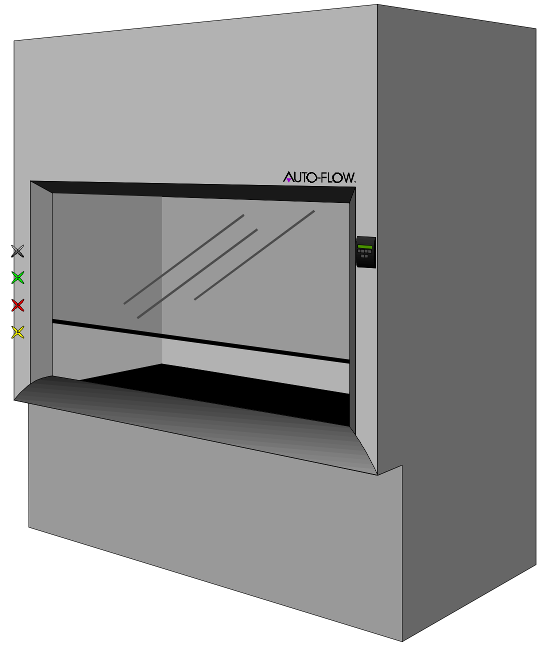
Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide

Application #1

Single Bench Fume Hood



In this Sequence:

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Sequence of Operation

Application #1: Single Bench Fume Hood

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LEDs capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood and perpendicular to the sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If velocity continues to fall below setpoint, the controller generates a local alarm (as described in the alarming section) after an adjustable time delay. When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If velocity continues to rise above setpoint, the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Such devices usually consist of emergency panic pushbuttons located at the exits of a space. Initiation of either device positions the hood exhaust damper to an user-defined fixed position. In this mode the controller display indicates that the hood is in emergency mode while the audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

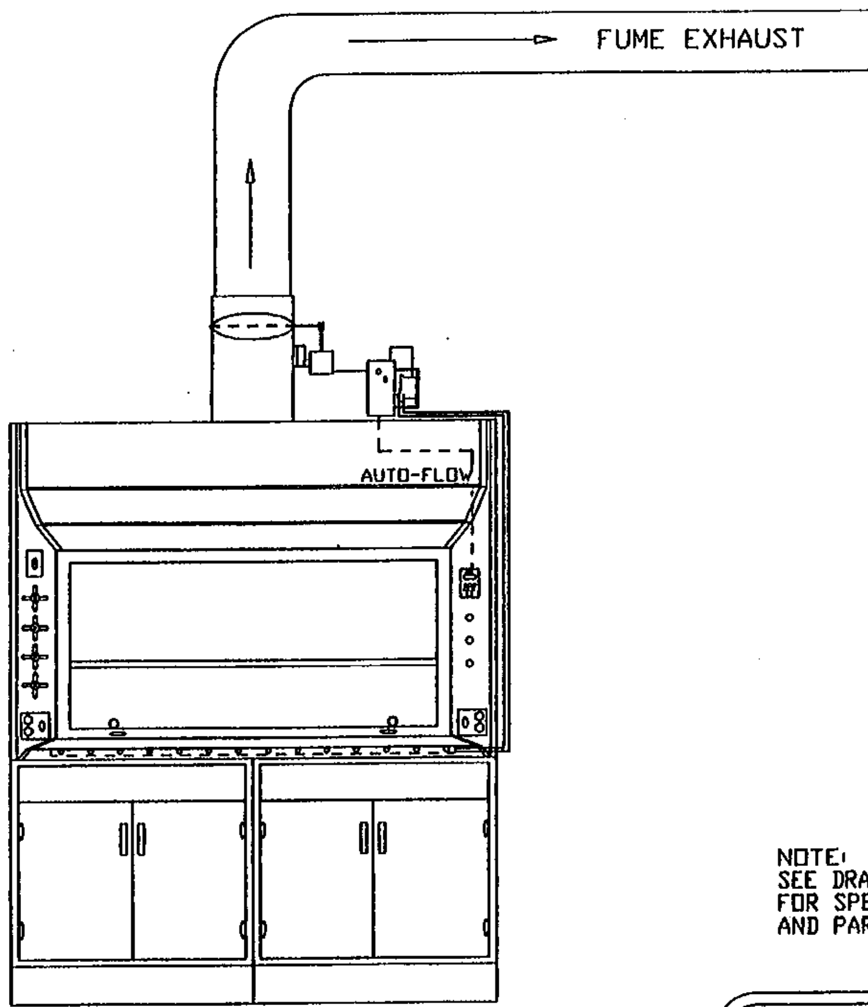
Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms can be silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that mimics the operation of the built-in audible alarm.

