AABC Commissioning Group

AIA Provider Number 50111116

AABC National Standards for Total System Balance, 7th Edition: A Guided Tour

Course Number: CXENERGY1624

Gaylon Richardson, TBE, CxA

Engineered Air Balance Co., Inc.

April 12, 2016

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Copyright Materials

This presentation is protected by US and International Copyright laws. Reproduction, distribution, display and use of the presentation without written permission of the speaker is prohibited.

® ENGINEERED AIR BALANCE

Course Description

Don’t miss this guide to the most important changes in AABC’s all-new, just-published National Standards, the organization’s first ANSI approved standard. The comprehensive rewrite includes new material on testing energy recovery systems and chilled beams, expanded material on hydronics, a chapter on TAB of healthcare facilities and much more.

Learning Objectives

At the end of the this course, participants will be able to:

1. Develop a better understanding of the scope of work required of the TAB agency in total system balancing of HVAC components and HVAC systems.

2. Learn the changes/updates to total system balancing as outlined in the Standards' new chapter on "Testing and Balancing Health Care Facilities."

3. Learn the changes/updates outlined in the Standards' new sections on testing energy recovery systems and chilled beams.

4. Understand the new information presented in the Standard's expanded chapters on hydronic balancing and new chapter on domestic water balancing.

Total System Balancing Chapter 1

Total System Balancing can be defined as the process of testing and balancing the heating, ventilating, and air-conditioning
(HVAC system) and related control systems to perform at the design intent, and operate at an optimum level.

Total System Balancing includes a review of the design documents for
balanceability, construction observation, and a methodical approach to the testing and balancing of all systems to their optimal performance with verifiable test results.

The Report Chapter 1

The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the TSB process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel.

The report shall be organized by systems, and shall include project identification, date, and sequential page numbers.

CONTINUING EDUCATION AIA

The Report Chapter 1

AHU #X

- Air Moving Equipment Data
- Cooling and Heating Coil Data
- Air Moving Equipment Static Pressure Profile
- Air Distribution Data
  - When the System Has Terminal Boxes Combine With Diffuser Data
- Duct Traverse Data

Instrumentation and TAB Tolerances Chapter 2

Instrumentation Calibration- AABC certified members shall verify that their instrumentation is calibrated and adjusted to maintain accuracy within the limits stated by the manufacturer. This can be accomplished by sending the instrument to the manufacturer or an independent laboratory for calibration, or by verifying calibration with in house flow stations or using a sheltered set of instruments on test stations. Calibration shall be demonstrated with a minimum of three test points within the range of the instrument scale (if the instrument has multiple scales , each scale shall be verified for calibration).

Instrumentation and TAB Tolerances Chapter 2

Sheltered Instruments- shall be purchased from the manufacturer, never used in the field, secured in the office, and used exclusively for verifying calibration of field test instruments. The verification process of field test instruments shall meet the manufacturer's test range criteria, and be within the specified tolerances of the device. All sheltered instruments shall be calibrated by sending the instruments to the manufacturer or independent laboratory on an annual basis. The calibration history shall be maintained.

Instrumentation and TAB Tolerances Chapter 2

Test Station- the reference measuring system shall be calibrated annually, in the range of use, by comparison with national measurement standard e.g., a National Institute of Standards and Technology (NIST) standard. The reference measuring system shall be calibrated as an assembly. Instruments shall be calibrated directly against the national standard or through a traceable chain of not more than two intermediary instruments. The measuring reference system shall be certified to provide an accuracy at least 2:1 better than the specified the instruments specified tolerance at the measurements point and under all the conditions required for the intended rating. For example a flow hood shall be tested within ± 5% of the test station, with an accuracy of at least ± 2.5% through the full range of tests, and traceable to NIST.

Instrumentation and TAB Tolerances Chapter 2

Test and Balance Tolerances- All AABC tolerances shall be superseded by the specification if different.

SYSTEMS-AIR	TOLERANCES OF PLAN DESIGN	REMARKS
Air Handling Units, Fans (Supply, Return, Exhaust	- 5% to + 10%	Systems with filters must be tested at dirty conditions
Outdoor Air	100% to 110%	To obtain this accuracy requires ductwork that can be traversed
Terminal Boxes	± 5%	
Diffusers and Grilles	± 10%	If the design is ≤ 100 CFM (47 l/s) will be ± 10 CFM (4.7 l/s)
Pressurized rooms- Positive	Supply- + 100% to + 105% Exhaust or Return 100% to 95%	Room offset tolerance to design 100% to +110%
Pressurized rooms- Negative	Supply- 95% to 100% Exhaust or Return 100% to 105%	Room offset tolerance to design 100% to +110%

Instrumentation and TAB Tolerances Chapter 2

Test and Balance Tolerances- All AABC tolerances shall be superseded by the specification if different.

SYSTEMS-WATER	TOLERANCES OF PLAN DESIGN	REMARKS
Coils, Heat Exchangers, Pumps, Evaporators, Condensers	± 5%	Coils designed for ≤ 10 GPM (0.6091 l/s) shall be set for ± 10%

Instrumentation and TAB Tolerances Chapter 2

Test and Balance Tolerances- All AABC tolerances shall be superseded by the specification if different.

SYSTEMS-TEMPERATURES	TOLERANCES OF PLAN DESIGN	REMARKS
Air Temperatures	± 0.5 °F (±0.9 °C)	
Water Temperatures	± 0.5 °F (±0.9 °C)	
Space Temperatures	± 0.5 °F (±0.9 °C)	
Capacity Testing	± 0.1 °F (±0.18 °C)	

CONTINUING EDUCATION AIA

Airside Volume Measurement Chapter 3

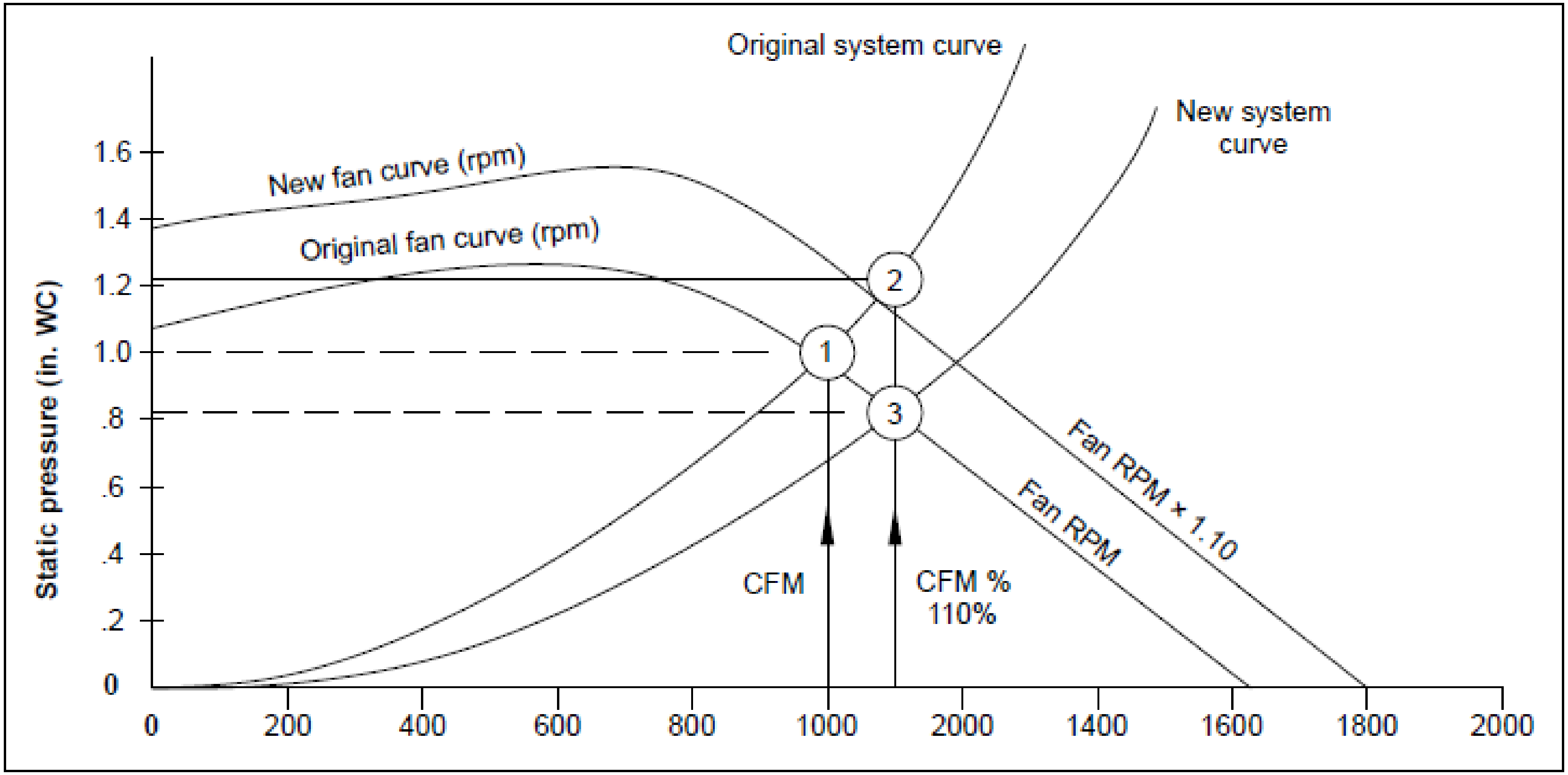
- Pitot Tube Traverses- a traverse plane is suitable for flow measurements if more than 75% of the velocity pressure readings are greater than 1/10 of the maximum velocity pressure measurement and are not negative or zero.

THIS STATEMENT STATES TRAVERSES MUST BE TAKEN WITH A PITOT TUBE AND MAONMETER (NOT A THEMO ANEMOMETER BECAUSE THEY CANNOT IDENTIFY A NEGATIVE READING)

- For round ducts use the Log Linear Rule and rectangle ducts use the Equal Area Rule or Log-Tchebychef Rule.
- Density Correction- when the temperature and altitude increase air Becomes less dense.
- Procedures for taking an Anemometer Coil Traverse are explained

Airside Volume Measurement Chapter 3

How to plot operational points on a fan curve are explained. How to use the fan curve to identify system effect is explained.



Airside Volume Measurement Chapter 3

Diversity a condition in which the total airflow to all zones (or terminal boxes exceeds the maximum airflow capacity of the fan or coil. Multi-zone systems and dual duct systems may be designed with diversity on the coils. Variable volume systems may be designed with diversity on the coils. AABC states the diversity in a system is set by closing off zones or terminal boxes to equal the diversity CFM and measuring the zones most difficult to supply.

Basic Measurements Chapter 4

This Chapter covers:

- Rotational Measurements
  - Equation for speed change
  - Equation for sheave sizing- with an explanation on sizing pulleys, sheaves and belts
- Electrical Measurements
- Temperature Measurements
  - Capacity Verification of Heat Exchangers

Leakage Testing Chapter 5

- Responsibilities
  - TAB Agency
    - Measure and Record the results of the duct leakage test
    - Report any unusual conditions
    - Report the test results
  - Engineer
    - Specify the system to be tested
    - Specify the allowable duct leakage percentage
    - Select a test pressure that does not exceed the pressure class rating of the duct

Leakage Testing Chapter 5

- Responsibilities
  - Contractor
    - Seal all openings, establish how system will be tested and not exceed the capacity of the test apparatus.
    - Provide connections from the duct to the test apparatus
    - Pretest the system and take any corrective action to seal the duct
    - Give reasonable notification for the final test

Leakage Testing Chapter 5

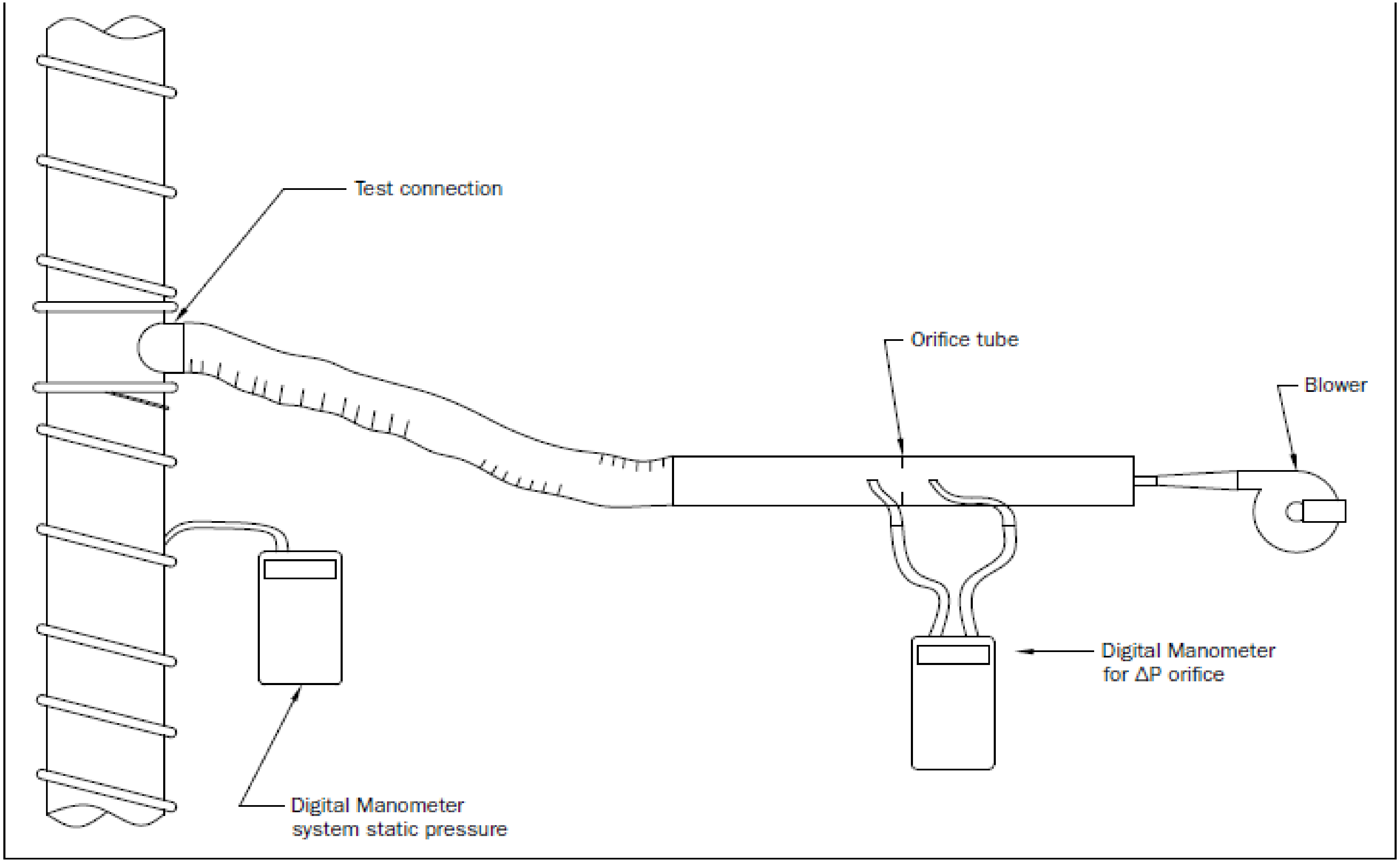
Test Parameters

Type of System	Minimum Test Pressure[3,5]	Maximum Allowable Leakage
1. Fractional horsepower fan system; fan coils, small exhaust/supply fans, and residential systems	0.50" WC (125 Pa)	2%
2. Small systems; split DX systems — usually systems under 2000 CFM (940 l/s), and residential systems	1.00" WC (250 Pa)	2%
3. VAV and CAV terminal boxes and associated downstream ductwork[1,2]	1.00" WC (250 Pa)	2%
4. Single zone, multi-zone, return ducts, and exhaust duct systems	2.00" WC (500 Pa)	2%
5. Chilled-beam primary supply	2.00" WC (500 Pa)	1%
6. All ducts in chases and concealed spaces[2], main return ducts on VAV and CAV systems, main ducts on general exhaust or outside air systems	3.00" WC (745 Pa)	1%
7. VAV and CAV terminal boxes tested with upstream ductwork	4.00" WC (995 Pa)	1%
8. Supply ducts for VAV and CAV systems	4.00" WC (995 Pa)	1%
9. Dual duct systems, both hot duct and cold duct	6.00" WC[4] (1495 Pa)	1%
10. High pressure induction system	6.00" WC[4] (1495 Pa)	0.5%
11. Exhaust systems for labs with air valves	6.00" WC[4] (1495 Pa)	0.5%
12. Grease duct Systems	4.00" WC (995 Pa)	0.0%
13. Supply, return, and exhaust ductwork located outdoors	3.00" WC[4] (745 Pa)	1%

CONTINUING EDUCATION AIA

Leakage Testing Chapter 5

The Procedure



Leakage Testing Chapter 5

Report Data

- Date of test
- Project name
- Description of duct being tested including location, sealing classification, and duct classification
- The design and actual test static pressure
- The design and actual leakage rate
- Calculation of duct leakage rate
- If the duct passed or failed
- Description of test apparatus, including orifice size, manufacturer and date calibrated
- The actual orifice drop with the actual flow
- The name of the person performing the test and any witnesses

Leakage Testing Chapter 5

AHU Pressure Testing

- Casing Leakage Test
- Casing Deflection Test

Rooms, Floor and Building Testing

The Foundation of Total System Balancing
Chapter 6

Document Review

- TAB Agency shall review the specifications, submittals and plans for Balanceability

Construction Observations

- Observation Checklists
- System Components

Developing Data Sheets

Contractor’s Responsibilities Prior to Balancing

Pre-balance Site Review

- Air systems
- Hydronic Systems

Economizer System Testing

Constant Volume Systems Chapter 7

Incremental and Stand-Alone Components

Basic Fan System

Constant Volume Air Handling Units

Multi-Zone Units

- Basic Multi-Zone Systems
- Multi-Zone Unit with Heating Coil in the Air Handling Unit
- Multi –Zone Unit with Bypass

Constant Volume Dingle Duct Systems

- Constant Volume Air Terminal Boxes
- Constant Volume Bypass Terminal Boxes
- Constant Volume Main Bypass and Variable Volume Air Terminal Boxes

Dual Duct Constant Volume Systems

High-Pressure Systems with Induction Units

Terminal Boxes for Constant Volume and Variable Systems Chapter 8

Single Duct Constant Primary, Constant Secondary

- Description
- Diversity
- Procedure

Single Duct Variable Primary, Variable Secondary

- Description
- Diversity
- Procedure

BOX NUMBER	VALVE NUMBER	MAXIMUM				MINIMUM				REMARKS
		DESIGN CFM	ACTUAL CFM	ACTUAL DISPLAY CFM	ACTUAL DAMPER POSITION %	DESIGN CFM	ACTUAL CFM	ACTUAL DISPLAY CFM	ACTUAL DAMPER POSITION %	
1	04-944-0062	1120	1135	1115	56	480	460	480	35	
2	04-944-0061	535	540	535	60	155	165	155	35	
3	04-944-0060	1200	1235	1210	88	1200	1235	1200	80	
4	04-944-0056	1200	1200	1210	65	0	0	0	0	
5	04-944-0055	240	240	240	62	85	85	85	35	
6	04-944-0059	1570	1515	1570	59	480	480	475	30	
7	04-944-0058	1200	1195	1205	72	720	705	715	49	
8	04-944-0057	1200	1210	1205	70	720	720	715	42	
9	04-944-0064	2000	1980	2005	70	600	650	595	33	
10	04-944-0064	1980	1985	1985	71	1200	1180	1200	50	
		12245	11155	12280		5640	5680	5620		
Boxes not in control at time of test			NONE	VFD Hertz		69.0	Final Maximum Static Pressure Setpoint			2.40"W.C.
Boxes closed for diversity (if applicable)			NONE	Diversity CFM		0	Final Minimum Static Pressure Setpoint			1.20" W.C.

Terminal Boxes for Constant Volume and Variable Systems Chapter 8

Single Duct Constant Primary, Variable Secondary Bypass Systems
Single Duct Variable Primary, Constant Secondary Induction Systems
Single Duct Variable Primary/Constant Secondary Fan Powered Series Terminal Boxes
Variable Primary/ Variable Secondary Fan Powered Parallel Terminal Box
Dual Duct Terminal Boxes

TERMINAL UNIT CONTROL CONFIGURATION & SEQUENCE VERIFICATION

TERMINAL UNIT NUMBER	4	AUX TEMP AI3 (15)	OK
EQUIPMENT TAG	04-944-0056	CLG FLOW MIN (31)	0
CONTROL SYSTEM NAME	04.TEC.4408	CLG FLOW MAX (32)	1200
CONTROL SYSTEM ADDRESS (1)	11	FLOW COEFF (36)	0.71
SETPOINT CFM (MAX/MIN)	1200/0	MTR 1 TIMING (51)	90
ACTUAL CFM (MAX/MIN)	1200/0	MTR SETUP (58)	1
DISPLAY CFM (MAX/MIN)	1210/0	DUCT AREA (97)	0.775
DAY CLG STPT (06)	74 (default)		
RM STPT MIN (11)	70		
RM STPT MAX (12)	74	CONTROL SEQUENCE TYPE (SEE SEQUENCE SUMMARY	
RM STPT DIAL (13)		DATE OF INITIAL UNIT VERIFICATION	
STPT DIAL (14)	No (DEFAULT)	DATE OF CONTROL SEQUENCE VERIFICATION	

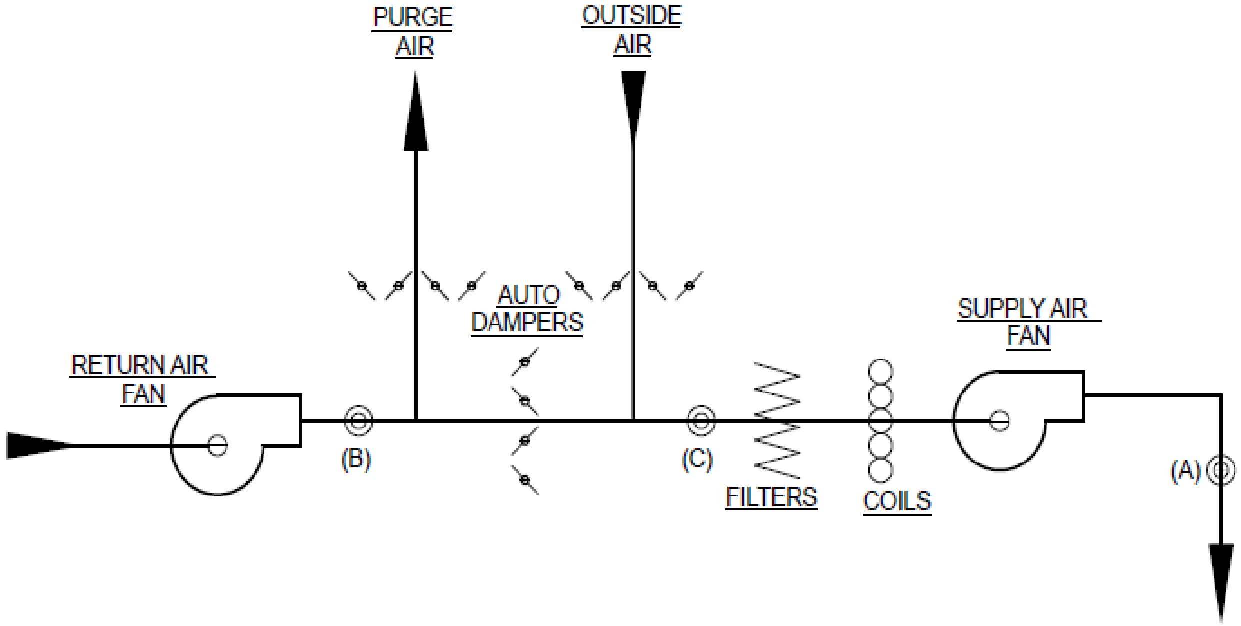
Variable Volume Chapter 9

Single Duct Air Valve with Variable Primary, Variable Secondary
Bypass Air Valve Constant Primary, Variable Secondary
Bypass System
Variable Primary/Constant Secondary Fan Powered Series Terminal Boxes
Variable Primary/Variable Secondary Fan Powered Parallel Terminal Box
Dual Duct Variable Volume
Fan ~~Wall~~ Array Systems
Underfloor Air Distribution Systems

Fan Systems: Supply/Return/Relief/Exhaust
Chapter 10

Air Handling Unit Systems

- Constant Volume Systems with Return Air Fans
- Variable Volume Systems with Return Air Fans
  - Fan Tracking
    - Volumetric Tracking
    - Plenum Pressurization Tracking

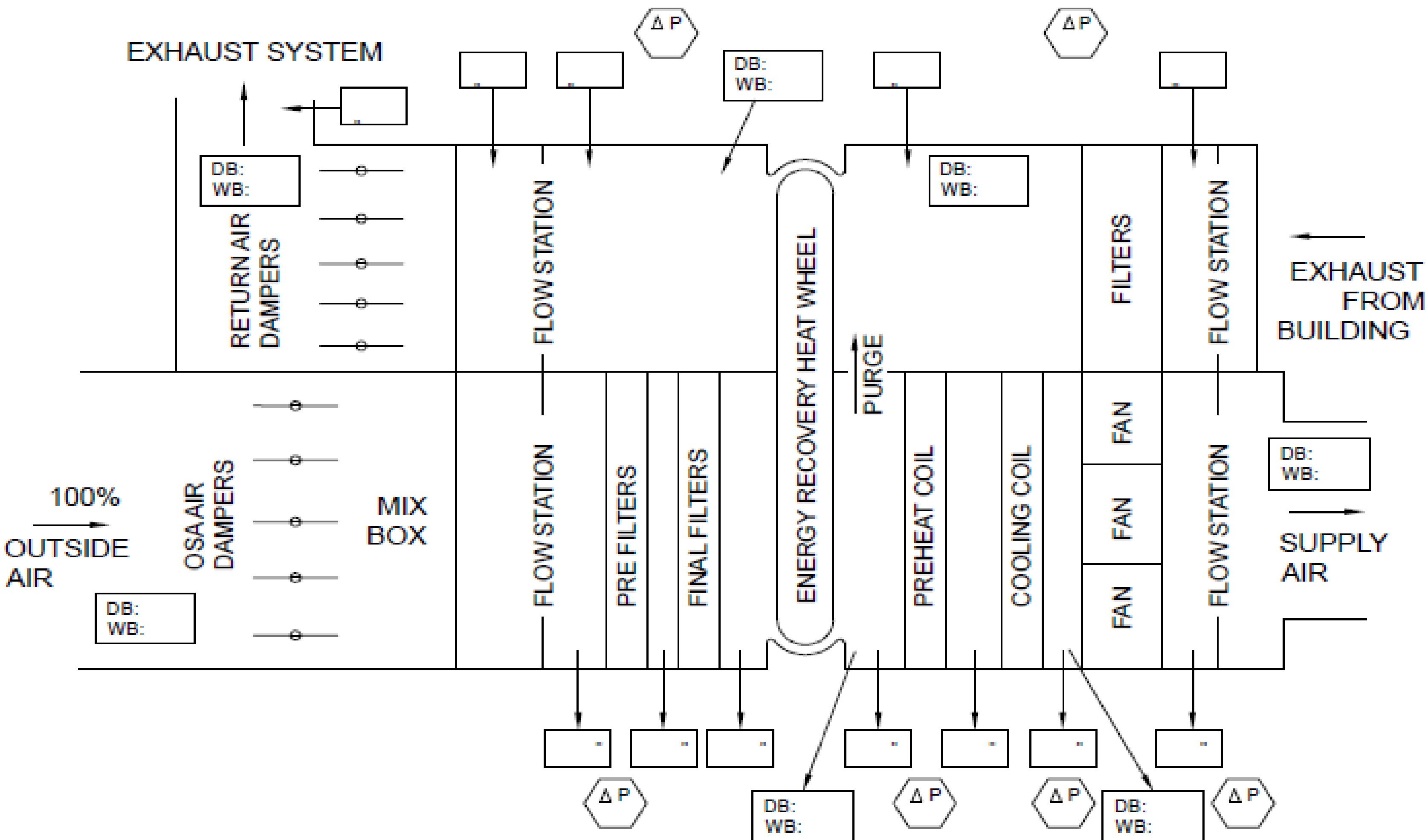


Fan Systems: Supply/Return/Relief/Exhaust
Chapter 10

        - Building Pressurization Tracking
    - Fan Staging
- Utility Vent Sets
- Tubular Centrifugal Fans
- Power Roof Ventilators
- Propeller Fans
- Axial Fans
- Variable Volume
- Manifold Systems

