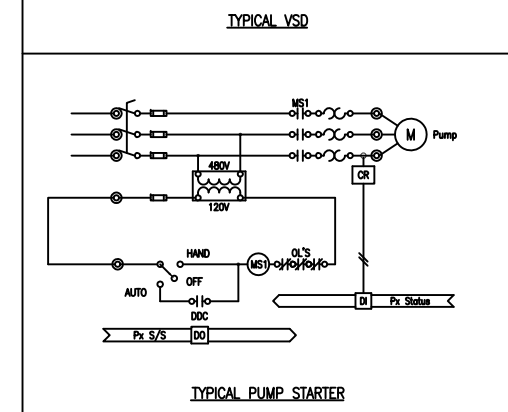
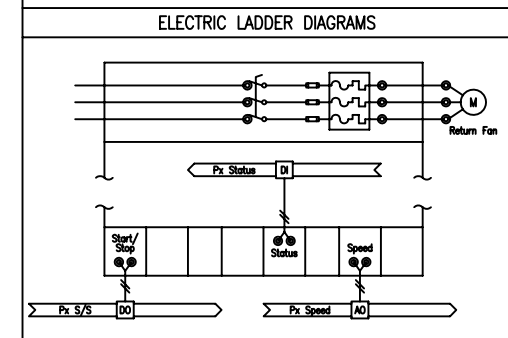


POINTS LIST					REVISIONS				
ADDRESS	POINT DESCRIPTOR	POINT TYPE			REMARKS	NO.	DESCRIPTION	DATE	
		DI	AI	DO					AO
	CH-1 Enable			*	NOTE 1				
	CH-1 Temp Reset			*	NOTE 1				
	CH-1 Status	*			NOTE 1				
	CH-1 Alarm	*			NOTE 1				
	PCHWPx S/S			2					
	CH-1 CHWS Temp	*							
	CH-1 CHWR Temp	*							
	CT-1 S/S			*					
	CT-1 Speed			*					
	CT-1 Status	*							
	CT Bypass Valve			*					
	CWPx S/S			2					
	CWPx Status	2							
	CWS Temp	*							
	CWR Temp	*							
	SCHWPx S/S			2					
	SCHWPx Speed			2					
	SCHWPx Status	2							
	CHWS Temp	*							
	CHWR Temp	*							
	CHW Flow	*							
	CHW RDP	*			NOTE 2				
TOTALS					9	8	8	5	

NOTE 1
 DO CH-1 Enable
 AO CH-1 Temp Reset
 DI CH-1 Status
 DI CH-1 Alarm

- NOTES
- In addition to the specific points shown, BAS shall monitor all available points via the Chiller Interface Device (CID).
 - LOCATE REMOTE DIFFERENTIAL PRESSURE (RDP) SENSOR AT MOST REMOTE CHW COIL AS DIRECTED. INSTALL TRANSMITTER AND BYPASS ASSEMBLY NO HIGHER THAN 6 FEET AFT.



Facility Dynamics ENGINEERING
 6300 Annapolis Rd, Suite 200
 Columbia, MD 21046 (410) 299-0000

HVAC CONTROLS

Eng	BWR
Drawn	BWR
Check	BWR
App'd	J/S
Issued	
Job No.	XXXXX
Scale	N/A
Proj Code	

CHW SYSTEM TYPE 2 CONTROLS
 18 OF 30 SHEET NUMBER
 C-3.3
 DWG NUMBER

SEQUENCE OF OPERATION

REVISIONS

GENERAL: BAS SHALL CONTROL THE CHILLED WATER SYSTEM AND EQUIPMENT AND PROVIDE MONITORING AND DIAGNOSTIC INFORMATION FOR MANAGEMENT PURPOSES.

COOLING ENABLE: COOLING SHALL BE ENABLED WHENEVER MANUALLY ENABLED BY THE OPERATOR AT THE OPERATOR INTERFACE VIA A GRAPHIC ICON OR WHEN OUTSIDE AIR TEMPERATURE IS ABOVE 55°F, WITH A 5°F CYCLE DIFFERENTIAL. ONCE ENABLED, COOLING SHALL REMAIN ENABLE FOR AT LEAST ONE HOUR.

PROOF OF CHILLER OPERATION: BAS SHALL PROVE THE OPERATION OF THE CHILLER VIA CHILLER STATUS AND ALARM POINTS. WHEN A CHILLER IS ASSESSED AS FAILED, A LEVEL 1 ALARM SHALL BE ENUNCIATED. THE FOLLOWING CONDITIONS SHALL RESULT IN THE ASSESSMENT THAT THE CHILLER HAS FAILED:

1. LOSS OF CHILLER STATUS FOR MORE THAN 15 MIN (ADJ.) AFTER IT IS INITIALLY REQUESTED.
2. CLOSURE OF CHILLER FAILURE INPUT.
3. LEAVING CHILLED WATER TEMPERATURE EXCEEDS SETPOINT PLUS 8°F FOR 10 MINUTES CONTINUOUSLY AND A MINIMUM OF 20 MINUTES HAS ELAPSED SINCE THE CHILLER HAS BEEN STARTED.
4. CHILLER ENVIRONMENT IS UNACCEPTABLE FOR 10 MIN. AS SPECIFIED BELOW.

CHILLER ENVIRONMENT MONITORING: BAS SHALL MONITOR THE ENVIRONMENT OF THE CHILLER AND REMOVE THE RUN COMMAND WHEN THE ENVIRONMENT IS ASSESSED AS UNACCEPTABLE. AN UNACCEPTABLE ENVIRONMENT WILL INCLUDE ANY OF THE FOLLOWING:

- A) LOSS OF STATUS ON THE ASSOCIATED PRIMARY CHW OR CW PUMP (PUMP PROOF DEBOUNCE TIME SHALL NOT APPLY)
- B) CONDENSER WATER ENTERING TEMPERATURE FALLS BELOW CHW SUPPLY TEMPERATURE SETPOINT PLUS 12°F OR RISES ABOVE 100°F (ALL VALUES ADJ.)
- C) IN THE EVENT THAT THE ENVIRONMENT IS ASSESSED AS UNACCEPTABLE, BAS SHALL ENUNCIATE A LEVEL 2 ALARM, REMOVE CHILLER RUN COMMAND (NOT THE CHILLER REQUEST; ALL SUPPORTING EQUIPMENT SHALL CONTINUE TO OPERATE) AND START A TIMER. IF THE ENVIRONMENT IS STILL UNACCEPTABLE AFTER 10 MIN. (ADJ.), FAIL THE CHILLER.

CHILLED WATER TEMPERATURE CONTROL: THE CHILLED WATER TEMPERATURE SHALL BE CONTROLLED BY THE INDIVIDUAL CHILLER CONTROL PANEL. THE BAS SHALL:

PRIMARY CHW PUMP CONTROL: BAS SHALL CONTROL THE PUMPS AS FOLLOWS:

1. START/STOP: LEAD PUMP SHALL BE STARTED WHEN THE CHILLER IS REQUESTED TO RUN, PER THE CHILLER START AND STOP SEQUENCES SPECIFIED BELOW AND SHALL RUN CONTINUOUSLY.
2. PROOF: BAS SHALL PROVE PUMP OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME. UPON FAILURE OF THE LEAD PUMP, BAS SHALL ENERGIZE THE STANDBY PUMP AND ENUNCIATE A LEVEL 1 ALARM.

SECONDARY CHW PUMP CONTROL: BAS SHALL CONTROL THE PUMPS AS FOLLOWS:

1. START/STOP: LEAD PUMP SHALL BE STARTED WHEN COOLING IS ENABLED AND SHALL RUN CONTINUOUSLY.
2. BAS SHALL PROVE PUMP OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME. UPON FAILURE OF THE LEAD PUMP, BAS SHALL ENERGIZE THE LAG PUMP AND ENUNCIATE A LEVEL 1 ALARM.
3. VSD CONTROL: WHENEVER COOLING IS ENABLED, BAS SHALL CONTROL THE OUTPUT OF THE ACTIVE PUMP VSDS PER A RA PID LOOP TO MAINTAIN CHW REMOTE DIFFERENTIAL PRESSURE (RDP) SETPOINT (DETERMINED BY TAB; INITIALLY 10 PSID). ON START AND STOP, THE VSD SHALL RAMP TO SPEED AND SLOW DOWN WITHIN ADJUSTABLE ACCELERATION AND DECELERATION LIMITS.
4. STAGING: WHEN THE PUMP VSD OUTPUT IS 100% FOR 10 MINUTES (ADJ.), BAS SHALL START AN ADDITIONAL PUMP. WHEN THE PUMP VSD OUTPUT IS < 50% FOR 2 MINUTES (ADJ.) AND MORE THAN ONE PUMP IS ENABLED, BAS SHALL STOP THE ACTIVE PUMP WITH THE GREATEST ACCUMULATED RUNTIME.

CONDENSER WATER PUMP CONTROL: BAS SHALL CONTROL THE PUMPS AS FOLLOWS:

1. START/STOP: LEAD PUMP SHALL BE STARTED WHEN THE CHILLER IS REQUESTED TO RUN, PER THE CHILLER START AND STOP SEQUENCES SPECIFIED BELOW AND SHALL RUN CONTINUOUSLY.
2. PROOF: BAS SHALL PROVE PUMP OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME. UPON FAILURE OF THE LEAD PUMP, BAS SHALL ENERGIZE THE STANDBY PUMP AND ENUNCIATE A LEVEL 1 ALARM.

CHILLER START SEQUENCE: ON A REQUEST FOR A CHILLER TO START, THE FOLLOWING SEQUENCE SHALL OCCUR:

1. VERIFY PRIMARY CHW AND CW PUMPS ARE OPERATING.
2. COMMAND THE CHILLER TO START UNDER ITS OWN CONTROL.
3. MONITOR CHILLER STATUS AND PROVE OPERATION. IF STATUS IS NOT INDICATED WITHIN 5 MINUTES (ADJ.) OF A COMMAND TO START, ENUNCIATE A LEVEL 2 ALARM.

CHILLER STOP SEQUENCE: WHEN THE CHILLER IS NO LONGER REQUESTED, REMOVE CHILLER RUN COMMAND.

MAINTENANCE MODE: OPERATORS SHALL BE ABLE TO LOCK OUT CHILLERS AND SECONDARY CHW PUMPS IN MAINTENANCE MODE. THIS MEANS THAT THE REQUESTS FOR THIS EQUIPMENT AND ASSOCIATED APPURTENANCES SHALL BE BYPASSED. THIS SHALL BE DONE THROUGH A GRAPHIC ICON ASSOCIATED WITH A VIRTUAL POINT INDICATING WHETHER THE MAINTENANCE MODE IS ACTIVE OR VIA A PROPERTY ASSOCIATED WITH THE BOILER ICON.

COOLING TOWER FAN CONTROL: BAS SHALL CONTROL THE TOWER FAN AS FOLLOWS:

1. START/STOP: TOWER FAN SHALL BE STARTED WHEN COOLING IS ENABLED AND CONDENSER WATER PUMP STATUS IS FROZEN.
2. PROOF: BAS SHALL PROVE FAN OPERATION AND USE THE STATUS INDICATION TO ACCUMULATE RUNTIME.
3. VSD CONTROL: WHENEVER THE TOWER IS ENABLED, BAS SHALL CONTROL THE OUTPUT OF THE FAN VSD PER A DA PID LOOP TO MAINTAIN CONDENSER WATER SUPPLY TEMPERATURE SETPOINT OF 75°F (ADJ.). ON START AND STOP, THE VSD SHALL RAMP TO SPEED AND SLOW DOWN WITHIN ADJUSTABLE ACCELERATION AND DECELERATION LIMITS.

COOLING TOWER BYPASS VALVE CONTROL: BAS SHALL MODULATE THE BYPASS VALVE VIA A RA PID LOOP TO MAINTAIN MINIMUM CONDENSER WATER SUPPLY TEMPERATURE SETPOINT OF 65°F (ADJ.).

NO.	DESCRIPTION	DATE

Facility Dynamics
 ENGINEERING
 6750 Alexander Ave. Dr. Suite 200
 Columbia, MD 21046 (410) 286-0000

HVAC CONTROLS

Rev.	BWR
Drawn	BWR
Checked	BWR
Issued	JIS
Job No.	XXXXX
Scale	N/A
Proj. Code	

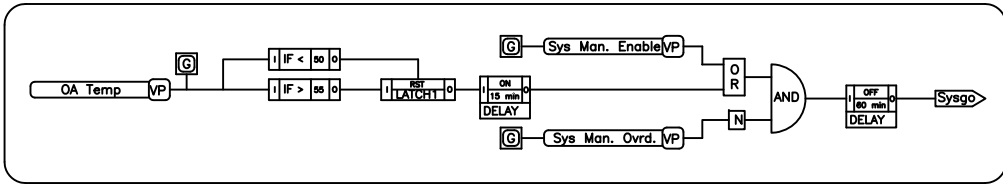
CHW SYSTEM
TYPE 2
CONTROLS
(CONT'D.)

19 OF 30
SHEET NUMBER

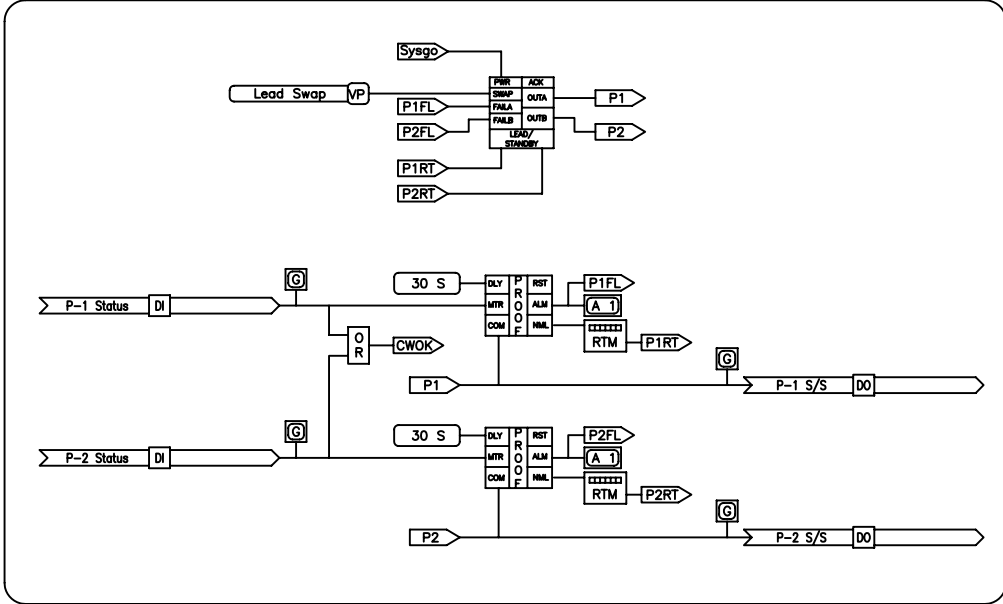
C-3.4

DWG NUMBER

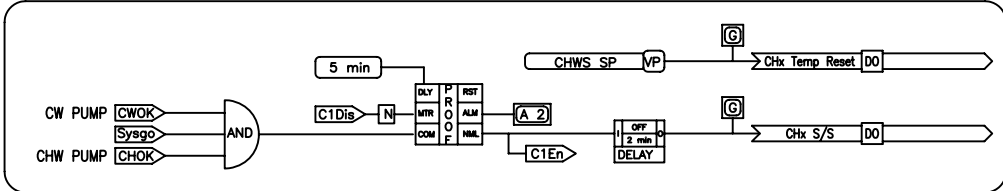
SYSTEM ENABLE



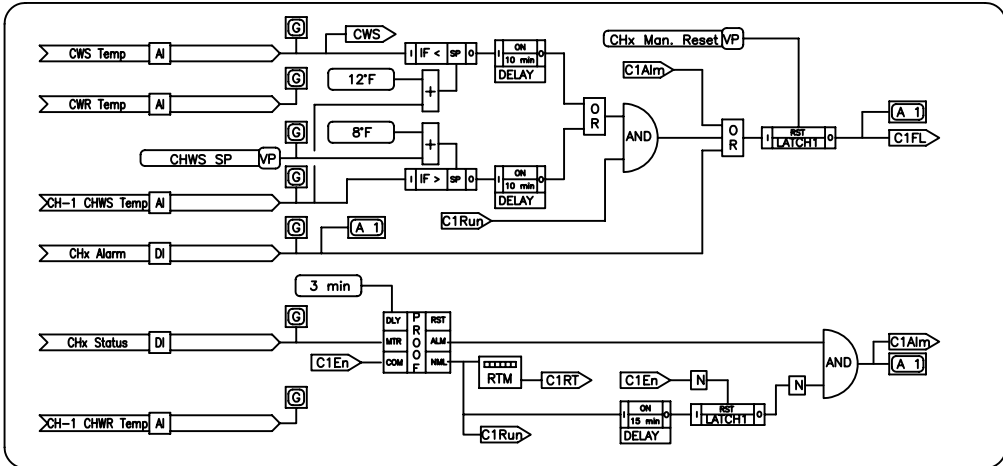
CW PUMP CONTROL (TYPICAL FOR PRIMARY CHW PUMPS)