SINGLE BENCH HOOD

PROJECT: SAMPLE Standard Application #1				PROJECT NO. :						DATE
										05/04/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP1	Controller	Hood Control	HC1	HC1-APP1-1	n/a	n/a	n/a	n/a		
APP1	Transmitter	Hood Face Velocity	FVR-1A	FVR-APP1-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP1	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP1-1	n/a	n/a	n/a	n/a		4-foot Hood
APP1	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP1-1	n/a	n/a	n/a	n/a		
APP1	Damper & Actuator	Hood Exhaust	PDA-8-NO-HM	PDAX-APP1-1	750	150	N/O	4-20 mA		4-foot Hood



BENCH TYPE FUME HOOD

NOTE:
SEE DRAWING A950051
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION #1	DRAWN: LHP	AUTO-FLOW
	ENGR: RVF	
	CHKD: RVF	SINGLE BENCH FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940041

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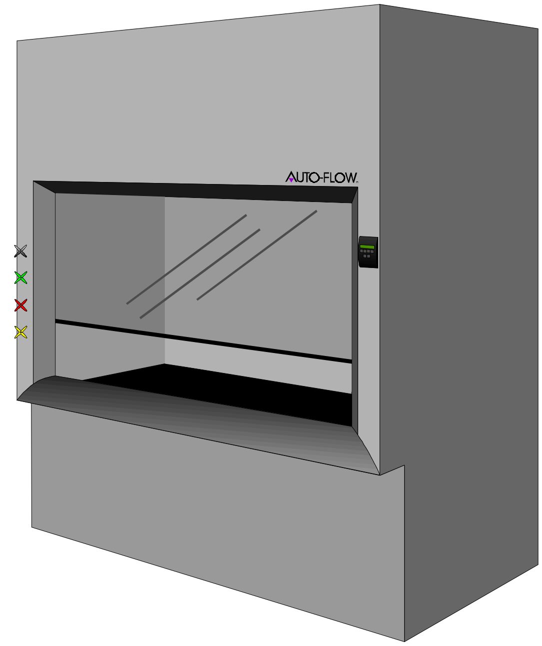
Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #2

Single Walk-in or Distillation Fume Hood

In this Sequence:

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #2: Single Walk-in or Distillation Fume Hood

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening with a space pressure primary sensor. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading acts as the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop 20 times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If velocity continues to rise above setpoint, the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