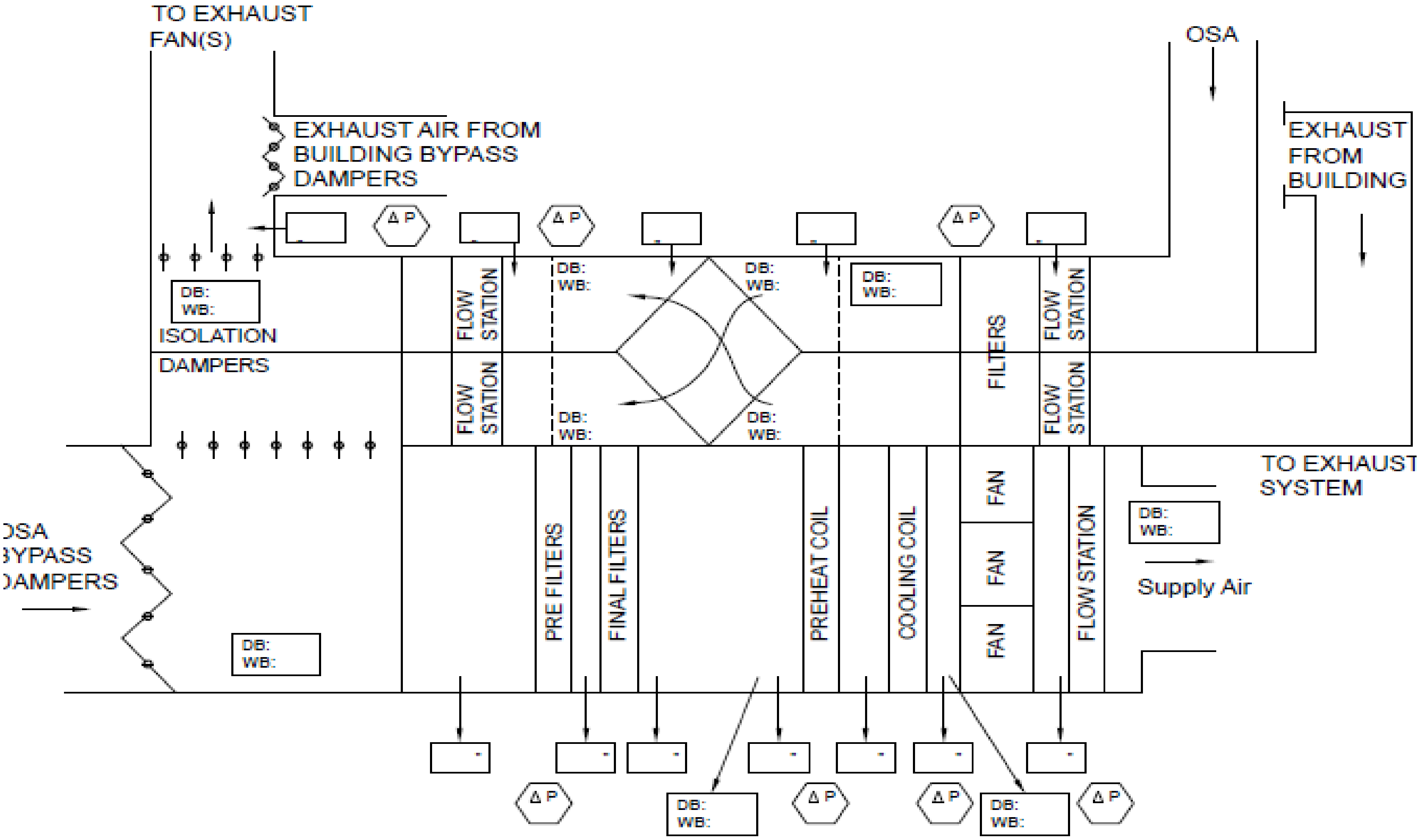
Energy Recovery Systems/Panels/Chilled Beams Chapter 11

Rotating Wheel and Rotating Desiccant Wheel



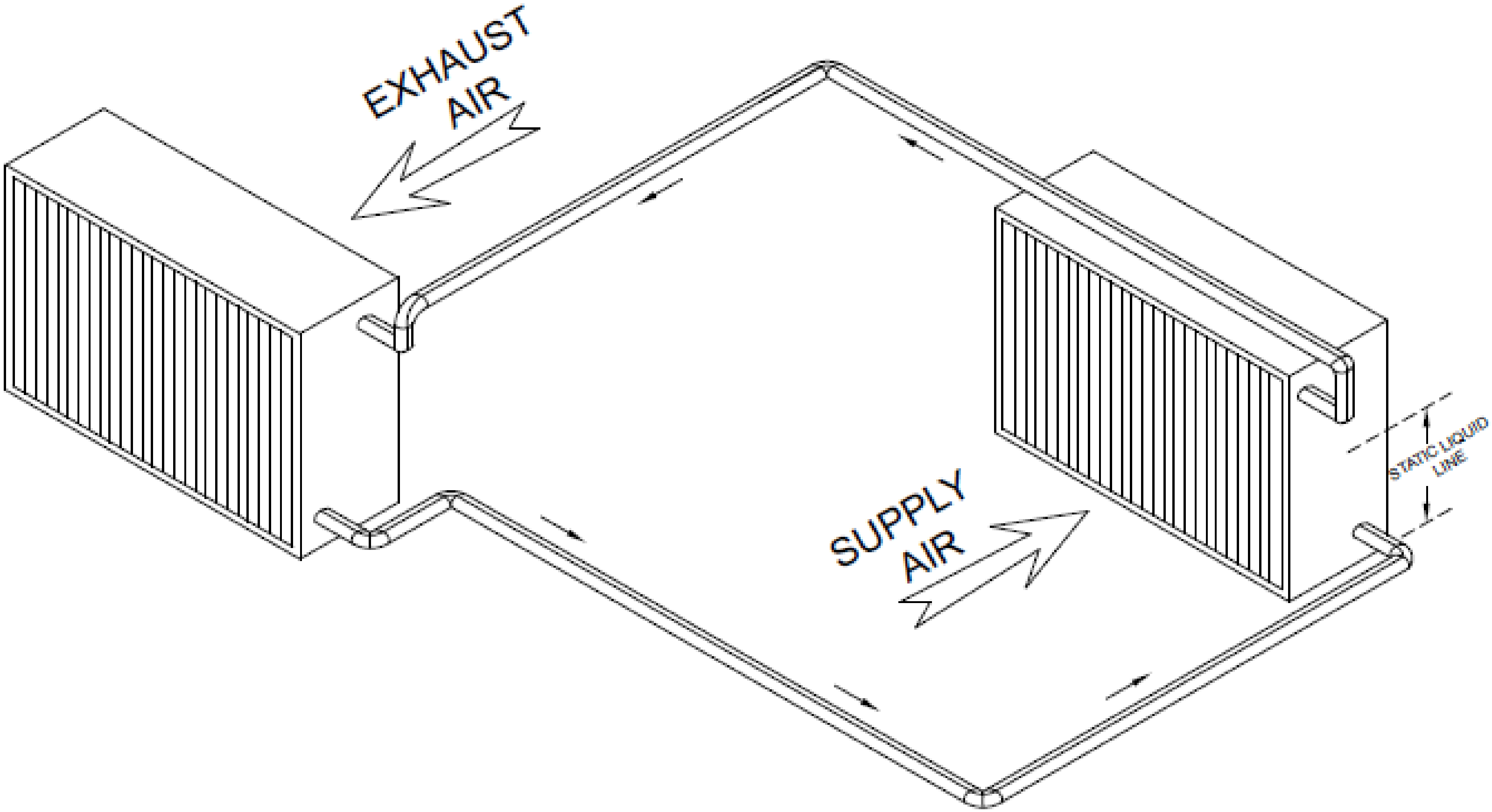
Energy Recovery Systems/Panels/Chilled Beams Chapter 11

Air-to-Air Plate Heat Recovery Units



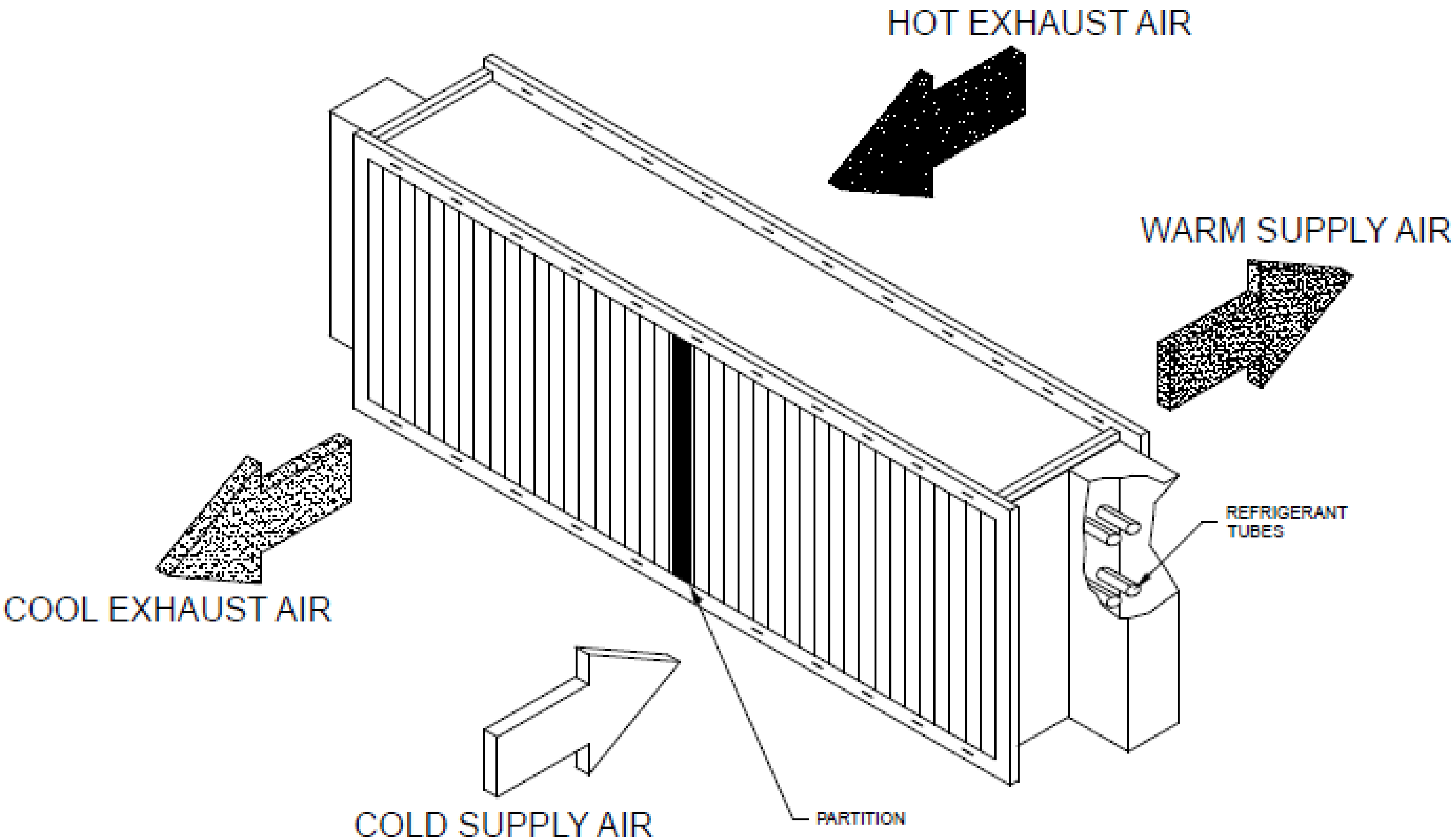
Energy Recovery Systems/Panels/Chilled Beams Chapter 11

Thermosiphon Heat Exchangers



Energy Recovery Systems/Panels/Chilled Beams Chapter 11

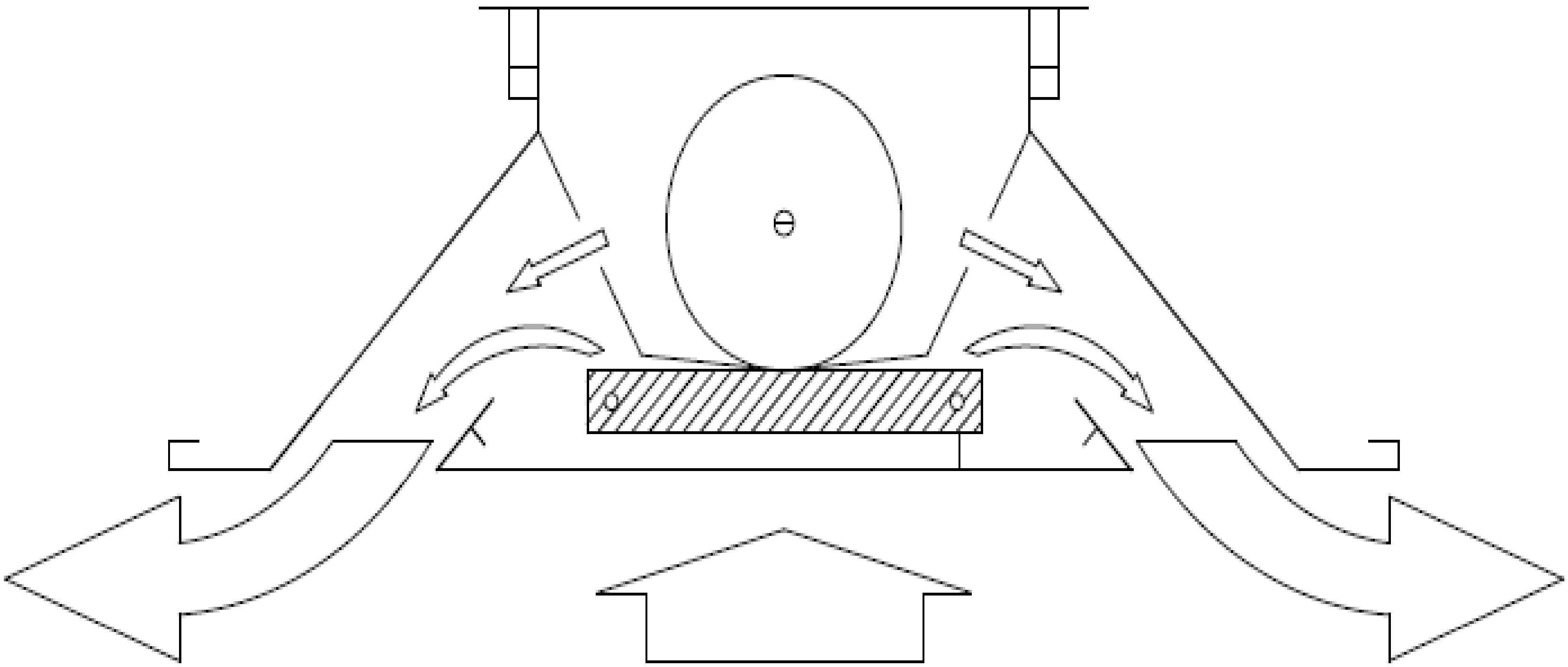
Run Around Coil



Energy Recovery Systems/Panels/Chilled Beams Chapter 11

Panels Used for Sensible Heating and Cooling

Chilled Beams



Temperature Control Systems Chapter 12

Responsibility of the TAB Agency is to set the controls to accomplish the Test and Balance Procedure and verifying the proper operation of the controls.

Basic Verification of Controls

- If the design documents do not require Total System Balancing or written verification, at a minimum the TAB agency shall:
  - Verify all hard wired safety-limiting controllers are calibrated, functional, and set at the required set point.
  - Verify all flow monitoring stations for air and water are properly calibrated and reading correctly.
  - Verify all temperature, humidity, and pressure sensors are properly calibrated and reading correctly.
  - Verify the controller set points meet the specification
  - Confirm that the sequences of operation for all control modes are in compliance with the final approved submittal.
  - Verify the settings and operation of end switches, pressure-electric switches, solenoid valves, contactors, etc.

Temperature Control Systems Chapter 12

- Check the operation of lockout or interlock systems.
- Check the operation of all control valve and damper actuators, Verify the valve or damper opens and closes 100%.
- Determine all controlled devices are properly connected.
- Confirm that all controlled devices are in the position indicated by the controller.
- Test the fail-safe modes of all controlled devices.
- Verify simultaneous heating and cooling does not occur.

Temperature Control Systems Chapter 12

- Verify all sensors are installed as shown on the contract documents.
- Check the location and installation of all sensors to determine if they will sense only the intended temperature, humidity, or pressure.

Verification and Documentation

- Control Sequences
  - Air Handling Units
    - Start each air handling, verify and document:
    - Shut down each air handling, verify and document:
  - Fan Systems
  - Hydronic Systems
- Component Calibration

Temperature Control Systems Chapter 12
Sensor Calibration and Control Point Verification Data

UNIT NO.	DDC POINT	PT 2 PT	DDC VALUE	ACTUAL VALUE	DATE	REMARKS
AHU-11	C.127.08.AHU.11.1.SS (SS)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.1.STAT (STAT)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.2.SS (SS)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.2.STAT (STAT)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.3.SS (SS)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.3.STAT (STAT)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.4.SS (SS)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.4.STAT (STAT)	OK	On/Off	On/Off	11-25-14	
AHU-11	C.127.08.AHU.11.CHW.VLV (CHW VLV)	OK	0-100%	0-100%	11-25-14	
AHU-11	C.127.08.AHU.11.DA.DPR.ES (DPR ES)	OK	Open/Close	Open/Close	4-17-15	
AHU-11	C.127.08.AHU.11.DA.SP (DA SP)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.DA.SP.HI.ALM (SP HI ALM)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.DA.SP.STPT (SP STPT)	OK			11-25-14	

CONTINUING EDUCATION AIA

Temperature Control Systems Chapter 12
Sensor Calibration and Control Point Verification Data

UNIT NO.	DDC POINT	PT 2 PT	DDC VALUE	ACTUAL VALUE	DATE	REMARKS
AHU-11	C.127.08.AHU.11.DA.TMP (CLG TMP)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.DA.TMP.STPT (DAT STPT)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.DA.TMP.UNOC.SP (UNOCC DAT ST)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.DOOR.SW (DOOR SW)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.DPR.ES.ALM (DPR ES ALM)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.FIRE.ALM (FIRE ALM)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.FNL.FIL (FNL FIL)	OK	Normal/Alarm	Normal/Alarm	11-25-14	Set @ 1.50 IWC
AHU-11	C.127.08.AHU.11.HSP (HSP)	OK	Normal/Alarm	Normal/Alarm	11-25-14	Set @ +6.00 IWC
AHU-11	C.127.08.AHU.11.LSP (LSP)	OK	Normal/Alarm	Normal/Alarm	11-25-14	Set @ -4.00 IWC
AHU-11	C.127.08.AHU.11.OA.CFM (VIR OA CFM)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.OA.CFM.LO.ALM (CFM LO ALM)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.OA.CFM.STPT (VIR OA CFM STPT)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.OA.DP (OA DP)	OK			11-25-14	

CONTINUING EDUCATION AIA

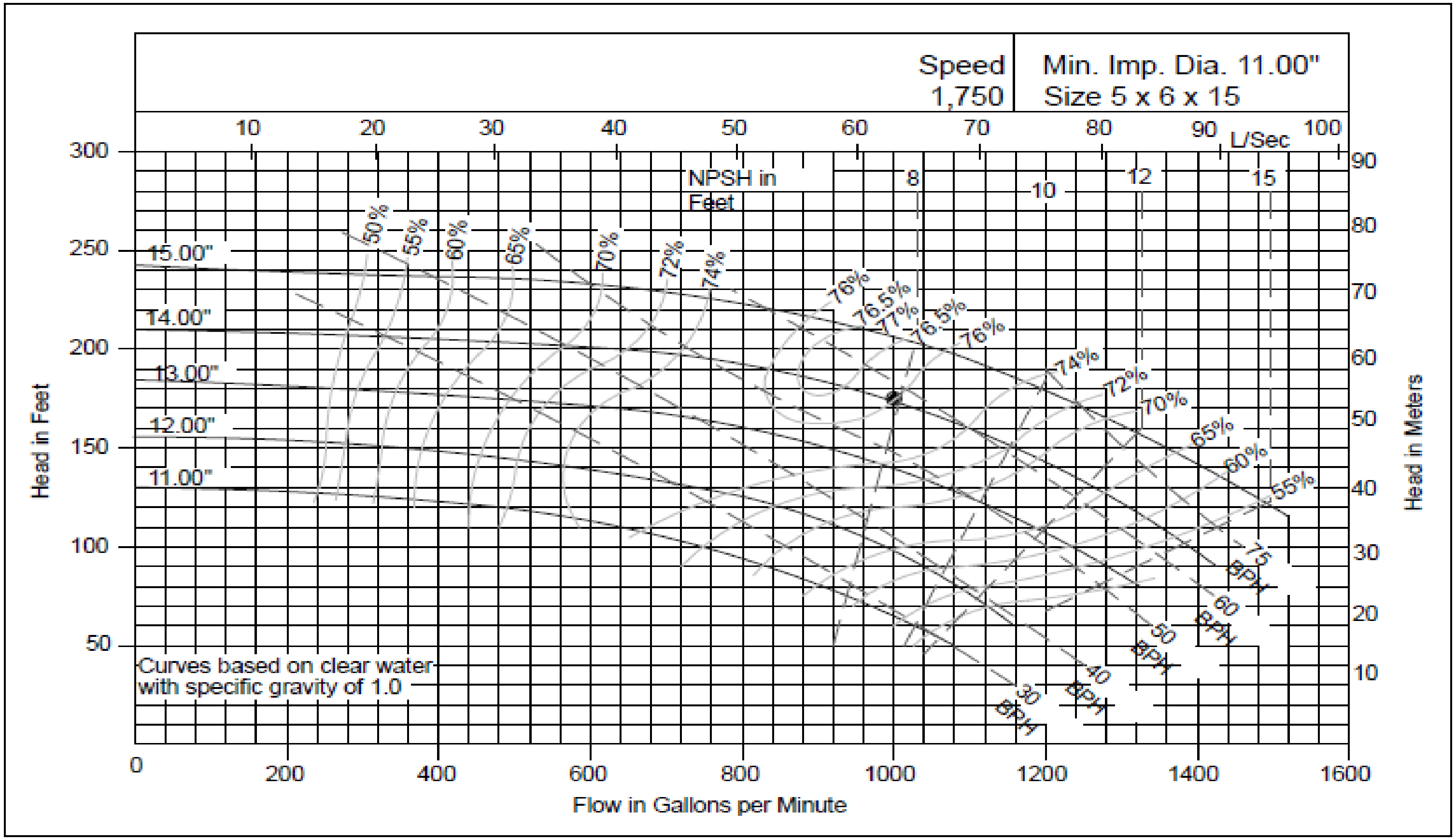
Temperature Control Systems Chapter 12
Sensor Calibration and Control Point Verification Data

UNIT NO.	DDC POINT	PT 2 PT	DDC VALUE	ACTUAL VALUE	DATE	REMARKS
AHU-11	C.127.08.AHU.11.OA.DPR (OA DPR)	OK	0-100%	0-100%	11-25-14	
AHU-11	C.127.08.AHU.11.OA.DPR .ES (DPR ES)	OK	Open/Close	Open/Close	11-25-14	
AHU-11	C.127.08.AHU.11.OA.DPR .MIN (OA DPR MIN)	OK			11-25-14	
AHU-11	C.127.08.AHU.11.OC	OK	Occ/Unocc	Occ/Unocc	11-25-14	
AHU-11	C.127.08.AHU.11.PRE.FIL (PRE FIL)	OK	Normal/Alarm	Normal/Alarm	11-25-14	Set @ 0.60 IWC
AHU-11	C.127.08.AHU.11.RA.DPR .ES (DPR ES)	OK	Open/Close	Open/Close	4-17-15	
AHU-11	C.127.08.AHU.11.VSD.1.F AL (FAULT)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.VSD.1.S PD (SPEED)	OK	0-100%	0-100%	11-25-14	
AHU-11	C.127.08.AHU.11.VSD.2.F AL (FAULT)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.VSD.2.S PD (SPEED)	OK	0-100%	0-100%	11-25-14	
AHU-11	C.127.08.AHU.11.VSD.3.F AL (FAULT)	OK	Normal/Alarm	Normal/Alarm	11-25-14	
AHU-11	C.127.08.AHU.11.VSD.4.S PD (SPEED)	OK	0-100%	0-100%	11-25-14	

Hydronic Pumps and Pumping Circuits
Chapter 13

Pump Head Measurement

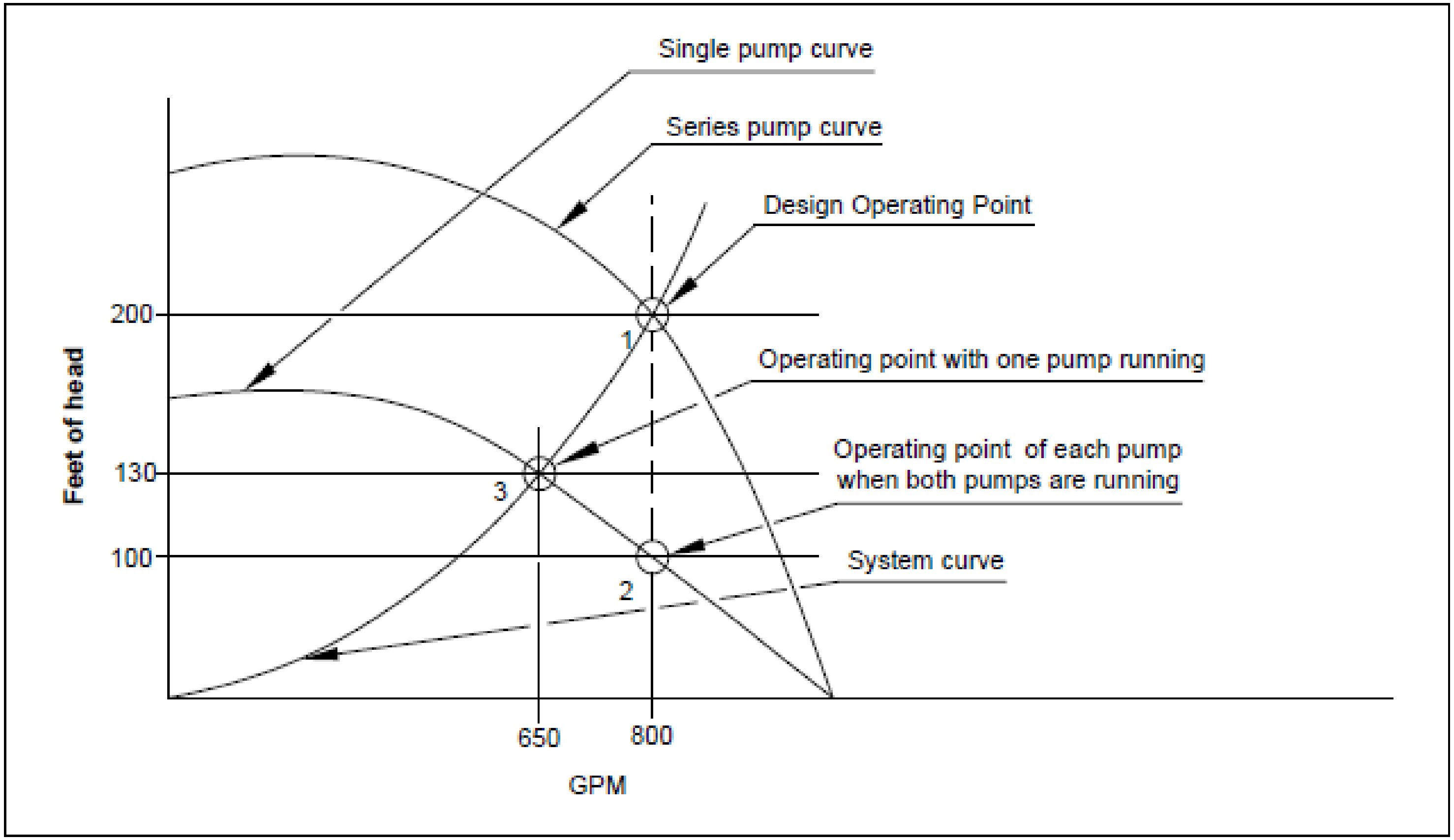
Verification of Impeller Size 210' Shut-off at 175' Operating Head and under operating 75 HP to be non-overloading



