AUTO-FLOW®

BACnet® Fume Hood Applications & Options

American Auto-Matrix has long held an important technology position in the areas of Critical Environments. Originally introduced in 1991, the Auto-Flow line includes the only BACnet BTL® listed Fume Hood & Laboratory controllers as well as a collection of related system components that augment the control products. These products include items manufactured by AAM and associated products qualified and sourced from other companies. Among the manufactured components are slack membrane, ultra-low pressure transmitters, high speed actuation, Type 1 PVC damper valves, and cross flow pitot tubes.

The AAM Fume Hood control Technology is capable of fume hood face velocity monitoring and control based on many different application approaches. Control can be established as either ”Closed Loop” or “Open Loop”, meaning that either there is direct feedback of the controlled parameter (face velocity) to the control process, or there is no such feedback. These different control methodologies have been organized in an Auto-Flow Application Chart which is structured to articulate the various fume hood control approaches and to identify the components for sensing and control that are relevant for each control approach.

Provided as part of a bundle package with the fume hood controller, the color touch screen display provides a local user interface for monitoring the status of the fume hood. The touch screen display reflects measured face velocity in the Auto-Flow method and calculated face velocity in the Sash Position method. It can also be configured to display the velocity setpoint. The system includes emergency override and a tiered alarm scheme that shows green for normal, flashing yellow for intermediate alarms, and flashing red for extreme alarms.

In addition to the control of fume hoods, AAM has developed a dedicated laboratory controller that is also BTL® listed for conformance to the BACnet Standard. This controller represents the latest technology in terms of controlling the state of a laboratory for differential pressures and/or volumetric flow offsets.

Also, AAM enjoys a strong Patent position which it defends in today’s critical environments system space. These patents include coverage for laboratories that have fume hoods and communicate with BMS Systems (No. 5,764,579) and patents on face velocity control of fume hoods, pressure transmitters, and feed forward control logic. Recently AAM prosecuted one of its Patents in US District Court against a major Lab Controls company and negotiated a license agreement. Although some aspects of the settlement are sealed, this settlement was a major victory for AAMs Intellectual Property position.

Auto-Flow (Face Velocity) Method

Application 1 : 3rd Party Face Velocity Sensor

This application represents a very economical approach to face velocity based closed loop control. A third party hot wire anemometer or other low range velocity sensor technology is used, mounted so as to reflect the average face velocity entering the hood. Often this location is through the hood side wall. The output from this sensor is then used as the face velocity input to the controller and the normal closed loop control approach is implemented.

Although this approach yields good control, the time delays associated with the sensors can sometimes result in sluggish response. To offset this disadvantage, a String Potentiometer can be added to enable feed forward control to augment the face velocity measurement.

EQUIPMENT	PART NUMBER	NOTES	PRICE
Required Equipment			
Controller and Display	**NB-FHC1-BDL**	Controller, display, and enclosure	
Through wall Velocity Transmitter	**AF-HWA-1**	Through wall hot wire anemometer Vortex shedding velocity meter	
Damper Assembly*	**AF-DPR-xx-A**	Type 1 PVC with Stainless Steel blade AF-ACT-1 high speed actuator included	

* In retrofit installations, existing dampers may be reused if acceptable

Total Price per Hood (equipment only) $

Optional Features

Exhaust Flow Feedback		
Pressure Transmitter	**AF-FTR-xx**	Specify pressure range based on duct air design velocity
Cross Flow Pitot Option	**-AP option**	w/ Butterfly Damper (AF-DPR-xx) adds cross flow pitot tube

When exhaust volume flow values are desired, as in the case of implementing flow tracking control, the optional **Exhaust Flow Feedback** components are necessary. Multiple hoods with this feature can be connected together to instantaneously totalize exhaust volume for the laboratory controller-based implementation of volumetric/flow offset laboratory control schemes.

