Chilled Water System Flow Test

HPCBS High Performance Commercial Building Systems — Functional Testing Guide For Air Handling Systems

Pacific Energy Center
Chilled Water System
Flow test in different operating modes

Purpose:

The purpose of this test is to document the PEC chilled water system pump performance different operating modes. The system is a constant volume system with ice storage. There are several three way valves in the system and they do not have balance valves in the bypass. This means that the flow characteristic of the valve could be very non-linear due to low resitance to flow in one position relative to the other. This could lead to temperature control problems as the valve tried to modulate, making loops difficult to tune or requiring larger proportional bands than might otherwise be necessary.

AHU1 temperature control trend data is also being collected to supplement the pump test data and assist with this assessment.

This test will document pump flow with the valves in different positions to assess the actual impact of the missing balance valves on system control performance. Pump differentail pressure readings will be taken and used to enter the pump curves to assess flow. This information will be cross checked against the turbine flow meters in the system.

The test will also establish the system curve for the pumping system. This will allow the match between the pump capacity with discharge valve fully open to be assessed against the actual head required to deliver design flow. Previous commissioning efforts established thet one pump could provided the systems flow requirements even though the original design intent was for two pumps to run. However, the head capacity of the pumps (110 ft.w.c.) relative to the estimated head requirement for the building (60-75 ft.w.c.) indicates that there may be room for further optimization via an impeller trim.

The results of this test can be used to identify if any additional opportunities exist.

Instructions:

Initial each step if the item is completed satisfactorily or the test item associated with the step met the test requirements and passed. If the item is not satisfactory or the step fails, record an "F" in the appropriate box instead of your initials. Document the reason for failing in the comments section as a numbered note and include the note next to the F on the test form. If the test step has data associated with it, document it on the test form in addition to your initials and the date and time.

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Equipment Required:

1. Digital pressure gauge or a reasonably accurate gauge on the pump.
2. An amprobe or kW meter (desirable but not manditory)

Acceptance Criteria:

The test is being run for the purpose of gathering data to assess the need for balance valves, thus there is no acceptance criteria. However, if balance valves prove to be desirable, then this test can be run subsequent to their installation to verify that they have been adjusted properly. In that case, the acceptance criteria would be that the system exhibit no significant flow variation as the control valves modulate full stroke.

Precations:

1. Exercise care when changing operating modes if a chiller is running.
2. Verify that all components between the pump discharge and the discharge service are rated for the peak pressure on the pump curve with the largest impeller size installed prior to performing a shut off test.
3. Avoid sudden flow changes to minimize the potential for water hammer.
4. Exercise proper precaution while working around live wiring and terminals to take amp readings.
5. Exercise proper precaution while working around the rotating parts of the pump.

References:

1. Pump curves for the pumps to be tested.
2. The system diagram developed in a prevoius PEC training class.
3. The Bell and Gossett Hydronic Engineering manal.
4. The *Back to Basics* columns in *Pumps and Processes* magazine; *Pumps and Your Processes: They Must Work Together*, January-February 2002; *Using System Curves to Enhance Pump Performance*; March-April 2002; *Pumps and Your Processes: When They Won't Work Together*; May-June 2002

Requirement	Data Include units	Completed Initials, Date and Time
Prerequisites:		
1. Gauges and valves are in place at the pump gauge taps. It is important that the gauges are arranged to measure pressure at the same location used by the manufacturer to develop the pump performance data.		
2. The test will not interfere with building operations.		
3. The system can be operated.		
4. Someone who is knowledable in operating the DDC system is available to command valves to different different positions		
5. The system can be operated.		

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Preparation:				
1.	Obtain pump curves for the CHW pump.			
2.	Coordinate as necessary with the trades.			
3.	Document the as found status of the system			
	CHW Pump 1			
	CHW Pump 2			
	AHU 1 status			
	AHU 1 CHW valve position			
	AHU 2 status			
	AHU2 CHW valve position			
	Chiller status			
	Chiller entering water temperature			
	Chiller leaving water temperature			
	System mode (normal or ice making)			
	Ice storage tank 1 status			
	Ice storage tank 2 status			
	Ice storage tank valve position			
	Ice storage entering temperature			
	Ice storage leaving temperature			
5.	Document the pump name plate data.			
		CHW Pump 1	CHW Pump 2	
	Make			
	Model			
	Serial Number			
	Flow			
	Head			
	Impeller Size			
	Motor Make			
	Motor Model			
	Motor HP			
	Motor Speed			
	Volts			
	Amps			
	Hz			
	Phase			
	Efficiency			
	Serial Number			
	Service Factor			
	Other			
	Other			
Procedure:				
1.	Position the sytem's control valves as follows:			
	AHU1 full flow to the coil			

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AHU 2 full flow to the coil		
Ice storage valve bypassing the tanks		
2. With one pump running (normal operating mode) document the following. Note the engineering units		
associated with the reading; i.e. psi or ft.w.c.		
Pump that is under test		
Pressure ahead of the strainer		
Pump suction pressure		
Strainer pressure drop (the difference		
between the two reading just taken)		
3. If the pressure drop through the strainer exceeds 3 psi/7 ft.w.c. suspend the test and inspect and clean the strainer. After the strainer is clean, proceed with the following.		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
4. Close the AHU 2 CHW valve		
5. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
6. Modulate the AHU1 CHW valve to 50% stroke		
7. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
8. Modulate the AHU1 CHW valve to full bypass		
9. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
10. Modulate the ice storage tank valve to 50% stroke		
11. Document the following		
Pump suction pressure		
Pump discharge pressure		

