

## Dalhousie University Lab & Fume Hood Control System Standard

This standard is based on Phoenix Celeris II, as of August 2014. Phoenix products from past generations of Laboratory and Fume Hood control are not acceptable. Price Critical Controls or Triatek systems are approved alternatives, provided that they meet or exceed the standards here in.

Fume Hood Alarm Meeting. Every project shall require a meeting to review/approve the Fume Hood Monitor's Alarms.

- a. List the alarms and the condition upon which they occur
  - a. Define for each, the action of the audible and visual alarm notification.
    - i. Audible shall initiate and mute indefinitely if pressed or re-alarm at a specific time interval.
    - ii. Visual shall initiate and remain in alarm condition until the alarm condition has cleared.

Actuator Failsafe Meeting. Every project shall require a meeting to review/approve each air valve's actuator type's failsafe:

For example:

Standard speed Tracking-pair Supply and GEX valves: Fail to LAST position

High speed supply valves (in room containing hoods): Fail to LAST/CLOSED (choose one) position

High speed GEX valves (in room containing hoods): Fail to LAST/OPEN (choose one) position

High speed fume hood valves: Fail to LAST/OPEN (choose one) position

### Laboratory Ventilation Rate

Occupancy Mode Triggers (What changes the ACH Rate Range)

1. Occupancy Sensor; from Networked Lighting Control System, or Dual Contact local only system, or dedicated sensors

Ventilation Rate

Occupied 2 - 10 ACH or greater if required by the Designer.

As directed by a Occupancy Sensor

Unoccupied 2 ACH

Occupied 10 ACH

Room Offset Volume

Typically we use 10% of the highest total required exhaust air flow for any operating condition;

The offset remains constant in all conditions and is based on the highest total exhaust in any mode. Constant volumetric offset means in any mode (ie thermal demand, hood max, or occ vent, etc) that has a lower total exhaust the % offset will increase because the volumetric flow value is constant.

This also works well with the Air Valve's ability to be within +/- 5% accuracy of the flow, regardless of position, minimizing the possibility of pressure relationship reversal.

At the end of the day, it is the design engineer's responsibility to choose and document that rational behind their offset values.

Another benchmark is 100 CFM per door that exists in the room. Or 150 – 200 CFM/door. This value would/should get tuned on site via empirical pressure measurement that will ensure that the doors can still function

#### **Ventilation System Static Pressure Setup:**

Based on Engineered Air Balance (EAB)'s experience with testing over 5000 valves, they recommend that the minimum differential pressure across any sized medium pressure valve be 1 inch and 0.7 inches for low pressure valves. All of the manufactures remain stable through to the published 3 inches. It is only Phoenix that remain stable above 3 inches. This is further supported from the Phoenix factory disclosing that their valves are characterized to be 'most' accurate at 1 inch differential pressure drop across the valve.

The central supply and exhaust air handling system air static pressure set points shall be sufficient for all valves to achieve the above differential pressure across them. Air system designs shall take these minimum requirements into account

Phoenix's pressure switches shall be adjusted for the above values.

Medium Pressure	1"
Low Pressure	0.7"

Other manufacturer's low pressure set points shall be adjusted for the above values.

Medium Pressure	1"
Low Pressure	0.7"

#### **Shop Drawings**

At the supplier's cost, including that of the Campus BMS Company, Supplier must install/mock up a live installation of the system and integrate it into the Campus BMS to demonstrate that it meets the BACnet specification. Failure to integrate successfully will result in rejected shop drawings.

Sequences of Operation that reflect exactly what is installed, including analytics, exceptions and safeties, is the minimum standard. Generic sequences are not acceptable unless they completely represent what has been installed.

The Air Flow of the small, non-electronic, Air Valve(s) for storage cabinets, snorkels, etc., must be documented and added as a Constant/Virtual Object in the Lab Fume Hood Control System Sequence of Operation, program and ultimately shown on the BMS graphic for each specific location/space

Phoenix Room Schedule Sheet (RSS) shall be sent to the consultant for completion/approval and maintained throughout the design and construction phase of the project.