Feed-Forward Control		
String Potentiometer**	**AF-SP1-50**	Long life string potentiometer

In some circumstances where extremely rapid response to changes in sash position are desired, an optional sash position potentiometer can be added. This enables what is referred to as **Feed-Forward Control**. The controller accepts this input and uses the sash position to temporarily over-ride the normal control algorithms until the face velocity responds and then normal control is resumed. ****String potentiometer cannot be used with compound hoods.***

Local Occupancy Detection and **Control Disable**		
STATbus Digital Input	**SSB-DI1**	Adds 1 Digital Input for PIR connection

If **Local Occupancy Detection** and **Control Disable** functions are **both** desired on a single fume hood, an extra digital input is necessary. This optional input is purchased in addition to the passive Infrared detector (PIR) which must be sourced separately. Care must be taken with this application to avoid unnecessary activation of the controls when personnel walk past the fume hood. The Control Disable function is used where exhaust flow is intentionally turned off and it is desired to stop modulating and alarming the hood flow.

Hood Lighting Control		
STATbus Digital output	**SSB-DO1**	Adds 1 Digital output (relay)

For fume hoods with interior lighting, a digital output can be added in order to control the light through the FHC-SD display interface.

Sash Position Method

Application 2: Butterfly damper with Exhaust Flow Volume Feedback (not for compound hoods)

This application uses a string potentiometer to determine the sash position and therefore can calculate the face area of the hood (simple sash designs only). The approach also measures the velocity in the exhaust duct thus the exhaust airflow volume can be determined. Then, since the controller "knows" the open hood face area and the exhaust flow volume, the desired face velocity can be maintained. Since the measured exhaust flow volume is being modulated, the type of control is a closed loop type even though the face velocity is not being measured.

An advantage of this approach is that the exhaust volume is known intrinsically as part of the basic control logic and thus volumetric offset / flow tracking can be applied in the Laboratory that houses the fume hood. Multiple hoods with this feature can be connected together to instantaneously totalize exhaust volume for the Laboratory controller based implementation of the laboratory control schemes.

EQUIPMENT	PART NUMBER	NOTES	PRICE
Required Equipment			
Controller and Display	**NB-FHC1-BDL**	Controller, display, and enclosure	
String Potentiometer	**AF-SP1-50**	Long life, multi-turn potentiometer	
Damper Assembly w/ Cross Flow Pitot*	**AF-DPR-xx-AP**	Type 1 PVC with Stainless Steel blade Specify duct size (8 -10-12) AF-ACT-1 high speed actuator included	
Pressure Transmitter	**AF-FTR-xx**	Specify pressure range based on duct design air velocity	

* In retrofit installations, existing dampers may be reused if acceptable

Total Price per Hood (equipment only) **$$**

Optional Features			
Local Occupancy Detection and **Control Disable**			
STATbus Digital Input	**SSB-DI1**	Adds 1 Digital Input for PIR connection	

If **Local Occupancy Detection** and **Control Disable** functions are **both** desired on a single fume hood, an extra digital input is necessary. This optional input is purchased in addition to the passive Infrared detector (PIR) which must be sourced separately. Care must be taken with this application to avoid unnecessary activation of the controls when personnel walk past the fume hood. The Control Disable function is used where exhaust flow is intentionally turned off and it is desired to stop modulating and alarming the hood flow.

Hood Lighting Control		
STATbus Digital output	**SSB-DO1**	Adds 1 Digital output (relay)

For fume hoods with interior lighting, a digital output can be added in order to control the light through the FHC-SD display interface.

Auto-Flow (Face Velocity) Method

Application 3: Air Foil Pitot Measurement (for most single sash and compound sash systems)

This application embodies the best features of the patented Auto-Flow® Methodology. It directly measures actual face velocity in the plane of the sash using specially adapted generally accepted flow measurement principles. The measured face velocity is controlled in a closed loop manner to effect control with either traditional PID control or fuzzy logic. Used with the AAM AspectFT® technology, loss control and risk management authorities can archive actual fume hood face velocities perpetually and in conjunction with personnel access records. This feature represents a unique capability of this technology. There is no other system that measures actual face velocity in the plane of the sash and provides this value along with other pertinent information in a manner that can be archived for future retrieval.

EQUIPMENT	PART NUMBER	NOTES	PRICE
Required Equipment			
Controller and Display	**NB-FHC1-BDL**	Controller, display, and enclosure	
Face Velocity Pitot Tube	**AF-AFP2-xx**	Length specific (3ft - 8ft)	
Face Velocity Transmitter	**AF-FVR-1A**	Ultra sensitive pressure transmitter	
Damper Assembly*	**AF-DPR-xx-A**	Type 1 PVC with Stainless Steel blade Specify duct size (8 -10-12) AF-ACT-1 high speed actuator included	

**** In retrofit installations, existing dampers may be reused if acceptable***

Total Price per Hood (equipment only) $$$

Optional Features			
Exhaust Flow Feedback			
Pressure Transmitter	**AF-FTR-xx**	Specify pressure range based on duct air design velocity	
Cross Flow Pitot Option	**-AP option**	w/ Butterfly Damper (AF-DPR-xx) adds cross flow pitot tube	

When exhaust volume flow values are desired, as in the case of implementing flow tracking control, the optional **Exhaust Flow Feedback** components are necessary. Multiple hoods with this feature can be connected together to instantaneously totalize exhaust volume for the laboratory controller-based implementation of volumetric/flow offset laboratory control schemes.

Feed-Forward Control			
String Potentiometer**	**AF-SP1-50**	Long life string potentiometer	

In some circumstances where extremely rapid response to changes in sash position are desired, an optional sash position potentiometer can be added. This enables what is referred to as **Feed-Forward Control**. The controller accepts this input and uses the sash position to temporarily over-ride the normal control algorithms until the face velocity responds and then normal control is resumed. *****String potentiometer cannot be used with compound hoods.***

Local Occupancy Detection and **Control Disable**			
STATbus Digital Input	**SSB-DI1**	Adds 1 Digital Input for PIR connection	

If **Local Occupancy Detection** and **Control Disable** functions are **both** desired on a single fume hood, an extra digital input is necessary. This optional input is purchased in addition to the passive Infrared detector (PIR) which must be sourced separately. Care must be taken with this application to avoid unnecessary activation of the controls when personnel walk past the fume hood. The Control Disable function is used where exhaust flow is intentionally turned off and it is desired to stop modulating and alarming the hood flow.

Hood Lighting Control			
STATbus Digital output	**SSB-DO1**	Adds 1 Digital output (relay)	

For fume hoods with interior lighting, a digital output can be added in order to control the light through the FHC-SD display interface.

Face Velocity Method

Application 4: Static Pressure Measurement (for hoods where a face velocity pitot cannot be used)

In some circumstances involving low-flow hoods or some hoods with compound sash it may not be possible to position a face velocity pitot to sense the face velocity directly. In these situations, face velocity control is accomplished using a system based on the measured static pressure across the face of the hood which correlates with the flow velocity in the face opening. The Space Pressure Primary is a special static pressure sensing tube along with two externally mounted static pressure sensing pickups. This system provides the same general control capabilities as Application 3, however, if the hood is operated with a high negative static pressure the high limit flow alarms will necessarily need to be deactivated. This is also a closed loop control application and the display reflects the measured face velocity. This application requires the FVR-1B transmitter due to higher pressure readings than in applications using the airfoil pitot.

EQUIPMENT	PART NUMBER	NOTES	PRICE
Required Equipment			
Controller and Display	**NB-FHC1-BDL**	Controller, display, and enclosure	
Space Pressure Primary Kit	**AF-SPP2-xx**	Length specific (4ft - 6ft) Includes Hood Static Probe & (2) AF-SPS-1	
Face Velocity Transmitter	**AF-FVR-1B**	Ultra sensitive pressure transmitter	
Damper Assembly*	**AF-DPR-xx-A**	Type 1 PVC with Stainless Steel blade Specify duct size (8 -10-12) AF-ACT-1 high speed actuator included	

** In retrofit installations, existing dampers may be reused if acceptable*

Total Price per Hood (equipment only) $$$$

Optional Features			
Exhaust Flow Feedback			
Pressure Transmitter	**AF-FTR-xx**	Specify pressure range based on duct air design velocity	
Cross Flow Pitot Option	**-AP option**	w/ Butterfly Damper (AF-DPR-xx) adds cross flow pitot tube	

When exhaust volume flow values are desired, as in the case of implementing flow tracking control, the optional **Exhaust Flow Feedback** components are necessary. Multiple hoods with this feature can be connected together to instantaneously totalize exhaust volume for the laboratory controller-based implementation of volumetric/flow offset laboratory control schemes.

Feed-Forward Control			
String Potentiometer**	**AF-SP1-50**	Long life string potentiometer	

In some circumstances where extremely rapid response to changes in sash position are desired, an optional sash position potentiometer can be added. This enables what is referred to as **Feed-Forward Control**. The controller accepts this input and uses the sash position to temporarily over-ride the normal control algorithms until the face velocity responds and then normal control is resumed. ****String potentiometer cannot be used with compound hoods.***

Local Occupancy Detection and **Control Disable**			
Statbus Digital Input	**SSB-DI1**	Adds 1 Digital Input for PIR connection	

If **Local Occupancy Detection** and **Control Disable** functions are **both** desired on a single fume hood, an extra digital input is necessary. This optional input is purchased in addition to the passive Infrared detector (PIR) which must be sourced separately. Care must be taken with this application to avoid unnecessary activation of the controls when personnel walk past the fume hood. The Control Disable function is used where exhaust flow is intentionally turned off and it is desired to stop modulating and alarming the hood flow.

Hood Lighting Control			
Statbus Digital output	**SSB-DO1**	Adds 1 Digital output (relay)	

For fume hoods with interior lighting, a digital output can be added in order to control the light through the FHC-SD display interface.

Sash Position Method

Application 5: Pressure Independent (Venturi Valve)

With this method a string potentiometer is used to measure the sash position. The signal indicative of sash position is used to modulate a calibrated Pressure Independent control valve. This type of control is referred to as Open Loop Control because there is no feedback of the actual measured face velocity to adjust the control loop. The system relies on the stability of the calibration in the valve to assure a known face velocity. This type of valve has been highly developed to operate under closely calibrated flows when the actual duct static pressure is variable.

Control using this approach is very fast because there is no latency in face velocity measurement. Because of how this type of valve functions, a minimum duct static pressure is necessary which increases the required system power especially in the smaller duct sizes. This fact reduces the energy efficiency of this type of control.

EQUIPMENT	PART NUMBER	NOTES	PRICE
Required Equipment			
Controller and Display	**NB-FHC1-BDL**	Controller, display, and enclosure	
String Potentiometer**	**AF-SP1-50**	Long life multi-turn string potentiometer	
Pressure Independent Valve*	**QUOTE SEPARATELY**	With high-speed actuator Factory Calibrated*** Specify corrosion protection	
		Total Price per Hood (equipment only)	**$$$$$**

* *In retrofit installations, existing dampers may be reused if acceptable*
** *String potentiometer cannot be used with compound hoods*
*** *Pressure Independent Value estimated at average Market Price for this study (not offered by AAM)*

Optional Features		
Exhaust Flow Feedback		
Pressure Transmitter	**AF-FTR-xx**	Specify pressure range based on duct air design velocity
Cross Flow Pitot Option	**-AP option**	w/ Butterfly Damper (AF-DPR-xx) adds cross flow pitot tube

When exhaust volume flow values are desired, as in the case of implementing flow tracking control, the optional **Exhaust Flow Feedback** components are necessary. Multiple hoods with this feature can be connected together to instantaneously totalize exhaust volume for the laboratory controller-based implementation of volumetric/flow offset laboratory control schemes.

Local Occupancy Detection and **Control Disable**		
Statbus Digital Input	**SSB-DI1**	Adds 1 Digital Input for PIR connection

If **Local Occupancy Detection** and **Control Disable** functions are **both** desired on a single fume hood, an extra digital input is necessary. This optional input is purchased in addition to the passive Infrared detector (PIR) which must be sourced separately. Care must be taken with this application to avoid unnecessary activation of the controls when personnel walk past the fume hood. The Control Disable function is used where exhaust flow is intentionally turned off and it is desired to stop modulating and alarming the hood flow.