Hydronic Pumps and Pumping Circuits
Chapter 13

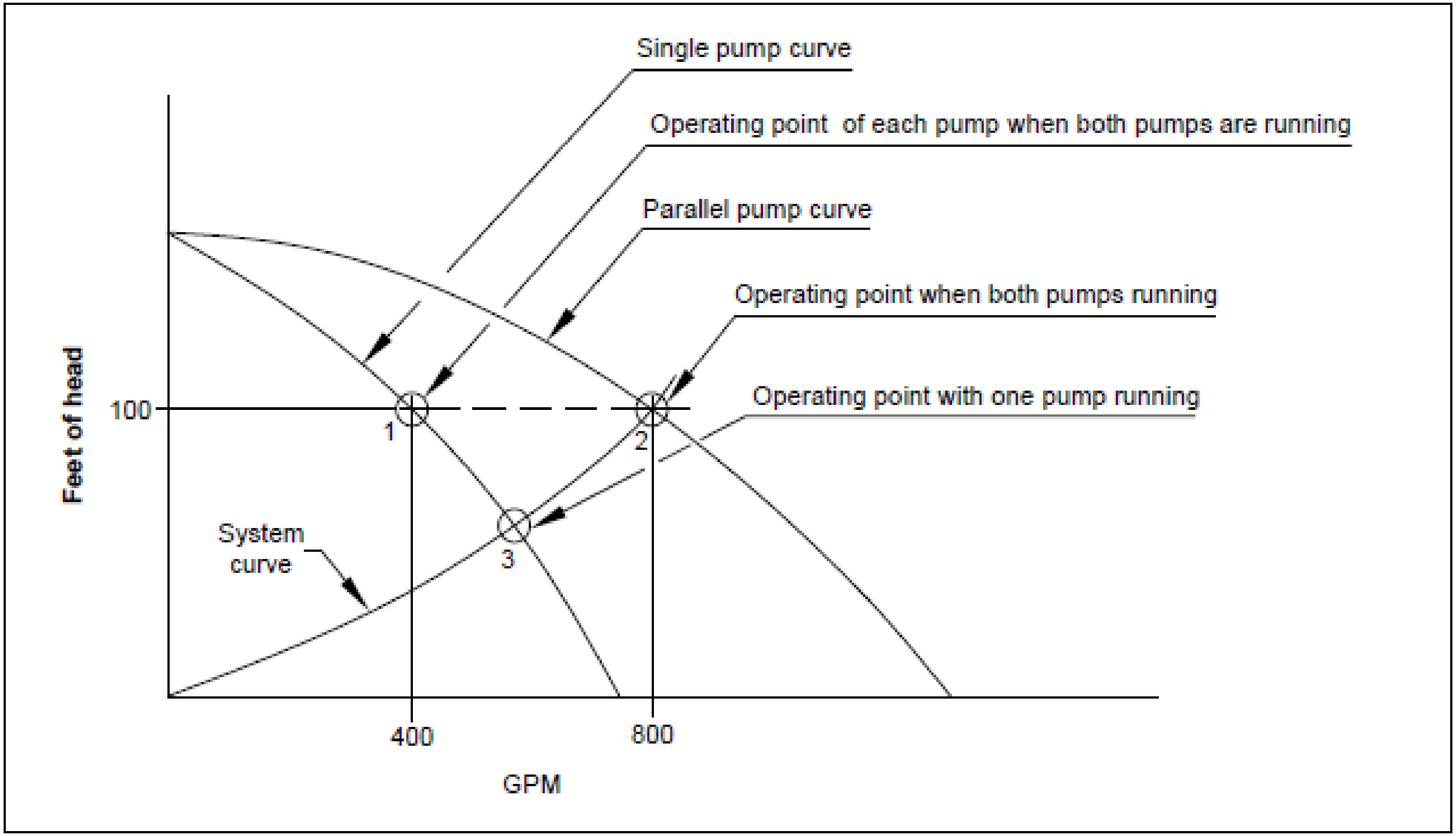
Determine Pump Flow

- Centrifugal Pump Performance
- Series Pump System Curves



Hydronic Pumps and Pumping Circuits
Chapter 13

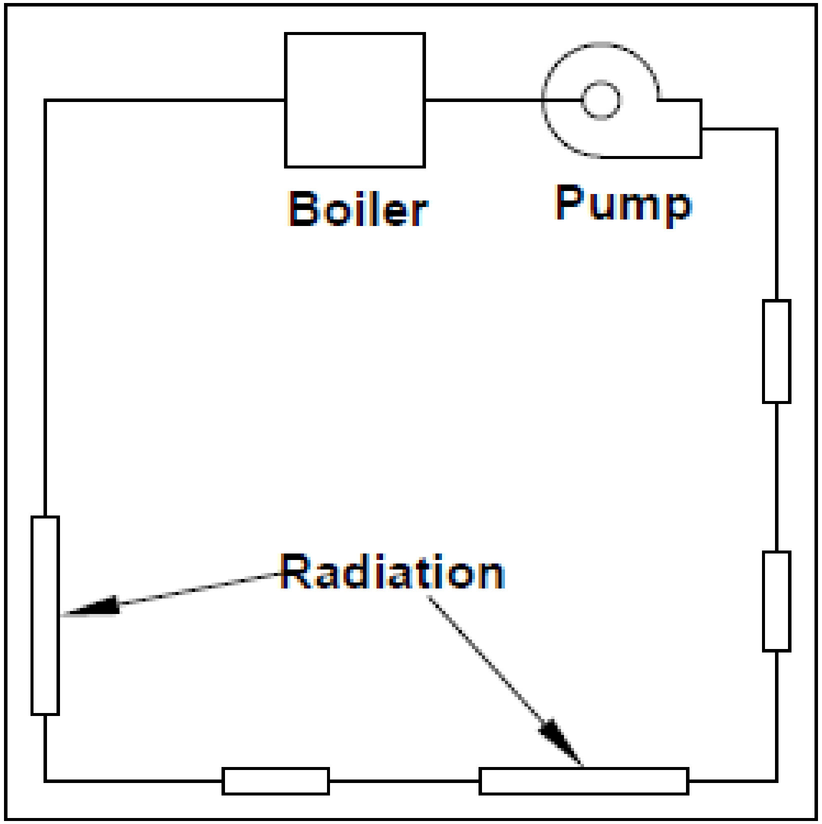
Parallel Pump System Curve



Hydronic Pumps and Pumping Circuits
Chapter 13

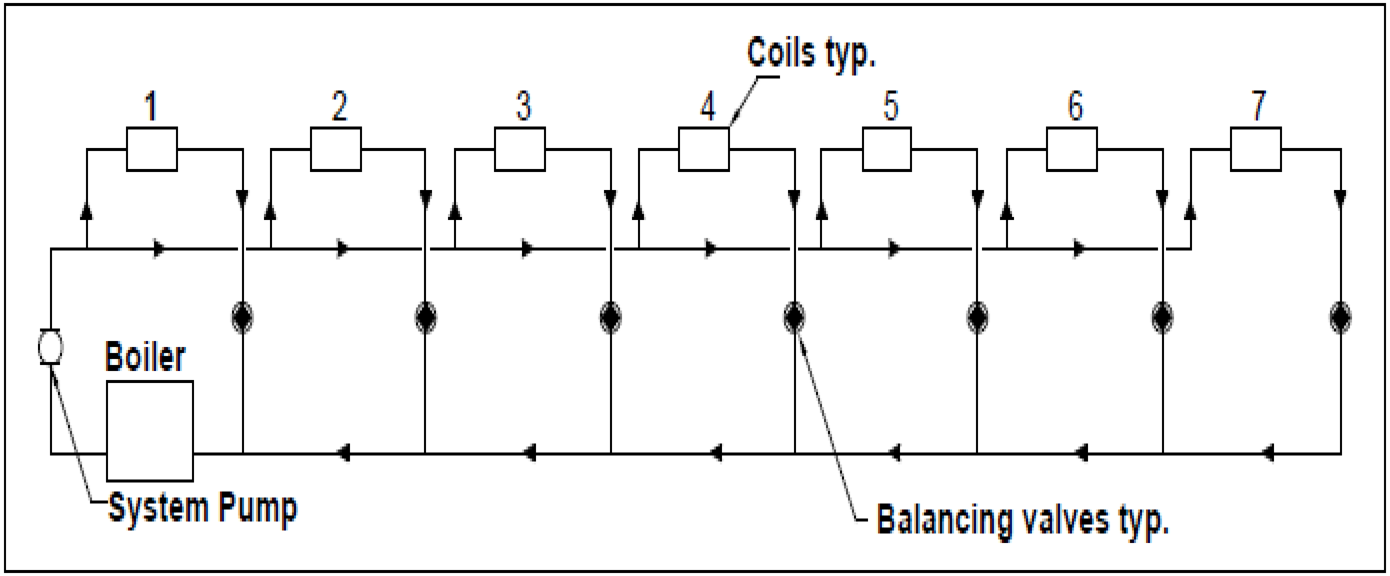
Piping Circuits

- Series Loop



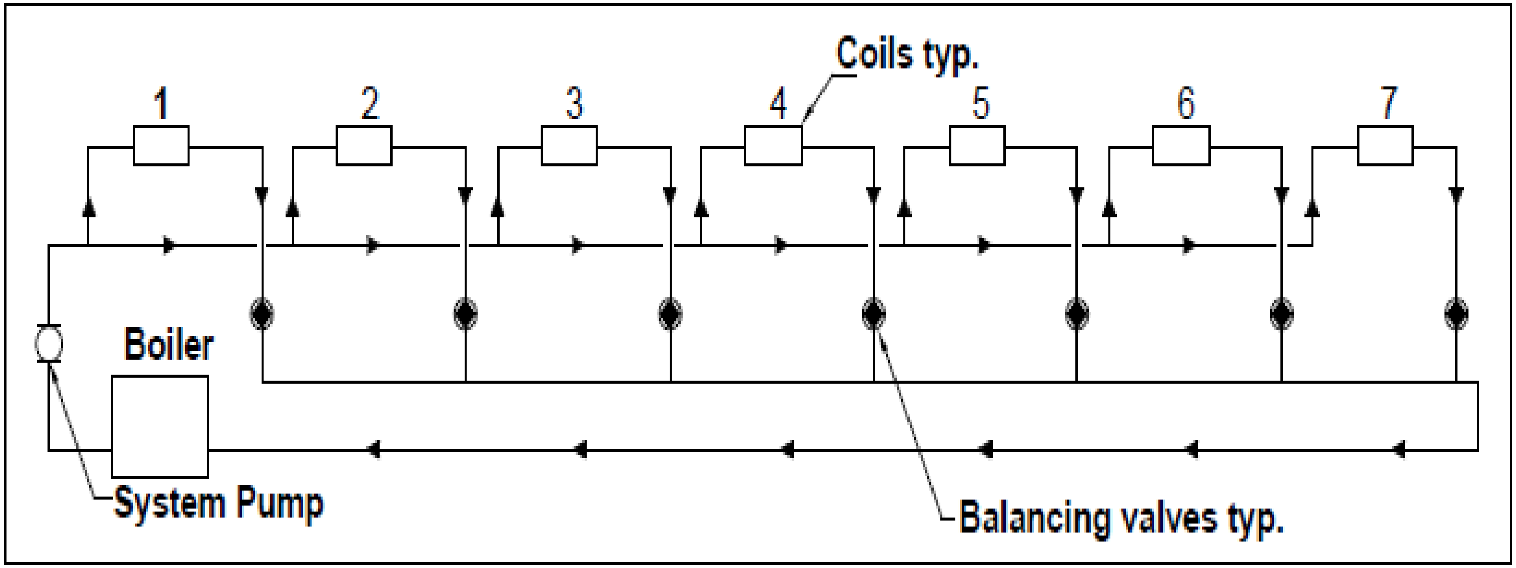
Hydronic Pumps and Pumping Circuits
Chapter 13