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Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
12. Modulate the ice storage tank valve to full flow through the ice tanks		
13. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
14. Modulate the AHU1 CHW valve to 50% stroke		
15. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
16. Fully open the AHU1 CHW valve		
17. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
18. Fully open the AHU2 CHW valve		
19. Document the following		
Pump suction pressure		
Pump discharge pressure		
Pump amps (all phases)		
Pump volts (all phases)		
Pump kW		
20. Perform a shut off test to verify the pump impeller size by briefly closing the discharge valve and and documenting the pump differential pressures. Proceed as follows:		
Document discharge valve position		
Start the second pump to prevent a chiller safety shut down due to loss of flow.		
Briefly close the discharge valve and		
document:		
Pump suction pressure		
Pump discharge pressure		

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Return discharge valve to original position.		
Follow up and Return to Normal:		
1. Remove all test equipment.		
2. Return the system to the state it was operating in		
at the start of the test or as requested by the		
operating staff.		
3. Plot test results on the pump curves to determine		
flow rates in all operating modes. Assess linearity.		
4. Verify the impeller size fro the pump that was		
tested based on the shut of test and document.		
Impeller size for the pump tested		
5. Compare the pump power requirements in the		
different operating modes.		

Test Coordinator(s)

Name	Affiliation	Work phone	Work e-mail

Test Team Members

Name	Affiliation	Work phone	Work e-mail

Test Completion Sign Off

This test has been performed to the best of my ability per the requirements of the procedure. Deviations or problems encountered have been noted at the end of the test form.

Test coordinator name (print)	
Signature, date and time	

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Comments and Notes

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Comments and Notes

Network Points

Chilled Water Set Point
Chiller Enable/Disable
Capacity Control Mode
Ice Making Request
Ice Termination Set Point
Refrigerant Ckt. 1 Temp.
Refrigerant Ckt. 2 Temp.
Refrigerant Pump Down Status
Hot Gas Bypass Status
Comporessor A Run Time
Comporessor B Run Time
Comporessor C Run Time

Comporessor D Run Time
Comporessor A Starts
Comporessor B Starts
Comporessor C Starts
Comporessor D Starts
Comporessor A Status
Comporessor B Status
Comporessor C Status
Comporessor D Status
Chiller EWT
Chiller LWT

Supply Temperature
Chiller BTU Meter

System Flow Meter

3"

Flow proof interlock

Chiller CH-1

Trane 40 Ton Air-cooled "Cold Generator"
4 refrigeration compressors
4 condenser fans
Cools 25% water/glycol mixture (brine)
Air Conditioning Cooling Mode
Cool 100 gpm of 53.6°F brine to 45°F with 95°F ambient air
Ice Making Cooling Mode
Cool 100 gpm of 30°F brine to 24°F with 75°F ambient air

To domestic water make-up via a back flow preventer

Chiller Btu Meter
Return Temperature Sensor

Abandon in place
Fl Sw

3"

Surface Temperature Sensor
Ice Tank Supply Temperature

Dr

Abandon in place
Fl Sw

3"

NOTES:
1. Sensors shown as surface temperature sensors ( ) appear to be installed with out wells. But the insulation has not been removed to verify this. Sensors labled as serving Btu meters have not been verified as being wired to the meter.

2. Line sizes are from the installation drawings and have not been field verified unless otherwise noted.

Chemical shot feeder

PRV

Expansion Tank

Suction Diffuser

Pump CHP1

Pump Farthest from the Wall
Bell and Gossett 1-1/2" BC
53 gpm at 106 ft.w.c.
5 hp
Differential pressure switch provides proof of operation input to the control system

Suction Diffuser

Pump Closest to the Wall
Bell and Gossett 1-1/2" BC
53 gpm at 106 ft.w.c.
5 hp
Impeller trimmed to 7-3/4" to deliver 106 gpm at 58 ft.w.c. using 2.7 bhp
Differential pressure switch provides proof of operation input to the control system

2-1/2" Typical

3"

3"

TCV 6
Ice Tank Valve

Ice Tank BTU Meter
Supply Temperature

Ice Tank Level
Bubbler type sensor

Ice Storage

Ice Storage

Ice Tank Level
Bubbler type sensor

1-1/4" (Typical)

3"

Ice Tank BTU Meter
Return Temperature

Dr

3"

Surface Temperature Sensor
Return Temperature

3"

4"

1-1/4"

PT

Vt

Training AHU

AHU2 - Training Room
2,400 cfm
Entering conditions - 77°Ft_{db}, 64°Ft_{wb}
Leaving conditions - 55.7°Ft_{db}, 55.1°Ft_{wb}
10 gpm of water entering at 45°F

PT

1-1/4"

Coil EWT Indicator
Sun Powered

Upper Coil

Lower Coil

AHU1 - Main Building
26,500 cfm
Entering conditions - 77°Ft_{db}, 64°Ft_{wb}
Leaving conditions - 56.8°Ft_{db}, 56°Ft_{wb}
95 gpm of water entering at 45°F

Coil LWT Indicator
Sun Powered

Th

Pacific Energy Center Ice Storage System

Revisions: 1 - Fixed pump manifold detail, added chillernetwork points 11-16-10
Revisions: 2 -
Revisions: 3 -

Drawn by: DAS	Date: 08-19-10
Checked by: DAS	Plot date:

SD-1

SERIES 1510 PUMP PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE