 AND B-2 TAKEOFF STACK TEMPERATURE
B-5 AND B-6 TAKEOFF STACK TEMPERATURE
B-3 AND B-4 TAKEOFF STACK TEMPERATURE
BOILERS B-1 AND B-2 STACK TEMPERATURE
BOILERS B-5 AND B-6 STACK TEMPERATURE
BOILERS B-3 AND B-4 STACK TEMPERATURE
HYDRONIC ECONOMIZER BOILERS B-2 AND B-6 (EXISTING TO REMAIN)
BOILER FILL CONTROL (TYPICAL)
BOILER FEEDWATER TEMP AFTER EXIST. STACK ECONOMIZER
FILL CONTROL
B-1 GAS VALVE ENGAGED SIGNAL
B-2 GAS VALVE ENGAGED SIGNAL
B-6 GAS VALVE ENGAGED SIGNAL
B-5 GAS VALVE ENGAGED SIGNAL
B-3 GAS VALVE ENGAGED SIGNAL
B-4 GAS VALVE ENGAGED SIGNAL
TO INPUT ON CONDEX CONTROL PANEL
150 GPM TO 250 GPM
8 PSIG
5 PSIG
PRIMARY
FROM BLOWDOWN HX (SECOND)
CW (EMERGENCY)
FEEDWATER TEMP LOOP ENTERING DEAERATOR TANKS
DEAERATOR TANK (EXISTING)
FEEDWATER TEMP LEAVING DEAERATOR TANKS
MIN FLOW ORIFICE BYPASS
FEEDWATER TEMP CONDENSATE RETURN
VFD ENABLE
VFD SPEED COMMAND
VFD SPEED FEEDBACK
VFD ALARM STATUS
VFD RUN STATUS
VFD POWER CONSUMPTION
MOTOR RUN STATUS
PROCESS HOT SIDE RETURN TEMPERATURE
PROCESS HOT SIDE SUPPLY TEMPERATURE
AIR SEPARATOR
PRESSURE FILL SYSTEM (EXISTING)
PRESSURE FILL SYSTEM GENERAL ALARM
HX-2 RETURN TEMPERATURE
HOT SIDE
COLD SIDE
CITY WATER MAKE-UP
HX-2 COLD-SIDE DIFFERENTIAL PRESSURE
HX-2 RETURN TEMPERATURE (HOT SIDE)
HX-2 SUPPLY TEMPERATURE (COLD SIDE)
CONDENSATE RETURN
CONDENSATE SURGE/STORAGE TANK (EXISTING)
MIN FLOW HEADERED BYPASS W/ REGULATOR
HX-1 RETURN TEMPERATURE
CITY WATER MAKE-UP FROM EXISTING MAIN BOOSTER PUMP
HX-1 COLD-SIDE DIFFERENTIAL PRESSURE
HX-1 RETURN TEMPERATURE (HOT SIDE)
HX-1 SUPPLY TEMPERATURE (COLD SIDE)
TEMPERED COLD WATER (T.C.W.)
BOOSTER PACKAGE BP-1 ALARM STATUS
HARD WIRED PRESSURE SENSOR TO BP-1
T.C.W. PRESSURE (B/4 PRV) DHW-1A, 1B, 1C
T.C.W. PRESSURE (AFTER PRV) DHW-1A, 1B, 1C
T.C.W. FLOW TO DHW-1A, 1B, 1C
C.W. FLOW TO DHW-1A, 1B, 1C
C.W. PRESSURE DHW-1A, 1B, 1C
EXISTING COLD WATER (C.W.) SUPPLY
"LOW ZONE" D.H.W. FEED
DOMESTIC WATER HEATERS DWH-1A DWH-1B DWH-1C
T.C.W. PRESSURE DHW-2A, 2B
T.C.W. FLOW TO DHW-2A, 2B
C.W. FLOW TO DHW-2A, 2B
C.W. PRESSURE DHW-2A, 2B
"HIGH ZONE" D.H.W. FEED
DOMESTIC WATER HEATERS DWH-2A DWH-2B
T.C.W. PRESSURE (B/4 PRV) DHW-3A, 3B
T.C.W. PRESSURE (AFTER PRV) DHW-3A, 3B
T.C.W. FLOW TO DHW-3A, 3B
C.W. FLOW TO DHW-3A, 3B
C.W. PRESSURE DHW-3A, 3B
"KITCHEN" D.H.W. FEED
DOMESTIC WATER HEATERS DWH-3A DWH-3B

1 MECHANICAL FLOW DIAGRAM
SCALE: N.T.S.

ENGINEERS/CONSULTANTS

11045 GAGE AVENUE
FRANKLIN PARK, IL 60131
P 847.451.5000 F 847.451.5011
www.hillgrp.com

Primera
100 S. Wacker Dr. STE 700 .
Chicago IL 60606 P:312-606-0910
F:312-606-0415

Johnson Controls, Inc.
3007 Malmo Drive
Arlington Heights, IL. 60005
P 847-364-1500
F 847-364-1536

Issues

No.	Description	By	Chk.	App.	Date
4	CONSTRUCTION SET #7R				11/21/13
3	SUBMIT FOR PERMIT				08/19/13
2	CONSTRUCTION SET #7				08/19/13
1	PROGRESS SET				07/19/13

Project Title

COOK COUNTY STROGER CAMPUS PERFORMANCE CONTRACT
1901 W. Harrison.
Chicago, IL 60612

Drawing Title

TEMPERATURE CONTROLS

Project No.	Date	Client Number
2012189		

Approved: MEB
Checked: RV
Drawn By: WPB
Drawing Number: **STR-M601**

SEAL