- Two-Pipe Direct Return



Hydronic Pumps and Pumping Circuits
Chapter 13

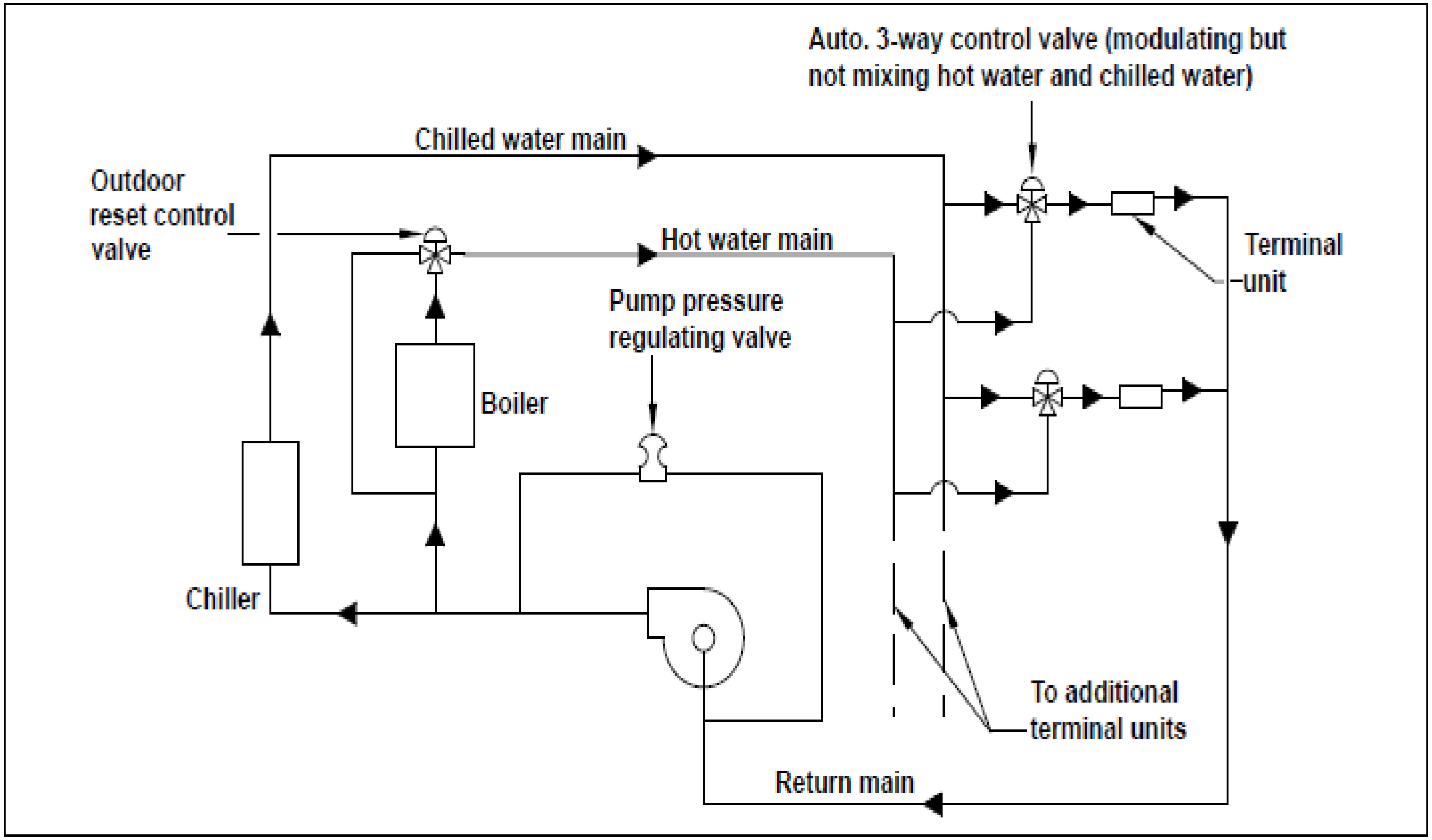
- Two Pipe Reverse Return System



Hydronic Pumps and Pumping Circuits
Chapter 13

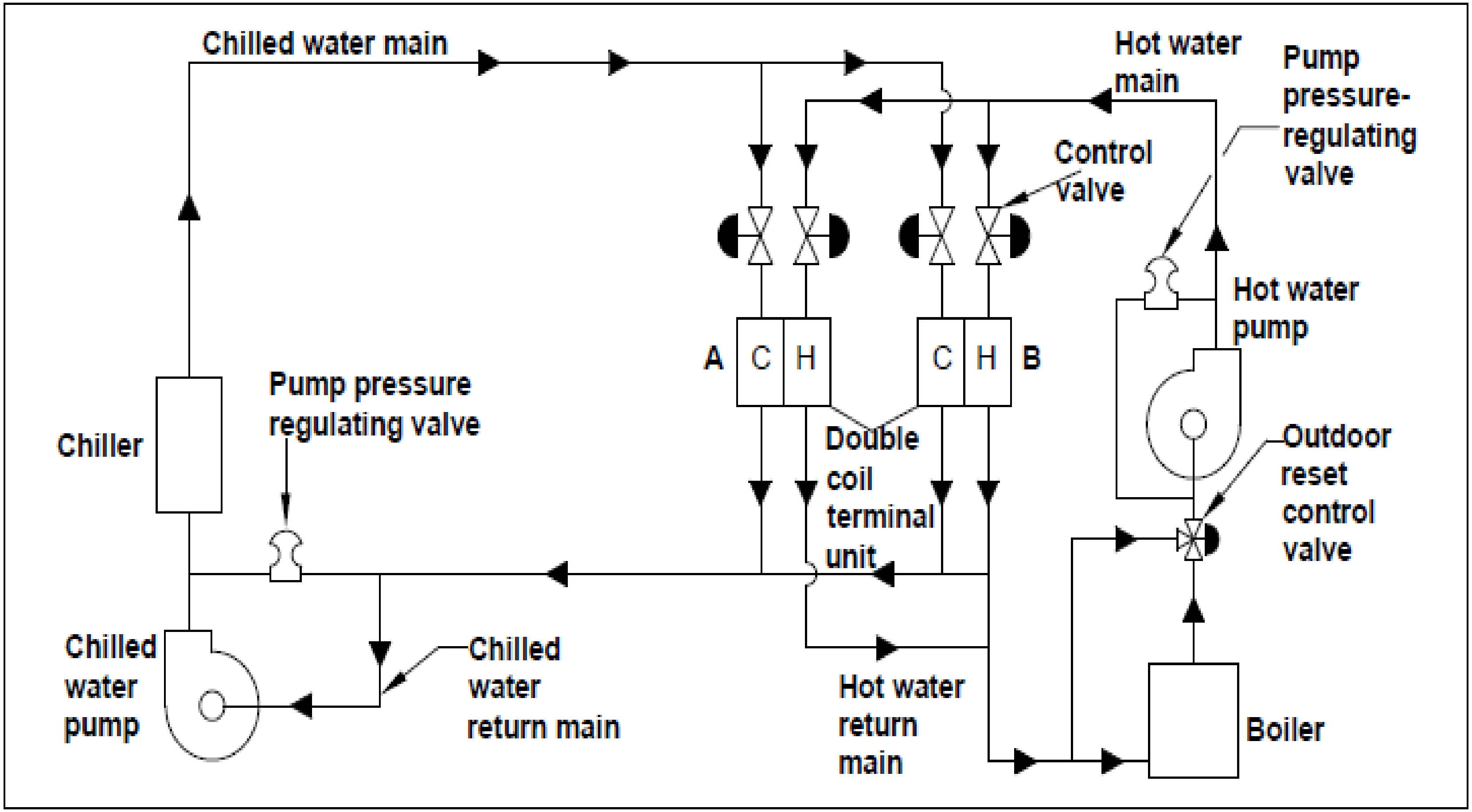
Combination Piping Circuits

- Three-Pipe Main



Hydronic Pumps and Pumping Circuits
Chapter 13

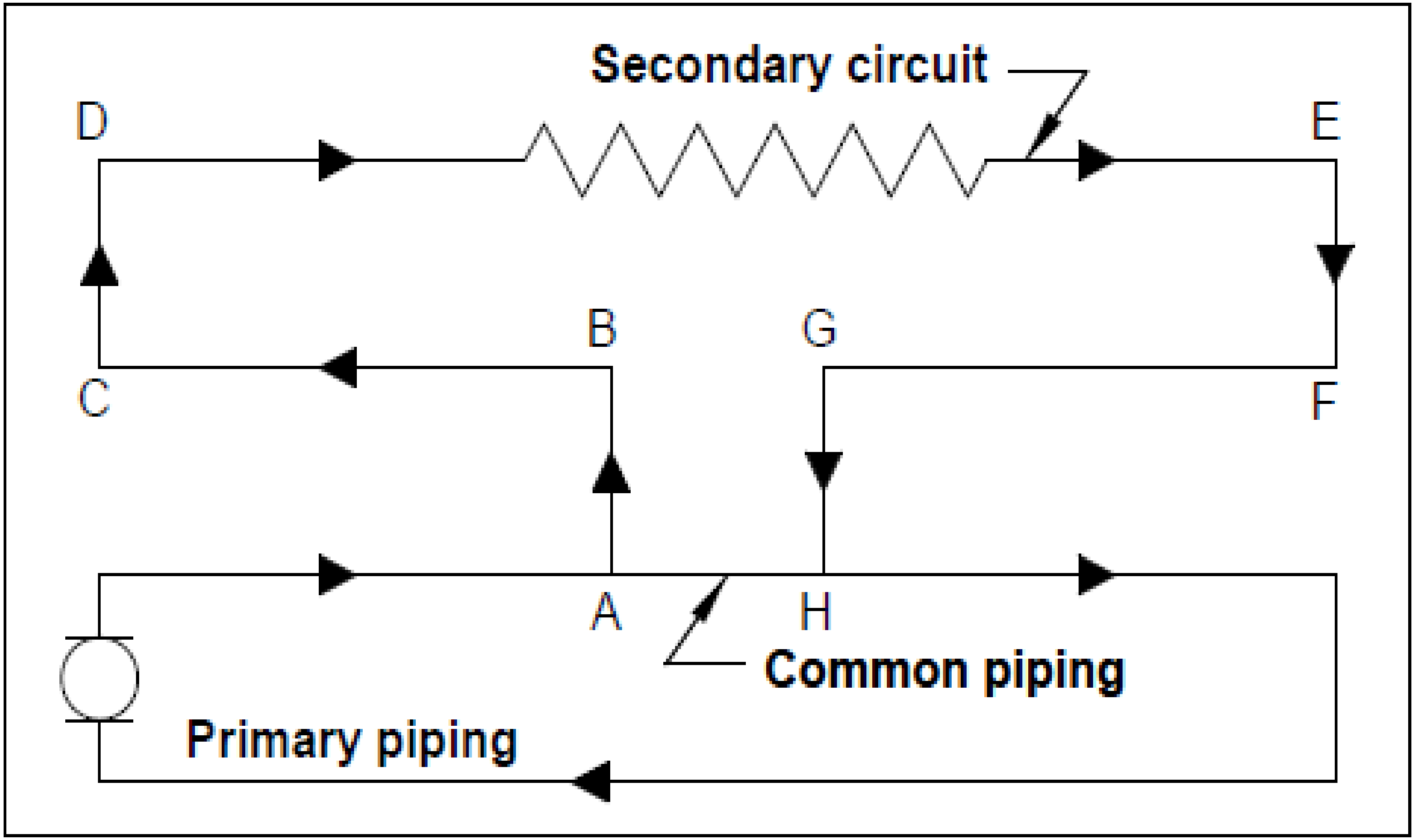
- Four Pipe Main



Hydronic Pumps and Pumping Circuits
Chapter 13

Pump Circuits

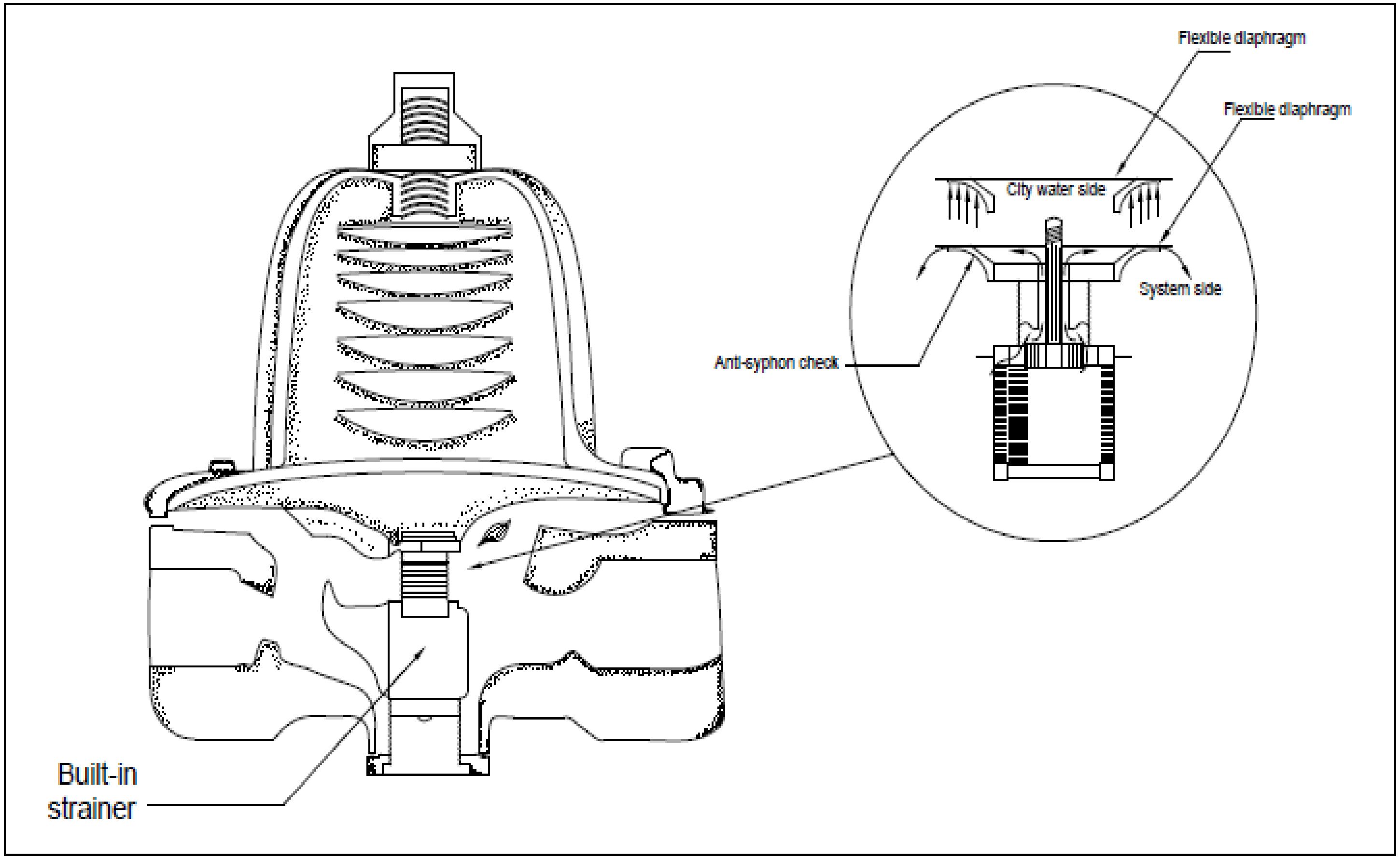
- Primary Secondary



Hydronic Devices Chapter 14

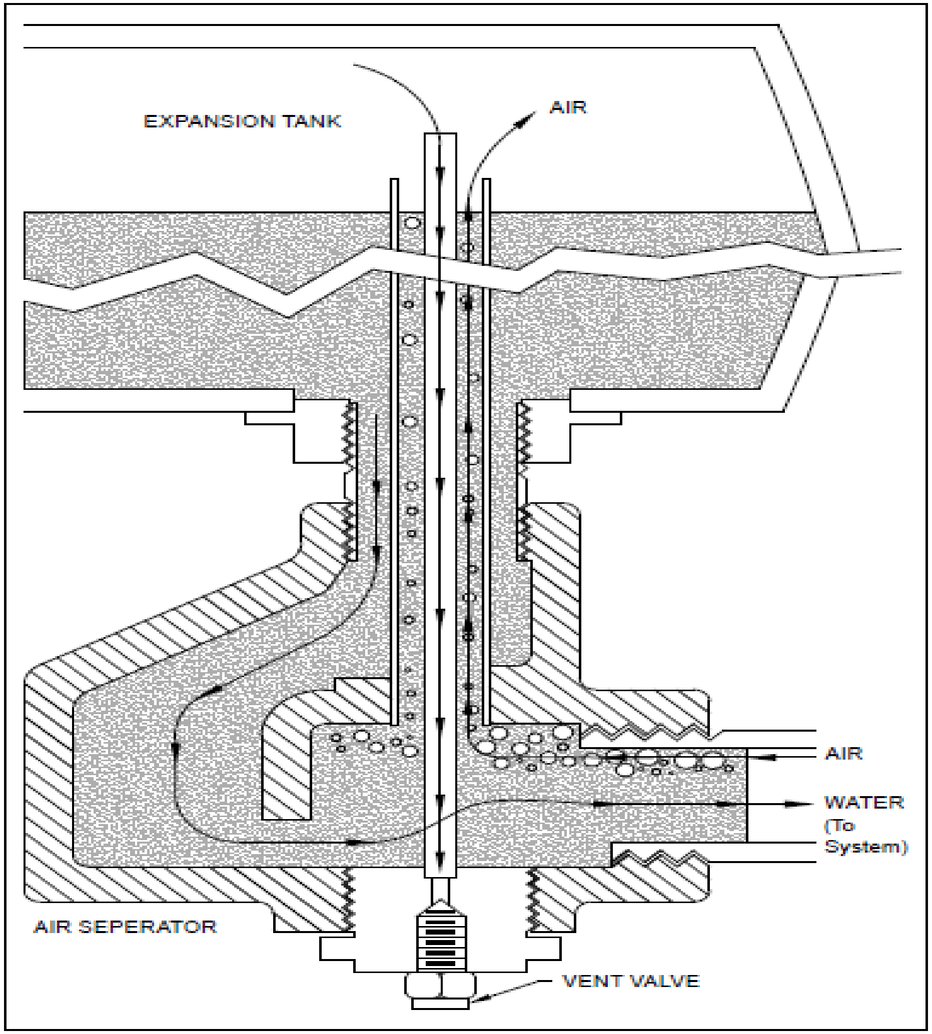
Pressure Control

- Pressure Reducing Valves (PRV)



