25 00 00 INTEGRATED AUTOMATION

At Div 25, *Section 25 00 00 Integrated Automation,* add the following hyperlinked Document, Date and Description to the bottom of the first Table:

Document	Version Date	Description
Building Automation Systems (BAS)	January 2008	These guide specifications are provided for the Professional to insert into their Technical Specifications. These shall be edited using the process described in the instructions contained at the beginning of the document. Use of other BAS specifications is not acceptable.
Building Automation Systems, Sub-system Integration	February 2003	Any specification section (Mechanical or Electrical) that specifies a sub-system to be integrated with the University's Building Automation System (BAS) shall include specification-text that refers to Figure 1 and Figure 2 at the end of the Building Automation System specification (15900). This document addresses this requirement.
Building Automation Systems Device Instances and Network Number Assignment	July 2006	This document contains the numbering scheme to follow for BACnet system designs. Coordination with the BAS group at Penn State University Park is required.
Pressure Independent Control Valve Selection	March 2011	This document contains design considerations and selection criteria to achieve uniform selection and installations if using pressure independent control valves This is not intended to require PIC valves in all cases,

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Add hyperlink for the Document Name in the table above to the document attached below.

PICCV Valve Selection.docm

Field Code Changed

END of revision

Update Commentary:

Section was updated primarily for the following reasons:

1) To achieve uniform selection and installations if using pressure independent control valves

Continuous Commissioning
The Pennsylvania State University
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University Park, PA 16802-1118

Application: Pressure Independent Control Valve Design and Selection

Systems Affected: Chilled and Hot Water PICCV Valves

Goal: To promote uniform selection and installation of pressure independent control valves, decrease startup and commissioning costs, improve system water quality.
This is not intended as a document to require the use of PICCV valves, but a means of providing uniform use and selection.

Belimo Pressure Independent Control Valve Design Considerations:

The PICCV valve requires 5 psi differential pressure to provide stable operation. Belimo asserts that a control valve selected at 3 psi, and a balancing valve at 2 psi result in an equal pressure requirement. If the balance valve is omitted, the pressure dependent valve requires less pressure to operate.

There are three criteria to consider when selecting PICCV valves:

1. The brass valve body maximum flow rate (denoted by the orange horizontal lines in the catalog).
2. The programmed flow rate of the actuator.
3. The piping package with unions should be selected with all valve installations, this guarantees the correct number and locations of test ports to properly assess valve operation.

While the programmed flow rate of the actuator can be modified up to the brass valve body peak flow rate utilizing either the electronic "tool" or a cable and software, the valve body maximum flow rate is set, and cannot be altered.

The actuator flow rate, set from the factory allows the valve only to modulate over the preset maximum flow range. Therefore, a 10V signal from the control system will not cause the valve to open 100%, it will open to the designated position that results in the maximum program flow.

Current valve selection process:

Pressure independent control valves are currently selected either with the aid of the Belimo valve selection software, or utilizing the printed catalog distributed by the local representative. The valves are selected by flow rate, rounded up to the nearest 0.5 gpm.

As shown below, this method can result in several unintended consequences:

- Undersized Valves: The energy conservation code requires that the heating airflow reduce to 30% of the peak cooling airflow. This forces an otherwise conservative engineer to use the bare minimum airflow required for heating, regardless of diffuser location, throw, and room orientation. In retrofit applications, this has the potential to undersize the heating load, and therefore the hot water flow rate and valve size.

- Water Stagnation: The specification and installation of valves below 1 gpm has the potential to cause stagnation and insufficient flow rates to flush debris from piping systems. Where a normal valve can be opened to 100% to allow the system to be flushed, the pre-programmed valve will not, causing insufficient flow to clear the piping of debris.
- Increased Maintenance: Water stagnation, and poor water quality lead to increased strainer, valve and water maintenance time.
- Decreased Occupant Comfort: The design engineer designs to a peak load, often exceeded, if only for a few hours per year. However, this situation, combined with stagnation and poor heat transfer due to buildup in the piping system may lead to unacceptable space comfort.
- Increased Commissioning Cost: Adjusting the valve flow rate after the fact requires a technician to access the valve, disconnect the BAS connection, plug in the tool, recalibrate the valve, and reconnect the BAS system. Based on the sheer number of terminal units in a VAV system, the cost of this time is not warranted.

The chart show below shows the allowable flow error as designed, and the allowable flow error to be adjusted before assembly replacement.

Current Selection Criteria							
Design Flow (gpm)	Valve Selection Actuator Setting Maximum Flow (gpm)	Allowable Error %	Allowable Error in Airflow (cfm)	Valve Selection Valve Body Maximum Flow (gpm)	Allowable Error %	Allowable Error in Airflow (cfm)	Valve Selection Valve Body Size
0.4	0.5	25.0%	**23.1**	2.5	84.0%	486.1	1/2"
1.2	1.5	25.0%	**69.4**	2.5	52.0%	300.9	1/2"
2.0	2.0	0.0%	**0.0**	2.5	20.0%	115.7	1/2"
2.4	2.5	4.2%	**23.1**	2.5	4.0%	23.1	1/2"
3.6	4.0	11.1%	**92.6**	5.5	34.5%	439.8	1/2"
4.5	4.5	0.0%	**0.0**	5.5	18.2%	231.5	1/2"
5.0	5.0	0.0%	**0.0**	5.5	9.1%	115.7	1/2"
5.3	5.5	3.8%	**46.3**	5.5	3.6%	46.3	1/2"
6.8	7.0	2.9%	**46.3**	10	32.0%	740.7	3/4"
7.5	7.5	0.0%	**0.0**	10	25.0%	578.7	3/4"
9.1	9.5	4.4%	**92.6**	10	9.0%	208.3	3/4"
10.2	10.5	2.9%	**69.4**	16	36.3%	1342.6	1 "

The allowable error in the max heating airflow is unachievable with the current design and construction tools, and is certainly so in retrofit applications.

While some of the selections allow for a reasonable amount of error in load calculation and building construction with the maximum adjustment of the valve body, some of the selections do not allow any error. All of these installations result in an unacceptable level of avoidable maintenance time to correct even the slightest miscalculation.

Recommendations:

An alternate method of selection would not select specific valve model numbers down to 1/2 gpm, but would select them based only on the maximum flow rate of the valve assemblies, with an allowance for flow rates near that maximum. This method has been confirmed with the local Belimo representative, and is currently applied in their European market. The chart below shows an example selection.

Valve Selection Criteria					
Design Flow (gpm)	Valve Selection Valve Body Maximum Flow (gpm)	Allowable Error %	Allowable Error in Airflow (cfm)	Valve Selection Valve Body Size	PICCV Valve Model Number
0.5	2.5	400.0%	**463.0**	1/2" Small	P2050B025-LRX24-MFT
1.0	2.5	150.0%	**347.2**	1/2" Small	P2050B025-LRX24-MFT
1.5	2.5	66.7%	**231.5**	1/2" Small	P2050B025-LRX24-MFT
2.0	5.5	175.0%	**810.2**	1/2"	P2050B055-LRX24-MFT
2.5	5.5	120.0%	**694.4**	1/2"	P2050B055-LRX24-MFT
3.0	5.5	83.3%	**578.7**	1/2"	P2050B055-LRX24-MFT
3.5	5.5	57.1%	**463.0**	1/2"	P2050B055-LRX24-MFT
4.0	5.5	37.5%	**347.2**	1/2"	P2050B055-LRX24-MFT
4.5	5.5	22.2%	**231.5**	1/2"	P2050B055-LRX24-MFT
5.0	10	100.0%	**1157.4**	3/4"	P2075B100-LRX24-MFT
5.5	10	81.8%	**1041.7**	3/4"	P2075B100-LRX24-MFT
6.0	10	66.7%	**925.9**	3/4"	P2075B100-LRX24-MFT
6.5	10	53.8%	**810.2**	3/4"	P2075B100-LRX24-MFT
7.0	10	42.9%	**694.4**	3/4"	P2075B100-LRX24-MFT
7.5	10	33.3%	**578.7**	3/4"	P2075B100-LRX24-MFT
8.0	10	25.0%	**463.0**	3/4"	P2075B100-LRX24-MFT
8.5	10	17.6%	**347.2**	3/4"	P2075B100-LRX24-MFT
9.0	10	11.1%	**231.5**	3/4"	P2075B100-LRX24-MFT
9.5	16	68.4%	**1504.6**	1 "	PICCV-25-015-LRX24-MFT
10.0	16	60.0%	**1388.9**	1 "	PICCV-25-015-LRX24-MFT
10.5	16	52.4%	**1273.1**	1 "	PICCV-25-015-LRX24-MFT
11.0	16	45.5%	**1157.4**	1 "	PICCV-25-015-LRX24-MFT
11.5	16	39.1%	**1041.7**	1 "	PICCV-25-015-LRX24-MFT
12.0	16	33.3%	**925.9**	1 "	PICCV-25-015-LRX24-MFT
12.5	16	28.0%	**810.2**	1 "	PICCV-25-015-LRX24-MFT
13.0	16	23.1%	**694.4**	1 "	PICCV-25-015-LRX24-MFT
13.5	16	18.5%	**578.7**	1 "	PICCV-25-015-LRX24-MFT
14.0	16	14.3%	**463.0**	1 "	PICCV-25-015-LRX24-MFT
14.5	16	10.3%	**347.2**	1 "	PICCV-25-015-LRX24-MFT
15.0	16	6.7%	**231.5**	1 "	PICCV-25-015-LRX24-MFT