The RSS shall be turned over as As-Built at the completion of the project, with all changes integrated into the one master RSS. The RSS shall be submitted in both PDF and Excel Spreadsheet formats.

RSS Shall Contain:

- Air Valve Factory Maximum Airflow
- Air Valve Factory Minimum Airflow

- Hood Minimum Flow that achieves 25 CFM/ft<sup>2</sup> of hood table
- Hood Maximum Flow that achieves 100 FPM @ 18" of sash opening.

- Lab Offset

- Makeup Air Valve

  - Flow that achieves 10 Air Changes per Hour (ACH) – Occupied Maximum

  - Flow that satisfies the maximum cooling load of the space

  - Flow that achieves 2 (ACH) – Un-Occupied Minimum

- General Exhaust Valve

  - MAV Occupied Maximum flow, plus Lab Offset flow, minus Hood(s) minimum flow

  - MAV Occupied Minimum flow, plus Lab Offset flow, minus Hood(s) minimum flow

  - MAV Un-Occupied Minimum flow, plus Lab Offset flow, minus Hood(s) minimum flow

- Lab Control Strategy

Each Room or Lab shall have its own drawing. Typical drawings are not acceptable.

Shop Drawings shall be submitted in electronic, and hard copy.

Product Literature shall be submitted in electronic format only. A bill of material that references the associated product literature and exact version which is installed shall be created and form part of the Shop Drawing package.

Electronic Submissions shall include one PDF file of all documents, book marked for easy navigation. Sections shall be labeled "Section X – <Section Description that is in the Table of Contents>".

All supporting documents such as PDFs, Excel Spreadsheets, Word for Window documents, Auto CAD, etc. files that were used to create the single PDF file shall be provided as Supporting Documentation.

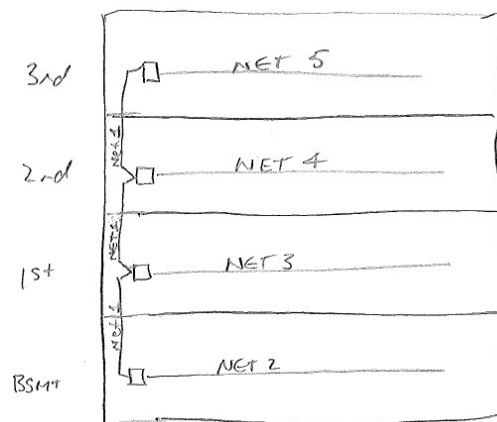
The Shop Drawings shall include each Room's Laboratory Verification Table. This Table shall have the Monitor Verification Table completed when there are one or more fume hoods in the room. This table shall list all of the 23 Parameters from the X30 Fume Hood Monitor User's Guide and the specific settings installed.

Server, Router and Repeater locations shall be documented on the shop drawings.

Neutralizers, if supplied, shall be shown on the consultant's design drawings as well as the Phoenix shop drawings. Neutralizers shall also be listed in the RSS.

### Topography

Network wiring shall conform to the following layout:



The repeater shall be located in the same location on each floor.

### Hardware

The Lab and Fume Hood controls contractor shall be responsible for adding Sash Stops to each Fume Hood if the Fume Hoods are delivered without them. It is permissible for

the Lab and Fume Hood controls contractor to ensure that the Sash Stops are in the Fume Hood supplier's specification, 'before' the project's tender closes.

Sash Stops – To Impede Opening

- .1 Sash stops, are to be supplied and installed on all hoods where they current do not exist at 18 inches of sash opening to impede opening the sash beyond that point.
- .2 Existing sash stops are to be relocated to the 18 inches of opening point.
- .3 Sash stops to be preapproved by the Engineer prior to installation. Example of acceptable sash stop is in Attachment 2.