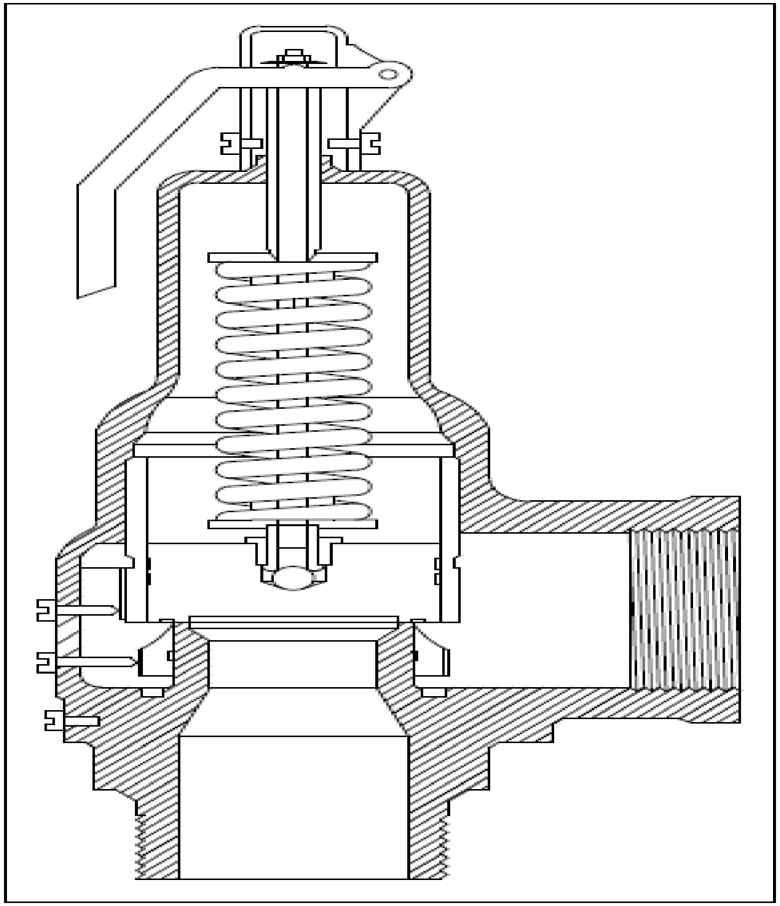
Hydronic Devices Chapter 14

- Expansion or Compression Tanks



Hydronic Devices Chapter 14

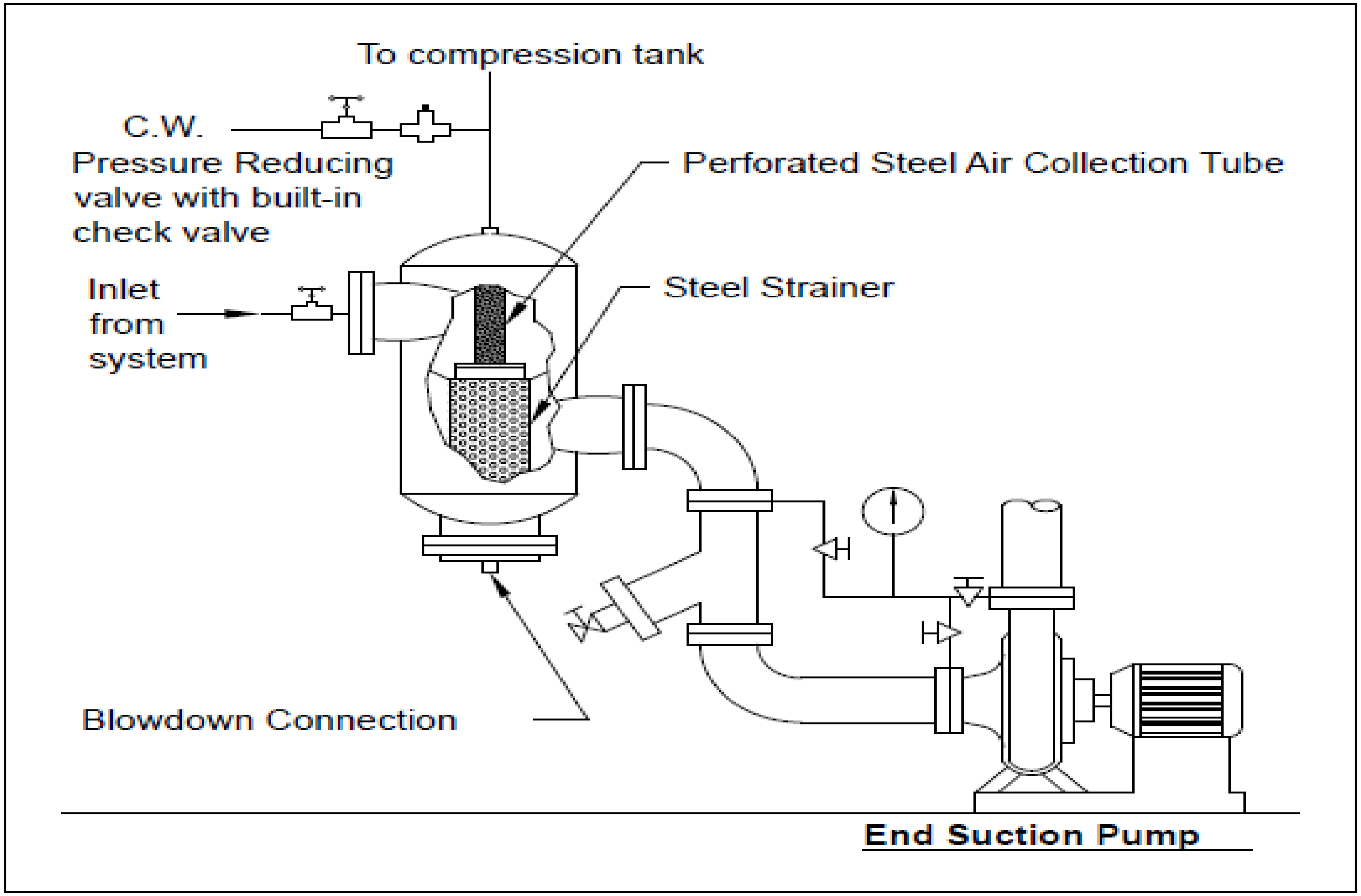
Pressure Relief Valves



Hydronic Devices Chapter 14

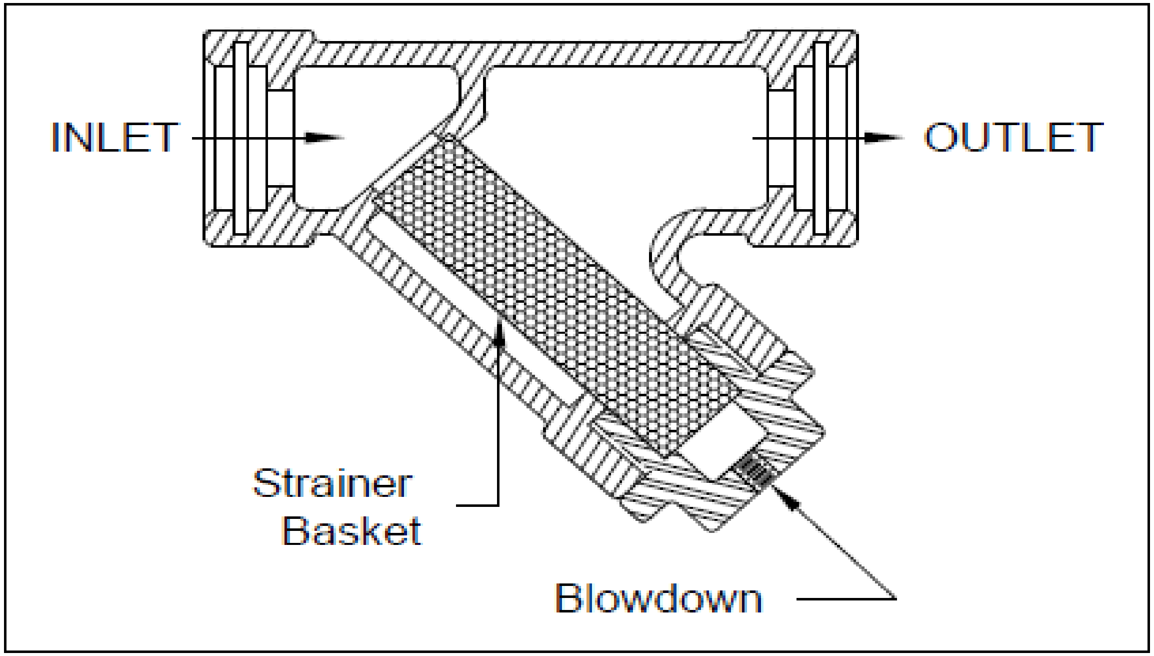
Air Control

- Air Vents
- Air Separators



Hydronic Devices Chapter 14

Strainers



Hydronic Devices Chapter 14

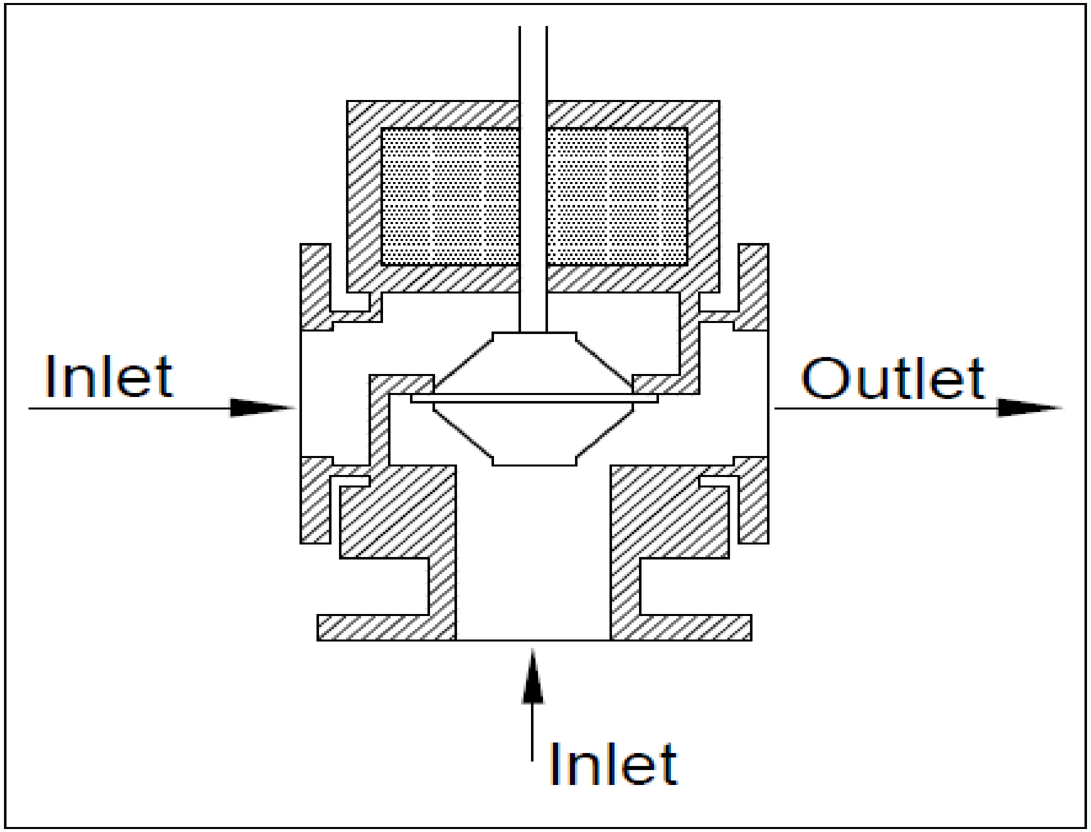
Valves

- Gate Valve
- Globe Valve
- Plug Valve
- Valve Throttling Characteristics
- Ball Valve
- Butterfly Valve
- Check Valve
- Combination Valve

Hydronic Devices Chapter 14

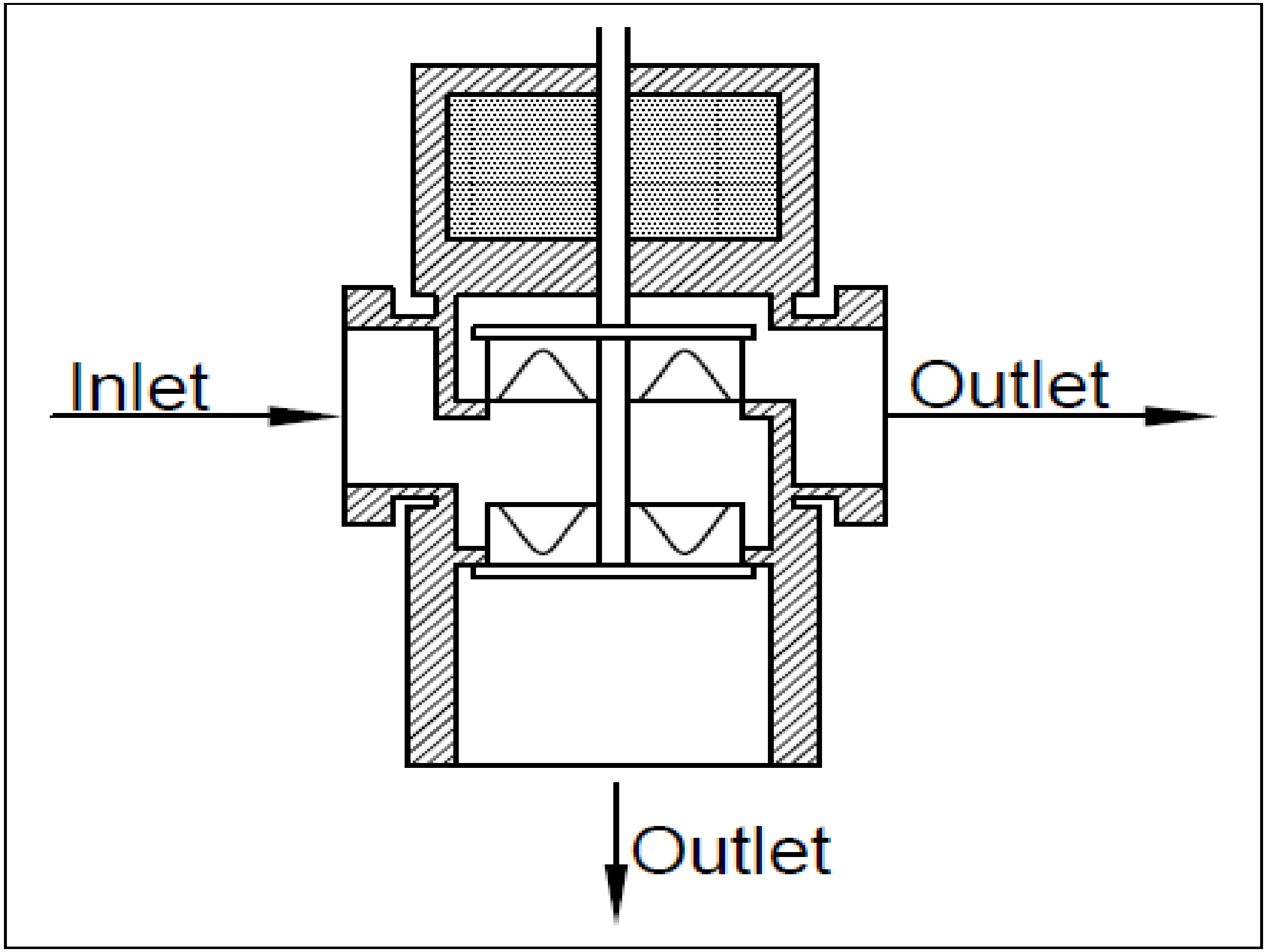
Automatic Valves

- Two-Way Valve
- Three-Way Valve
  - Three-Way Mixing Valve



Hydronic Devices Chapter 14

- Three-Way Diverting Valve



Hydronic Devices Chapter 14

Heat Transfer Devices

- Heat Exchangers
  - Shell and Tube
  - U Tube
  - Helical
  - Plate
  - Water Coil
  - Thermometer Well
  - Pressure/Temperature Taps

Hydronic Devices Chapter 14

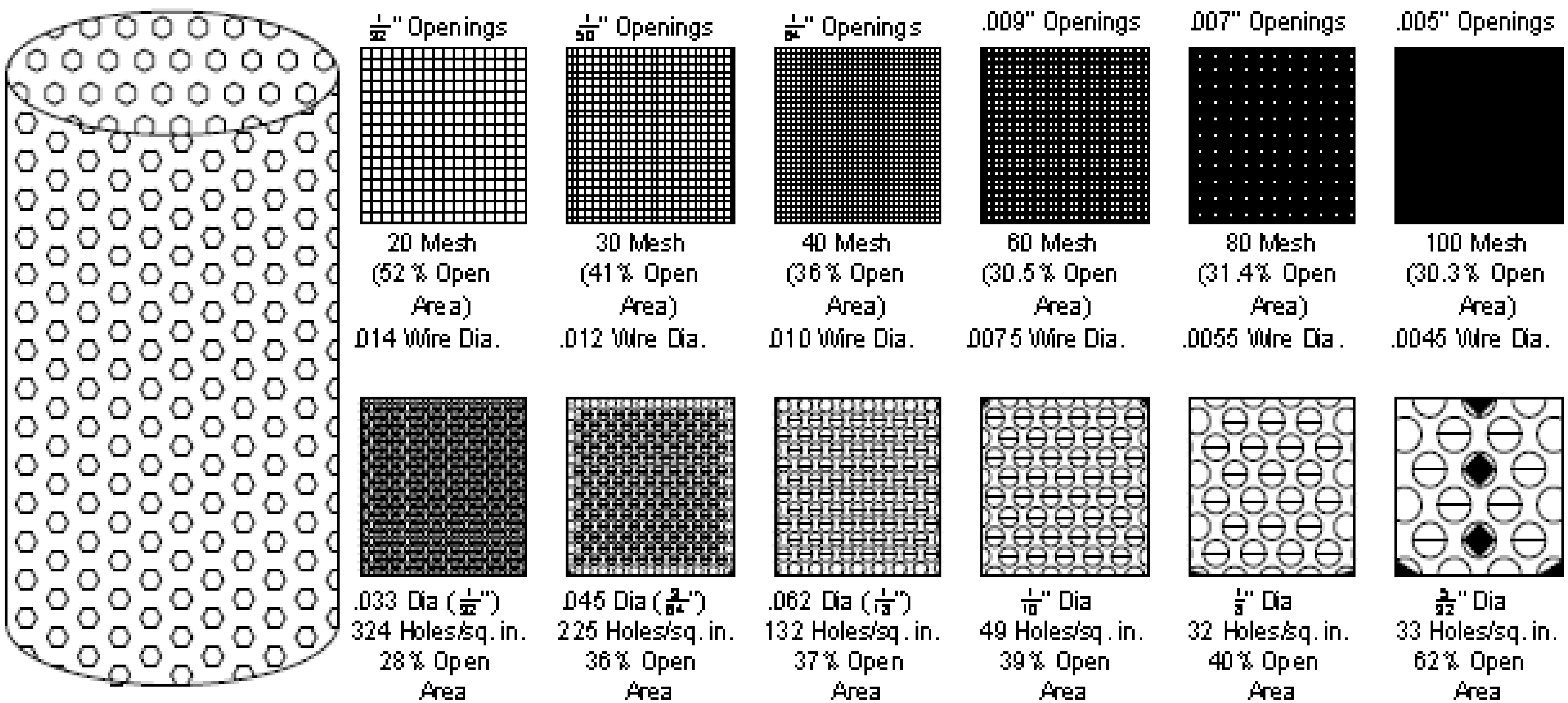
Hydronic Flow Measuring

- Orifice Plate
- Venturi
- Hydronic Pitot Tube Traverse
- Calibrated Balancing Valves
- Spring-loaded Constant Flow Devices