Hood Lighting Control		
Statbus Digital output	**SSB-DO1**	Adds 1 Digital output (relay)

For fume hoods with interior lighting, a digital output can be added in order to control the light through the FHC-SD display interface.

NB-GPC^{FHC}
Fume Hood Controller

EQUIPMENT	PART NUMBER	NOTES
Fume Hood Controller	**NB-FHC1-BDL**	BTL Listed as AAC Controllers All fume hood applications

The NB-GPC^{FHC} is a Native BACnet controller utilizing American Auto-Matrix GPC Technology.

In combination with the FHC-SD color touch-screen local user interface, the NB-GPC^{FHC} offers unprecedented technology combined with flexibility of control found nowhere else in the industry today.

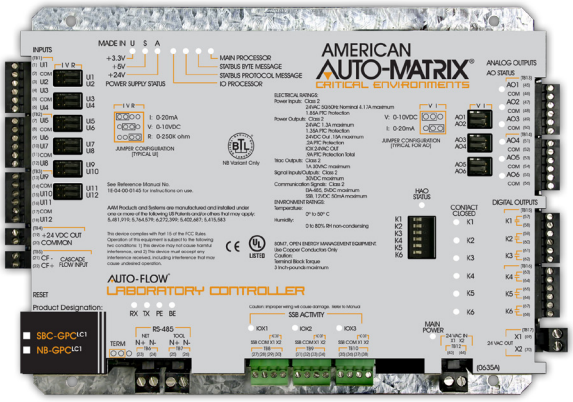
Through this controller, fume hoods can be configured to support a number of control methodologies including face velocity, hot wire, vortex shedding, and sash position methods through a single controller.

NB-GPC^{LC1}
Laboratory Controller

EQUIPMENT	PART NUMBER	NOTES
Laboratory Controller	**NB-GPCLC1**	BTL Listed as AAC Controllers All fume hood applications

The AAM Laboratory Controller is a special variant of the established GPC family of 32 bit processor,flexible BACnet (or PUP) programmable controllers. Beyond the robust and powerful features of the standard GPC, this controller is specially refined for laboratory use. The product includes Control Loops designed to process 20 times per second.

In addition to Schedules, intrinsic alarming, and many other standard BACnet objects, it supports special accumulator objects that accept the totalized fume hood exhaust flow volumes so that volumetric offset/flow-tracking concepts can be easily applied in a laboratory setting.



APPLICATION NOTES

- This application uses the AAM high speed over-shaft actuator which modulates a full 90 degrees of travel in 1 1/2 seconds. This actuator also has non-contact damper position feedback as a standard feature.
- The Damper Assembly is manufactured from Type 1 PVC Schedule 40 Laboratory duct material with 300 Series Stainless Steel components and PEEK™ bearings. Although this type of damper is often criticized for its non-linear characteristics, the closed loop control obviates this objection. Moreover, the valve characteristics are also linearized in the controller.
- The patented precision pressure transmitter uses a straightforward torsion beam operating principle. An inert slack membrane forces against a torsion beam and photosensors sense the beam deflection. The device does not allow a flow-through of potentially contaminated air and with this method only highly corrosion resistant materials are ever exposed to the exhaust stream.
- The Face Velocity method represents a complete engineered solution designed to accurately control face velocity through measurement in the plane of the sash. Conforming to ASHRAE Standard 110, this method combines ultra low pressure sensors, high accuracy air velocity sensors, BACnet DDC control, high speed electronic actuators, and precision control dampers, to create a safe and energy efficient critically controlled environment. The patented Auto-Flow Face Velocity method is the only method that actually offers complete closed loop control. Auto-Flow Patent Numbers: 5,402,687; 5,415,583; 5,481,919; 5,764,579; 5,920,488; 5,946,221; 6,272,399.

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