Sash Stops – To Impede Closing

- .4 Sash stops, are to be supplied and installed on all hoods where there is no under ledge airfoil to impede full sealing with the sash closed. The stop will cause the sash to never close beyond the 1 inch level.

Fume Hood Monitor FHM631-ENG-XXX

Routers. Each lab shall have its own router. Tracking Pairs can share a router.

Air Valves

Vertically installed valves are not preferred. Engineer to obtain University approval in advance for any vertically installed valves.

Horizontal valves shall have the ductwork on both sides supported such that the connection between the ductwork and the valve does not provide any structural support, only an air seal.

Vertical Air Valves

Shall be provided with factory supplied flanges. No Band Clamps

Band Clamps

To be used on Horizontal Air Valves only.

Band Clamps shall be provided at the discretion of the installing contractor.

There shall be no penetration of coated air valves, such as screws or otherwise.

Neutralizers

Laboratories will be designed to maintain background noise as per the latest published ASHRAE guidelines. RC(N): QAI ≤ 5dB Criterion.

**Laboratories (with fume hoods)**

Testing/research, minimal speech communication	45 – 55
Research, extensive telephone use, speech communication	40 – 50
Group teaching	35 – 45

It is expected that noise levels can be achieved without any neutralizers. If a neutralizer is specified the engineer must submit to the owner for review the acoustic assessment that attests to its requirement.

If neutralizers are required, they shall be shown on the Engineer's ventilation detail drawings as well as the Phoenix Shop Drawings and the RSS table.

No Differential Pressure Sensor or switch shall be supplied on SUP or GEX valves, unless they are part of the base or standard product.

No LDU's will be provided for Vivariums, or any other space. A Metasys User Group will be created with the same information for the user.

No Lab Pressure Monitoring.

All Auxiliary Temperature Control Zones shall be via Phoenix LabFull configuration and a temperature sensor and control valve. There shall be no independent third party Temperature Control using additional controllers. In the event that Tracel valves are specified, upgrade to low speed Celeris should be considered.

Macro Servers shall be installed in air louvered ventilated cabinets which have an Un-Interrupted Power Supply (UPS).

In retrofit applications, unless the Engineer can demonstrate that the existing or retrofitted system can accommodate Medium pressure Air Valves, Low Pressure Air Valves shall be provided.

All cabinets shall be labeled and correspond to the Shop Drawings

All power circuits shall be documented on the As-Built drawings.

Switchable Rooms will be changed via the BMS and available within the user's specific User Group

**Configuration**

Set Primary Temperature Control to 'Use BMS Set Points' rather than 'Use These Set Points'

PCClabfull configuration shall always be used for a Lab. PCClabcompact is not to be used. If necessary supply a GEX Controller Card (no valve) and have its minimum flow

set to zero when the Min Hood Volumes are sufficient for the cooling load, making a GEX valve not necessary.

Space Temperature Control Set Points

Occupied

As directed by a Occupancy Sensor

Occ Heating 20C  
Occ Cooling 24 C

Unoccupied (Standby)

Within the Occupied time period of the BMS TOD Schedule

Stby Heating 19C  
Stby Cooling 26 C

Unoccupied

As directed by a Occupancy Sensor

UnOcc Heating 18C  
UnOcc Cooling 28 C

Temperature Control Setup

The Integral Reset for the heating temperature control loop should always be ~500 rather than the default of 200. This avoids the modulating control device from hunting and behaving like a 2-position device.

The default of 200 for cooling is fine.

Writeable Points

Occ\_Clg 24 C  
Occ\_Heat 20 C

Stby\_Clg 26 C  
Stby\_Heat 19 C

UnOcc\_Clg 28 C  
UnOcc\_Heat 18 C

Read Only Points

Eff Temp SP

LON Database names 'must' comply with the University's BMS naming convention.

**Air Valve Setup**

Valve Minimum shall always be the factory valve minimum not the Hood Minimum. This is so that the decommission mode can work/add value.

All rooms shall be configured to have Occupied and Un-Occupied Modes, Occupied Maximums (10 ACH), Occupied Minimums (6 ACH) and Un-Occupied Minimums (2 ACH). The Engineer shall establish these and provide them in an Excel spreadsheet. Simply provided in AutoCAD is not acceptable. If a room is

not to have different volumes for Occupied vs Un-Occupied the values for both modes shall be identical.

**Fume Hood Monitor Calibration Parameter Setup**

(Hood Monitor to be setup in Imperial Units)

Number	Name	Standard	Comment
1	FHM Mode	Depends on type	Must be documented
2 – Step 1	Display Parameter and Unit of Measure	00001 – ft/min	
2 – Step 2	Display Parameter and Unit of Measure	Yes Display is active.	
3	Flow Scale Factor	200 CFM/V	
4	Standard Face Velocity Set Point	100 ft/min	
5	Leakage Area	Determined on site	Must be documented. Hood Type Dependent. The default of 0.3 = 0.3 ft <sup>2</sup> of leakage area. $FV = CFM/Area$ . $Area = Sash\ Opening + Leakage\ Area$ .
6	Fixed Sash Dimension	Determined on site	Must be documented
7	Minimum Hood Flow	Determined by the Engineer	<b>25 CFM/ft<sup>2</sup> of hood counter, or</b> based on Engineer’s Spec. Must be documented.
8	Maximum Hood Flow	See comment	Based on 18 inches of Sash Opening. Hood must have a sash stop at 18 inches
9	Minimum Sash Opening	S-cl	Must be documented
10	Maximum Sash Opening	S-oP	Must be documented. Should be no greater than 12 inches
11	Face Velocity Display Offset Adjustment	0	<b>NEVER TO BE USED. INSTALLATION MUST ENSURE THAT THE CORRECT LEAKAGE AREA IS INPUT – ITEM 5</b>
12	Setback %	60%	If a Zone Presence Sensor Exists
13	Minimum Setback Clamp	No	If set to “No”, the flow will never go below the Hood’s minimum flow, or minimum ventilation. If set to “Yes” it will go below.
14	Sash Opening Alarm	oPAL	Set at 20 inches of opening
15	Broken Sash Threshold	Py_o	



Number	Name	Standard	Comment
16	Sash Fully Closed	Py_c	
17	Beeper Volume	Hi	
18	Emergency Mutable	Yes	
19	Mute Duration	5	
20	Auto Mute	0	
21	Drive Application Offset and Gain	N/A	Non Applicable unless a Variable Speed Drive type hood.
22	Fume Hood Decommission	FAcE	Sets the Hood in Decommission mode at the hood monitor only. Not the BMS
23	Energy Waste Alert	No	Enable

Setup needs to account for traditional leakage, plus the air flow of a Secuflow supportive air fan, if applicable.

Emergency Exhaust shall be the valve's software maximum, not the valve's full physical opening.

Parameters for each Fume Hood are to be manually documented and provided as part of the O&M manuals.

### **Fume Hood Sash Sensors**

Sash sensors shall be mechanically attached to the hood. No tapes or adhesives are permitted.

Sash sensors shall be mounted outside of the fume hood so as to avoid corrosion to its potentiometer.

The fume hood control manufacturer shall provide the sash sensor's mounting bracket, if necessary.

The preference is to have hood supplied and installed sash sensors.

### **Micro Server vs. Macro Server**

There shall be no Micro Servers installed. All Phoenix Laboratory and Fume Hood Control components shall be connected to the nearest Macro Server. The choice of which Macro Server to connect to will be confirmed in writing with the University, in advance of connection. Each building shall have a unique database on its Macro Server.

A Username and Password that provides all capabilities for the Macro Server shall be provided to the University.

The IP Address & MAC Address & Subnet Mask for the Macro Server shall be identified on the Network Drawing. The Macro Server location shall be documented on the Network Drawing. Macro Servers will use DHCP.

**OptiNet/Air Quality Interface, not applicable unless preapproved for a specific project by the University.**

This interface shall always be hard wired. A network dependent solution is not acceptable.

See spreadsheet for setup configuration/procedure that accounts for the meaning of the OptiNet signal and lab ventilation systems that are designed for 10 ACH maximum, rather than 18 ACH.

**Engineering Units**

The Engineering Units to be used shall be as follows:

Hood Monitor = Imperial

Elsewhere = Metric

Temperature = Deg C

Flow = Liters/Sec

Face Velocity = FPM (Feet per Minute)

**BAS Integration**

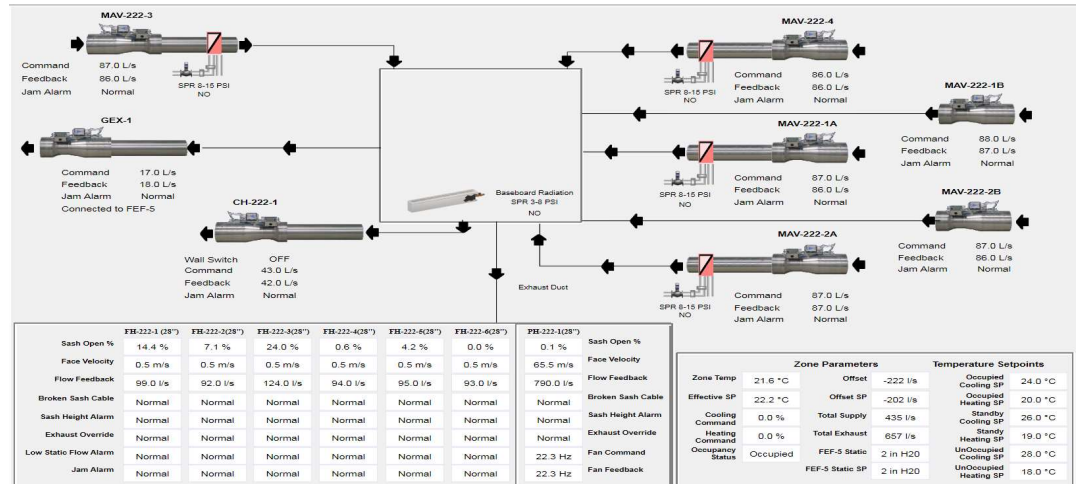
The System shall conform to the latest version of the University's BACnet spec, which should be in the project's Division 1.

Integration shall be BACnet IP, not MS/TP so that the Lab & Fume Hood Controls Manufacturer can connect to the system via a University provided VPN. The system must be capable of manufacturer access via a University provided VPN.

Only temperature control Set Points and temperature control devices shall be adjustable/over rideable from the BMS. All other objects shall be read only.

The following Objects shall be available for integration into the BMS:

Sample Graphic Building Management System Graphic and minimum Lab & Fume Hood Controls Objects to be available for integration:



Sash Opening % shall always be based on the full physically possible opening of the sash. The maximum physical opening, in inches, is to be documented next to the hood label. (See above graphic).

Additional objects, as applicable

Air Flow of the small, non-electronic, Air Valve(s) for storage cabinets, snorkels, etc.

Perimeter Radiation Control Valve Command

Reheat Coil Control Valve Command

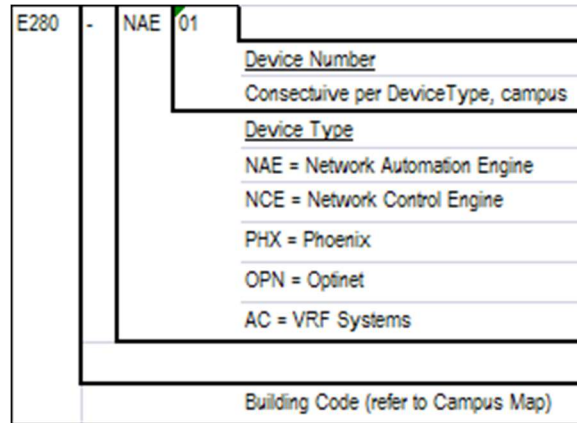
Previously identified Lab and Fume Hood points will be **trended** in the BMS. Trends shall be configured COV or COS as per the University Trending Standard. Trends will be set up to archive automatically to the ADX server.

## Naming Convention

### Server Naming

Server devices that that require an IP address will be named in using the building code, an equipment specific name and a consecutive numbering scheme campus wide (ie. Number does not restart with each building). Building codes will be provided by the Dalhousie Project Manager.

The IP address shall be obtained using the Network Registration Form which will be provided by Johnson Controls. This form is to be submitted to FMIT by Johnson Controls through the Dalhousie Project Manager.



### **Naming**

Phoenix points shall be named using the full location and equipment reference as described below:

[Building Name].RM-[Room # Location].[Equipment Type].[Point Description]

*Phoenix System examples using the DOS Building Main Lab*

Controller Names:

DOS.RM-135.MAV-1 (Makeup Air Valve 1 serving Room 135 in DOS Building)

DOS.RM-135.GEX-1 (General Exhaust Air Valve 1 serving Room 135 in DOS Building)

DOS.RM-135.FH-1 (Fumehood 1 serving Room 135 in DOS Building)

Point Names:

DOS.RM-135.MAV-1.SA-F (DOS Building, Room 135, Makeup Air Supply Air Flow)

DOS.RM-135.FM-1.JAM-ALM (DOS Building, Room 135, Fumehood 1 Jam Alarm)

### **Instance Numbers:**

Instance numbers for all equipment shall be coordinated through the Johnson Controls project team. The vendor will supply the count of instance numbers required and Johnson Controls will supply a block of values to apply to that particular project.

Phoenix objects shall use instance numbers in the range of 100,000 through 199,000.

**Training:**

**TRAINING PROGRAM**

- .1 Delivered by Lab Type.
    - .1 At the completion and turnover of the first laboratory Type
      - .1 "In Lab" training with Operations Staff and Laboratory users on the Fume Hood Controls
      - .2 "In Lab" training with Operations Staff only for in-depth Fume Hood Controls, Laboratory Air Flow Control, Temperature Control, ancillary device (such as canopies) airflow or temperature control.
    - .2 At the completion and turnover of the 2nd and subsequent laboratories of the same Type as .1 above
      - .1 "In Lab" training with Laboratory users on the Fume Hood Controls
    - .3 At the completion and turnover of the 2nd and subsequent "unique" laboratory Type
      - .1 "In Lab" training with Operations Staff only for in-depth Fume Hood Controls, Laboratory Air Flow Control, Temperature Control, ancillary device (such as canopies) airflow or temperature control.
    - .4 At the completion of the Building Management System Integration
      - .1 Joint training with the BMS contractor on the parameters that come through the integration that have not been reviewed with the in laboratory equipment
      - .2 Training on any Web Based access User Interfaces that bypass the Building Management System and connect directly to the Laboratory and Fume Hood Controls.
  - .2 Training to be project-specific to the unique attributes of this project.
  - .3 Training to occur at a time mutually agreeable between the Contractor, Consultant and the University.
  - .4 Operations Training to Include the following:
    - .1 Explanation of drawings, operation and maintenance manuals.
    - .2 Walk-through of the job to locate control components.
    - .3 General System architecture.
    - .4 System Communications.
    - .5 User Interfaces and peripherals.
    - .6 Elementary preventive maintenance.
    - .7 Operator control functions.
- 1.2 ADDITIONAL SYSTEM TRAINING
- .1 To be available from Contractor and/or manufacturer for personnel requiring greater in-depth understanding of hardware or software than provided by training specified herein.

- .2 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.
- .3 If required, this additional training will be contracted for at a later date.