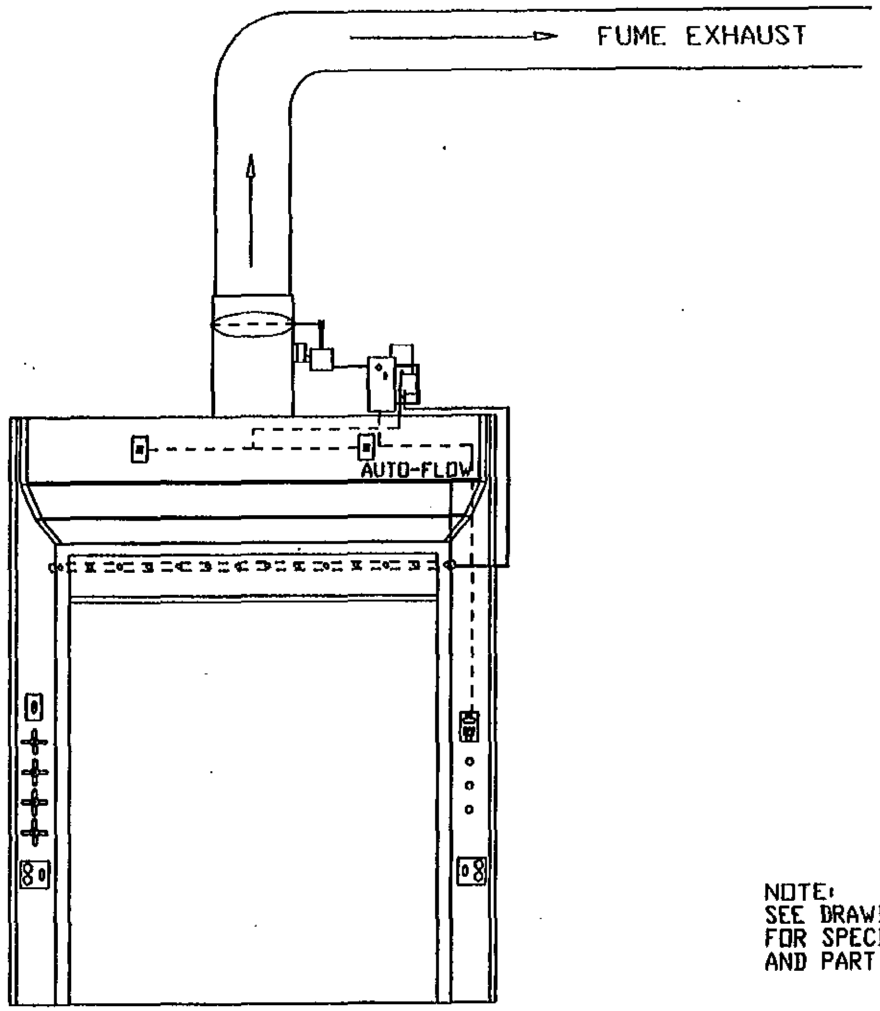
The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

	Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Table 1	**Velocity Low**	<90 FPM	Yellow LED and pulsing audible alarm
	Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module.. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

SINGLE WALK-IN HOOD

PROJECT: SAMPLE Standard Application #2				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP2	Controller	Hood Control	HC1	HC1-APP2-1	n/a	n/a	n/a	n/a		
APP2	Transmitter	Hood Face Velocity	FVR-1B	FVR-APP2-1	n/a	n/a	n/a	0.0 - 0.003 "wc		
APP2	Space Press. Prim.	Hood Face Velocity	SPP1-51	SPP-APP2-1	n/a	n/a	n/a	n/a		5-foot Walk-in Hood
APP2	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP2-1	n/a	n/a	n/a	n/a		
APP2	Damper & Actuator	Hood Exhaust	PDA-10-NO-HM	PDAX-APP2-1	2250	280	N/O	4-20 mA		5-foot Walk-in Hood



WALK-IN OR DISTILLATION
TYPE FUME HOOD

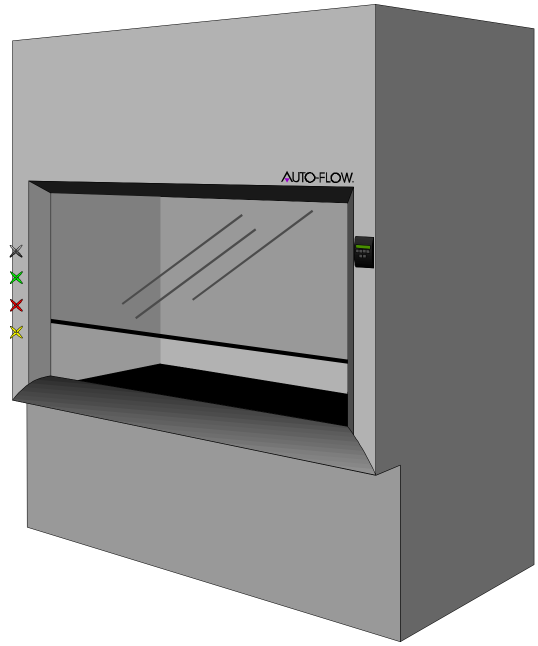
NOTE:
SEE DRAWING A950052
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION #2	DRAWN LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE WALK-IN HOOD FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940042