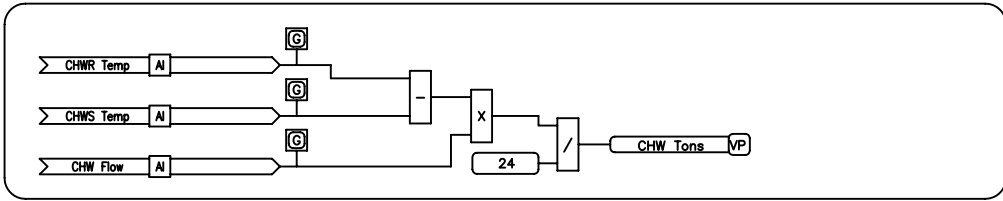
CHILLER START SEQUENCE



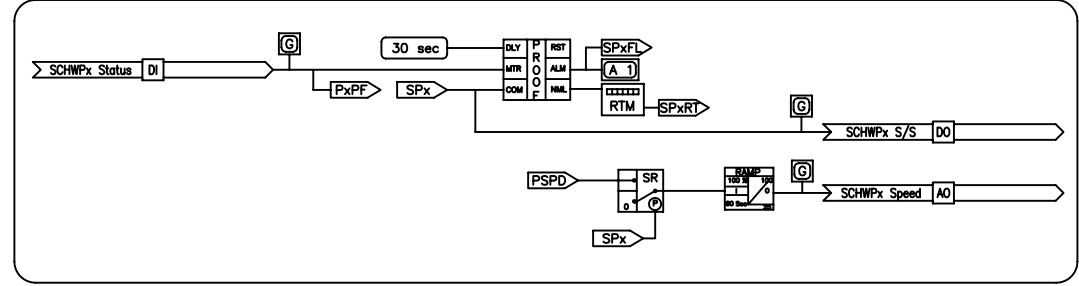
CHILLER ENVIRONMENT MONITORING



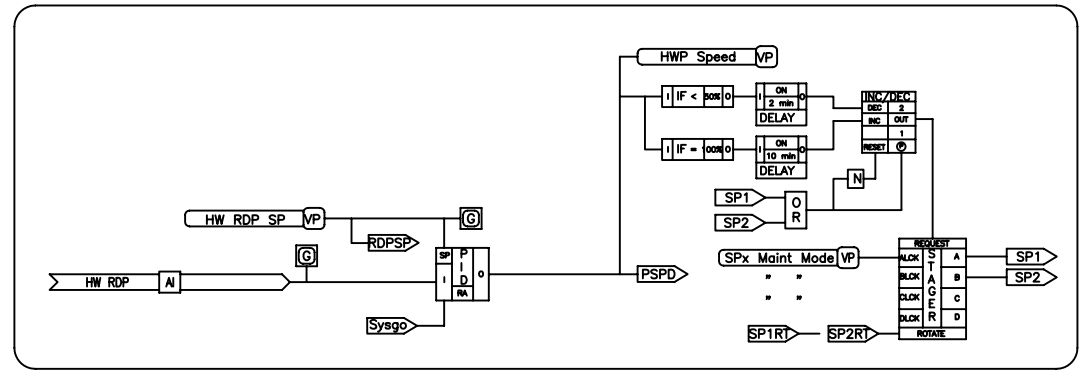
CHW LOAD CALCULATION



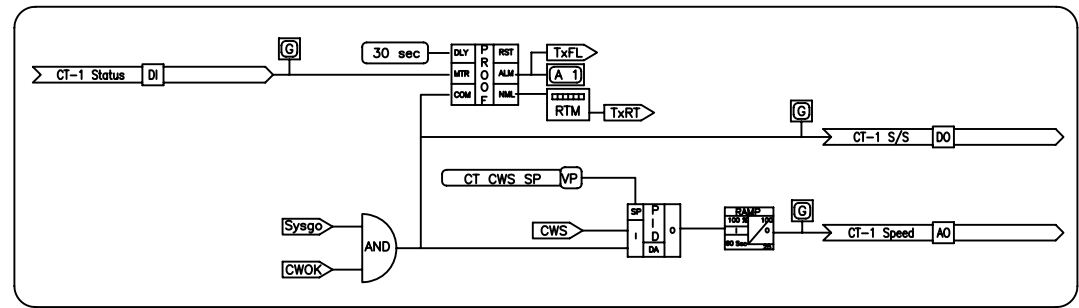
TYPICAL SECONDARY CHW PUMP



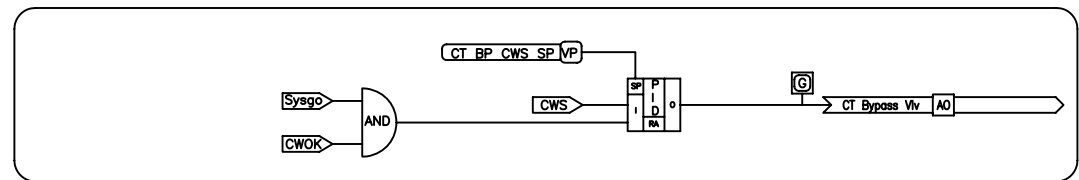
SECONDARY CHW PUMP SPEED CONTROL AND STAGING



COOLING TOWER FAN CONTROL



COOLING TOWER BYPASS VALVE CONTROL



General: BAS shall control the chilled water system and equipment and provide monitoring and diagnostic information for management purposes.

Cooling enable: cooling shall be enabled whenever manually enabled by the operator at the operator interface via a graphic icon or when outside air temperature is above 55°F, with a 5°F cycle differential. Once enabled, cooling shall remain enabled for at least one hour.