Hydronic Procedures Chapter 15

Hydronic System Readiness- the following shall be verified:

- Construction Strainers have been removed and replaced with per



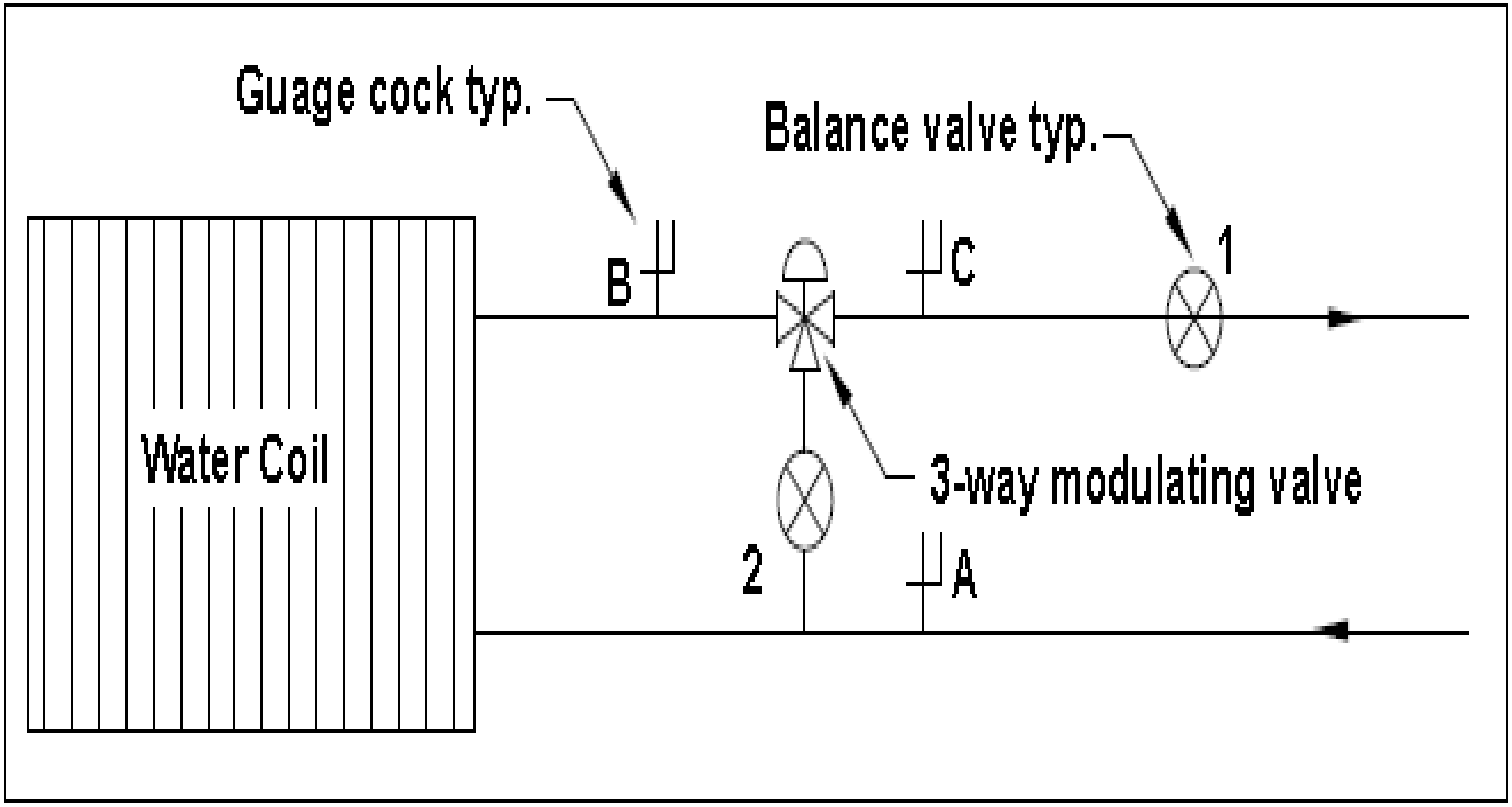
Hydronic Procedures Chapter 15

- All valves are open or set to their normal positions.
- All temperature and volume controls have been installed and are fully functional.
- Air has been purged from the system.
- Measure and record the PRV pressure with the system at rest.
- Measure and record the pressure at the highest point in the system with the system at rest (suggest 5-10 PSI [34.5 – 68.9 KPa]).

Hydronic Procedures Chapter 15

- Expansion or Bladder tank is properly set.

Constant Volume Water Balance Procedure (Two-Pipe System, Direct or Reverse Return)



Hydronic Procedures Chapter 15

Variable Volume Water Balancing Procedure

- Proportioning
  - Determine if the system has diversity by totaling all the coil maximum design GPM, if the coil GPM is greater than the pumping capacity or heat exchanger, the difference is the diversity flow. Coils closest to the pump should have their valves closed to simulate the diversity allowing the system to be proportioned at 100% flow

Capacity Testing

- Performance Test of Water Cooled Liquid Chilling Systems
- Performance Test of Air Cooled Chillers
- Performance Test of Air Cooled Chiller Without the Condenser

Chiller Testing Chapter 16

Basic Testing

- Water Cooled Chiller
- Air Cooled Chiller
- Air Cooler Chiller With Remote Condenser(s)
- Air Cooled Condenser

Field Performance Testing of Chillers

Performance

Cooling Tower Testing Chapter 17

Basic Test

- Tower Designation
- Manufacturer
- Model number and serial number
- Rated capacity in tons
- Fan motor nameplate data with actual amps and volts, calculated brake horsepower
- Design and Actual RPM
- Design and Actual flow of the water
- Design and Actual entering water temperatures
- Design and Actual leaving water temperatures
- Design and Actual entering wet bulb
- Design and Actual ambient dry bulb

CONTINUING EDUCATION AIA

Cooling Tower Testing Chapter 17

Performance Test Parameters for both AABC and CTI

- General Procedures
- Instrumentation
- Report of Results
- Evaluating the Test

AABC Performance Test

- AABC Test Procedure
- Analysis of the test data
- Cooling Tower Terms

CTI Performance Test

- Inlet air temperature measurements
- Water flow rate measurement
- Fan motor power
- Wind velocity
- Test Data

Evaluation by Performance Curve Method

Boiler Testing Chapter 18

Basic Test for Hot Water Boilers

Boiler Performance Calculations

- Water Boilers
- Steam Boilers

Efficiency Test

- Combustion Testing
- Overall Efficiency
- Seasonal Efficiency

Boiler Testing Procedure

Domestic Water Balance & Procedures
Chapter 19

Domestic hot water preparation may include reviewing the project documents and setting up data sheets. The procedures will include conducting on-site inspections, gathering data during TAB procedures, and final field observations.

The typical domestic water system may include one or more of the following:

Hot Water Heaters

Hot Water Return Circulation Pump

Thermal Mixing Valves

Pressure Reducing Valves

Kitchen Systems Chapter 20

Kitchen Systems

- Heating, Cooling and Ventilating System
  - The Restaurant HVAC systems supply outdoor air adequate to:
    - Meet occupant ventilation requirements
    - Replace 100% of air exhausted from the restaurant thru hoods and/or general ventilation such as restroom exhaust.
    - Maintain design pressures to atmosphere and differential pressures between customer areas and production areas such as dining and cooking, dishwashing, serving, etc.

Kitchen Systems Chapter 20

- Replacement Air sources may include:
  - Transfer Air – Conditioned outdoor air supplied to spaces such as dining rooms to meet occupant ventilation requirements then transferred to production areas to aid in the conditioning of those areas and to replace some or all of the air exhausted from those areas. This air is typically introduced thru conventional Roof Top Units (RTU). Care should be exercised to not exceed the outdoor air capacity of the RTU which is typically 20 – 30% of unit airflow.

CONTINUING EDUCATION AIA

Kitchen Systems Chapter 20

- Kitchen Supply – Conditioned outdoor air supplied directly to production areas to condition the space, and to replace air exhausted from those areas. This air may be introduced through a conventional (RTU) or a Dedicated Outdoor Air Unit (DOAS Unit), which is designed to condition 100% outdoor air. ASHRAE Standard 154 "*Ventilation for Commercial Cooking Operations*" Appendix A Figure A-2 provides an air balance schematic showing the DOAS Unit system as a restaurant best practice example.

Kitchen Systems Chapter 20

Kitchen Hoods

- Type 1 Hood are used for the removal of grease and smoke. Type I Hoods are required over kitchen equipment that produce smoke or grease laden vapors such as a fryer, broiler, griddle, ranges, etc.

  There are two categories of Type I Hoods: non-listed hoods that are not allowed to have fire-actuated exhaust dampers and may or may not be accepted by the local code jurisdiction; and listed hoods that are designed, constructed, and operated according to the manufacturer's listed testing standards, and meet the local code jurisdiction.

Kitchen Systems Chapter 20

- Type II Hoods can be divided into condensate hoods and heat/fume hoods. Condensate hoods are used with applications that have high moisture content, such as the dishwasher . The hood is designed to allow the moisture to be channeled into perimeter drains while not allowing any moisture to drip back onto the appliance. Air filters and/or condensate baffles may be used. The heat/fume hood is installed over equipment producing heat and/or fumes only, such as an oven. This type of hood may include air filters. Steam kettles not recommended for use under Type II hoods.

CONTINUING EDUCATION AIA

Kitchen Systems Chapter 20

- Hoods With Make Up Air Provisions

Short Circuit Hoods introduce outdoor air into the interior of the hood. Care must be taken not to introduce too much air into the hood, which will affect the exhaust capabilities of the hood. ASHRAE Kitchen Ventilation Technical Committee 5.10 recommends short circuit hoods not be used. The PIER Design Guide 2 “Optimizing Makeup Air” also recommends short circuit hoods not be used. Many restaurant chains have discovered they can decommission short circuit hood systems and achieve lower hood exhaust airflow with improved hood C&C and improved comfort. Listed devices may be required if installed inside the hood.

Kitchen Systems Chapter 20

Front Face Discharge- This application allows make-up air to be introduced into the kitchen. If the air is not pretreated, it can create uncomfortable situations in hot and cold climates. The hood should be observed to be certain the discharge grille does not induce exhaust air from the hood.

Kitchen Systems Chapter 20

- These types of hoods may be used to cool the cooking staff. The air can be heated or cooled, depending on the climate. Discharge velocities shall be observed to assure there is no disturbance on the cooking surface, or any instances of cooling the food or adding to the discomfort of the cooking personnel.

.

Laboratory Systems (Constant Volume & Variable Volume) Chapter 21

Laboratory testing and balancing can be divided into several steps:

- The exhaust, which can be through fume hoods, general exhaust, canopies, snorkels, biological safety cabinets, etc.
- The supply system.
- The pressurization to the building, other laboratories, or outside.
- The complete exhaust system.
- The complete supply system.
- The stack velocity.
- Verifying each system's performance through its full range of operation.

Sound Chapter 22

Sound Measuring Instruments

Sound Rating Methods

- A-Weighted Sound Level
- Noise Criteria Method
- Room Criteria Method

- Acceptable Noise
- Testing Procedures for Measuring Sound Levels

Vibration Testing Chapter 23

Vibration Meters

Test Points

- Air Handling Units
- Fans
- Inline Fans
- Utility Fans
- Vane Axial Fans
- Pumps
- End Suction Pump

Testing Procedures for Vibration Measurements

CONTINUING EDUCATION AIA

Smoke Control Testing Chapter 24

Basic Testing

- Fan Testing
- Stairwell Pressurization Test

Smoke Control Acceptance Testing

- Verification
- Terminology

Testing Procedures for Smoke Control

- Review of the documents
- Review of the facility
- Testing

Atriums

Testing and Balancing Health Care Facilities Chapter 25

This chapter covers testing and balancing of systems presented in *ANSI/ASHRAE/ ASHE Standard 170-2008 Ventilation of Health Care Facilities*[1], *NFPA 99-2005 Standard for Health Care Facilities*[2], and *FGI Guidelines for Design and Construction of Health Care Facilities*[3], States have their own regulations overseen by their Departments of Health which have their own set of statutes and tables that must be met prior to licensing. Almost every procedure mentioned in the *AABC Standard* will be applicable when testing systems in a health care facility.

Testing and Balancing Health Care Facilities Chapter 25

Pressurization- AABC agrees with the National Institute of Health that the control pressure between pressurized rooms and the adjacent spaces be 0.05”WC and alarm at 0.03”WC[4]. *ANSI/ASHRAE/ASHE Standard 170-2008, Ventilation of Health Care Facilities*, requires that the minimum pressure differential must be at least 0.01” WC.

Testing and Balancing Health Care Facilities
Chapter 25

The chapter includes the following:
Hospitals
Duct Design
Operating Rooms
Airborne Infection Isolation Rooms
Protective Environment Rooms
Procedures for Measuring Room Pressures
Smoke Testing for Direction of Airflow
Reporting Procedures for ORs, AII Rooms and PE Rooms
Heating
Outdoor Air Intakes and Exhaust Discharge
Filtration

CONTINUING EDUCATION AIA

HVAC Commissioning Chapter 26

When considering commissioning, it is critical to consider the total system balance process. As defined in Chapter 1, *Total System Balancing* is "the process of testing and balancing the heating, ventilating, and air conditioning systems to deliver the design intent and operate at an optimum level."

The *Total System Balancing* process can be compared to ASHRAE's definition of *commissioning*: the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent.

Specification Chapter 27

The following basic specification is suggested when the TAB Agency is directly contracted by the owner.

Contractor’s Responsibility Specification

Contractor Preparation for Testing and Balancing

- General Requirements
- Scope of work
- Responsibilities of the Project Contractor
- Contractor Supplied Items

Report Analysis and Verification Chapter 28

The purpose of Progress Field Inspections and Report Verification Procedures is to verify:

- The accuracy of the field work
- The repeatability and integrity of the reported data
- The work has been performed in accordance with AABC National Standards and in accordance with the project specifications.

What the Report Provides

Using a Report

- Capacity Evaluation
- Verification
- Data Records
- Interpreting Reports

This concludes The American Institute of Architects Continuing Education Systems Course

Contact Information

Gaylon Richardson

Engineered Air Balance Co., Inc.

281-873-7084

grichardson@eabcoinc.com

www.eabcoinc.com