This selection criteria allows for the following operational and maintenance procedures:

- Valve flow limits, which are based on a software input, are now controlled at the BAS level, not the device level. This allows for fine tuning and corrective action from the control system, not above the ceiling.
- During part load or lower-than-predict load, the system functions the same as the current selection method due to the proportioned characteristics of the valve assembly.
- Increased space comfort, even on the days outside the ASHRAE 99% range.
- The airflow adjustment allowances should result in fewer errors requiring field

modification or equipment replacement.

- Uniform valve selection from in-house design and controls, to maintenance replacement and consultant engineer projects.
- Reduced commissioning time.
- Allows for the implementation of a water circulation routine to maintain water quality throughout the system during all seasons. Increased water quality results in greater heat transfer, lower energy use, and decrease system maintenance.
- A water circulation routine would lock all control valves to 100%, and circulate the entire pumping system for 15 minutes at a frequency to be determined. This would help alleviate buildup and stagnation, particularly in the low flow or "dead leg" portions of the hydronic system.

The chart below can be used to input a output signal limit for limiting flow per the design documents.

NC, Non-Spring Return Actuators, LRX-MFT, ARX-MFT

(½ " and ¾" Valves with Brass Disc)

Actuator	Valve Size	Disc Size	PICCVs	Flow	MIN %	MAX %	Signal
LRX24-MFT	1/2"	Small	P2050B005	0.5	0	48	NC
LRX24-MFT	1/2"	Small	P2050B010	1	0	68	NC
LRX24-MFT	1/2"	Small	P2050B015	1.5	0	81	NC
LRX24-MFT	1/2"	Small	P2050B020	2	0	88	NC
LRX24-MFT	1/2"	Small	P2050B025	2.5	0	93	NC
LRX24-MFT	1/2"	Large	P2050B030	3	0	82	NC
LRX24-MFT	1/2"	Large	P2050B035	3.5	0	86	NC
LRX24-MFT	1/2"	Large	P2050B040	4	0	87	NC
LRX24-MFT	1/2"	Large	P2050B045	4.5	0	90	NC
LRX24-MFT	1/2"	Large	P2050B050	5	0	93	NC
LRX24-MFT	1/2"	Large	P2050B055	5.5	0	96	NC
LRX24-MFT	3/4"		P2075B060	6	0	73	NC
LRX24-MFT	3/4"		P2075B070	7	0	80	NC
LRX24-MFT	3/4"		P2075B080	8	0	88	NC
LRX24-MFT	3/4"		P2075B090	9	0	96	NC
LRX24-MFT	3/4"		P2075B100	10	0	100	NC
LRX24-MFT	3/4"		P2075B065	6.5	0	77	NC
LRX24-MFT	3/4"		P2075B075	7.5	0	84	NC
LRX24-MFT	3/4"		P2075B085	8.5	0	91	NC
LRX24-MFT	3/4"		P2075B095	9.5	0	100	NC
LRX24-MFT	1"	Small	PICCV-25-011	11	0	77	NC
LRX24-MFT	1"	Small	PICCV-25-012	12	0	79	NC
LRX24-MFT	1"	Small	PICCV-25-013	13	0	83	NC
LRX24-MFT	1"	Small	PICCV-25-014	14	0	83	NC
LRX24-MFT	1"	Small	PICCV-25-015	15	0	85	NC
LRX24-MFT	1"	Small	PICCV-25-016	16	0	91	NC
LRX24-MFT	1"	No Disc	PICCV-25-017	17	0	77	NC
LRX24-MFT	1"	No Disc	PICCV-25-018	18	0	81	NC
LRX24-MFT	1"	No Disc	PICCV-25-019	19	0	88	NC