Proof of chiller operation: BAS shall prove the operation of the chiller via chiller status and alarm points. When a chiller is assessed as failed, a level 1 alarm shall be enunciated. The following conditions shall result in the assessment that the chiller has failed:

1. Loss of chiller status for more than 15 min (adj.) after it is initially requested.
2. Closure of chiller failure input.
3. Leaving chilled water temperature exceeds set point plus 8°F for 10 minutes continuously and a minimum of 20 minutes has elapsed since the chiller has been started.
4. Chiller environment is unacceptable for 10 min. As specified below.

Chiller environment monitoring: BAS shall monitor the environment of the chiller and remove the run command when the environment is assessed as unacceptable. An unacceptable environment will include any of the following:

- A) Loss of status on the associated primary CHW or CW pump (pump proof debounce time shall not apply)
- B) Condenser water entering temperature falls below CHW supply temperature setpoint plus 12°F or rises above 100°F (all values adj.).
- C) In the event that the environment is assessed as unacceptable, BAS shall enunciate a level 2 alarm, remove chiller run command (not the chiller request; all supporting equipment shall continue to operate) and start a timer. If the environment is still unacceptable after 10 min. (adj.), fail the chiller.

Chilled water temperature control: the chilled water temperature shall be controlled by the individual chiller control panel.

Primary CHW pump control: BAS shall control the pumps as follows:

1. Start/stop: lead pump shall be started when the chiller is requested to run, per the chiller start and stop sequences specified below and shall run continuously.
2. Proof: BAS shall prove pump operation and use the status indication to accumulate runtime. Upon failure of the lead pump, BAS shall energize the standby pump and enunciate a level 1 alarm.

Secondary CHW pump control: BAS shall control the pumps as follows:

1. Start/stop: lead pump shall be started when cooling is enabled and shall run continuously.
2. Proof: BAS shall prove pump operation and use the status indication to accumulate runtime. Upon failure of the lead pump, BAS shall energize the lag pump and enunciate a level 1 alarm.
3. VSD control: whenever cooling is enabled, BAS shall control the output of the active pump VSDs per a raPID loop to maintain CHW remote differential pressure (RDP) set point (determined by tab; initially 10 psid). On start and stop, the VSD shall ramp to speed and slow down within adjustable acceleration and deceleration limits.
4. Staging: when the pump VSD output is 100% for 10 minutes (adj.), BAS shall start an additional pump. When the pump VSD output is < 50% for 2 minutes (adj.) And more than one pump is enabled, BAS shall stop the active pump with the greatest accumulated runtime.

Condenser water pump control: BAS shall control the pumps as follows:

1. Start/stop: lead pump shall be started when the chiller is requested to run, per the chiller start and stop sequences specified below and shall run continuously.

2. Proof: BAS shall prove pump operation and use the status indication to accumulate runtime. Upon failure of the lead pump, BAS shall energize the standby pump and enunciate a level 1 alarm.

Chiller start sequence: on a request for a chiller to start, the following sequence shall occur:

1. Verify primary CHW and CW pumps are operating.
2. Command the chiller to start under its own control.
3. Monitor chiller status and prove operation. If status is not indicated within 5 minutes (adj.) of a command to start, enunciate a level 2 alarm.

Chiller stop sequence: when the chiller is no longer requested, remove chiller run command.

Maintenance mode: operators shall be able to lock out chillers and secondary CHW pumps in maintenance mode. This means that the requests for this equipment and associated appurtenances shall be bypassed. This shall be done through a graphic icon associated with a virtual point indicating whether the maintenance mode is active or via a property associated with the boiler icon.

Cooling tower fan control: BAS shall control the tower fan as follows:

1. Start/stop: tower fan shall be started when cooling is enabled and condenser water pump status is proven.
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime.
3. VSD control: whenever the tower is enabled, BAS shall control the output of the fan VSD per a DA PID loop to maintain condenser water supply temperature set point of 75°F

(adj.). On start and stop, the VSD shall ramp to speed and slow down within adjustable acceleration and deceleration limits.

Cooling tower bypass valve control: BAS shall modulate the bypass valve via a RA PID loop to maintain minimum condenser water supply temperature set point of 65°f (adj.).