**Warranty:**

**1.2 WARRANTY**

- .1 Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request 24 hours Monday through Friday and 48 hours on Saturday and Sunday.
- .2 The on-line support services via Internet shall allow the local and manufacturer technical representatives to monitor and control the facility's system. This remote connection to the facility shall be within 3 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays. The University shall provide a Representative/Manufacturer specific VPN to facilitate this access.
- .3 Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
- .4 Provide for 16 hours of customized programming after verification by the original programmer to ensure the intent of the original design is implemented. These hours can be used for program modifications, data acquisition analysis, meeting with owners or owner's representatives. Each hour of time shall be documented as to requested information and completed resolution.

**Attachment 1 – Lab Types**

Lab Type	Perchloric Fume Hood with VFD	Canopy Hood with Valve & Wall Switch	GEX	Fume Hood with Valve, SS & Mon	MAV	Air Reheat CV	Perimeter Radiation CV
Type 1	1	1	1	1	1	1	1
Type 2	0	1	1	1	1	1	1
Type 3	0	0	1	1	1	1	1
Type 4	0	0	0	1	1	1	1
Type 5	0	0	1	0	1	1	1

Options that may be added to any of the Standard Lab Types:

1. Add a Fume Hood to any of the Lab Types
2. Add a GEX to any of the Lab Types
3. Add a MAV to any of the Lab Types
- 4a. Add a Canopy/Capture Hood to any of the Lab Types
- 4b. Add a Storage Cabinet to any of the Lab Types
- 4c. Add a Snorkel to any of the Lab Types
5. Add a Perchloric Hood to any of the Lab Types.
6. Add a Perimeter Radiation Control Valve to any of the Lab Types
7. Add a Fan Coil to any of the Lab Types
8. Add a Chilled Beam to any of the Lab Types



**Attachment 2 – Spring Loaded Sash Stop**

	DATE	BY		① SASHLATCH CATCH (1)	② SASHLATCH BRACKET (1)	③ SPRING PIN (1)	④ HEX NUT (2)	DWG.NO. <b>HD-8a</b>
DWN.	11/4/99	TETREAULT		019970 (HMP-0940)	019971 (HMP-0941)	F-5572-00	F-5573-00	PART NO. <b>019972</b>
DET.								
CKD.								
LTR	REVISIONS							
△	PER N.P.I.	9911-05						
		11/12/99	JWM					

IF YOU HAVE BEEN DIRECTED TO THIS DRAWING BY REQUEST OF GRAVITY SASH STOP OPTION, PLEASE FOLLOW THE DIRECTIONS BELOW.

FOR STANDARD SASH STOP (H30/H36 HOOD LESS THAN 96" LONG)  
WHEN USING OPTION (8) WITH WITH OPTION (2) OR (3), PLEASE DELETE 019632 AND ADD 019972.

FOR STANDARD SASH STOP (H30/H36 HOOD 96" L. OR GREATER)  
WHEN OPTION (8) IS REQUESTED, DELETE 019632 AND ADD 019972.

FOR STANDARD SASH STOP (H32 HOOD)  
WHEN OPTION (8) IS REQUESTED, DELETE 019632 AND ADD 019972.

INSTALLATION NOTES:  
 1. MOUNT SASHLATCH BRACKET AND SPRING PIN TO THE SASH FRAME AS SHOWN, WITH A 3/16" GAP BETWEEN THE SPRING PIN AND FACIA.  
 2. MOUNT SASHLATCH CATCH ABOVE THE SPRING PIN WITH THE SASH LOCATED AT THE SPECIFIED SASH HEIGHT OPENING.

3/16" GAP

<u>TOLERANCES</u>	SIZE	TITLE
ALL FRACTION DIM ±1/64"		SASH LATCH/STOP ASS'Y FOR ALUMINUM HANDLE, TYPE "A" & STILED FRAMED SASHES.
ALL DECIMAL DIM ±.015"	MATERIAL	PART NO. <b>019972</b>
ALL ANGLES ±1/2"	SCALE	DWG.NO. <b>HD-8a</b>
UNLESS OTHERWISE SPECIFIED		REV.LTR. -

FILE : LPRSHD.DWG 11/9/90

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