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #3

Single Bench Fume Hood with Air Flow Tracking

In this Sequence:

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #3: Single Bench Fume Hood with Air Flow Tracking

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LEDs capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

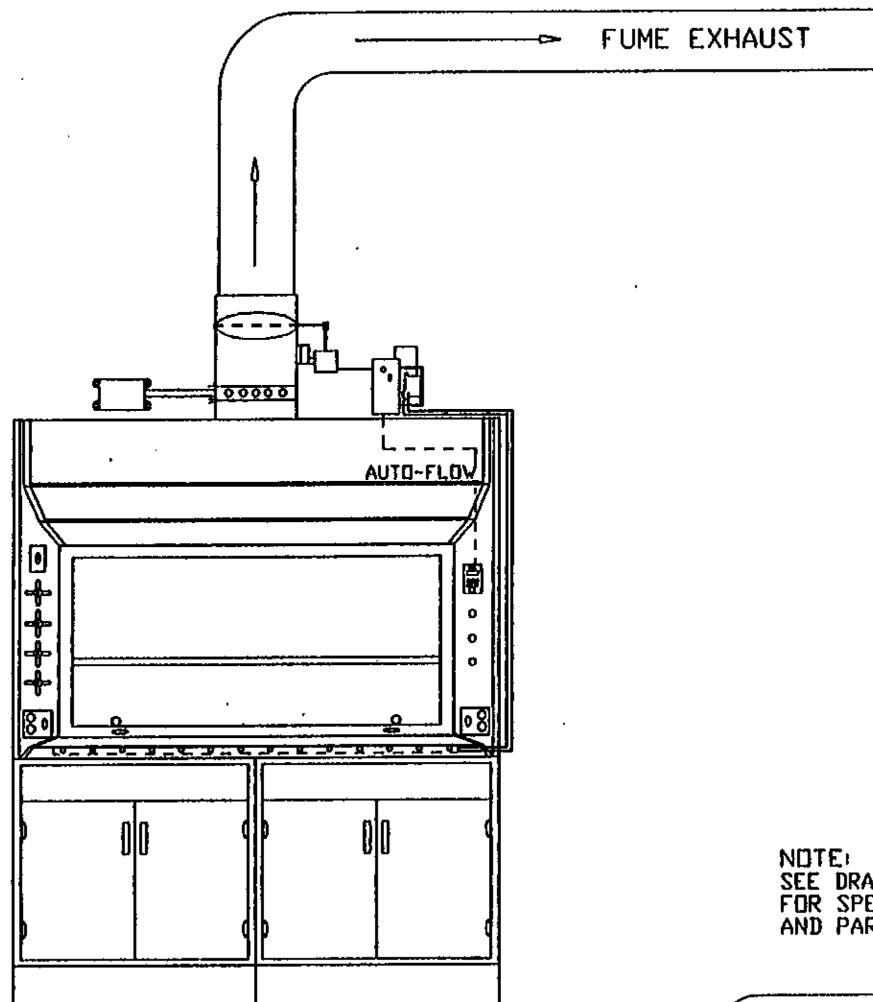
Table 1	**Velocity Unsafe**	<80 FPM or >120 FPM	Red LED and continuous audible alarm
	Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
	Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controler's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period.

After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

SINGLE BENCH HOOD with Air Flow Tracking Capability

PROJECT: SAMPLE Standard Application #3				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP3	Controller	Hood Control	HC1	HC1-APP3-1	n/a	n/a	n/a	n/a		
APP3	DP Transmitter	Hood Face Velocity	FVR-1A	FVR-APP3-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP3	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP3-1	n/a	n/a	n/a	n/a		4-foot Hood
APP3	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP3-1	n/a	n/a	n/a	n/a		
APP3	Damper & Actuator	Hood Exhaust	CPP-P-8-NO-HM	CPPX-APP3-1	750	150	N/O	4-20 mA		4-foot Hood
APP3	DP Transmitter	Hood Exhaust CFM	FTR-0.5	FTRX-APP3-1	988	0	n/a	4-20 mA		



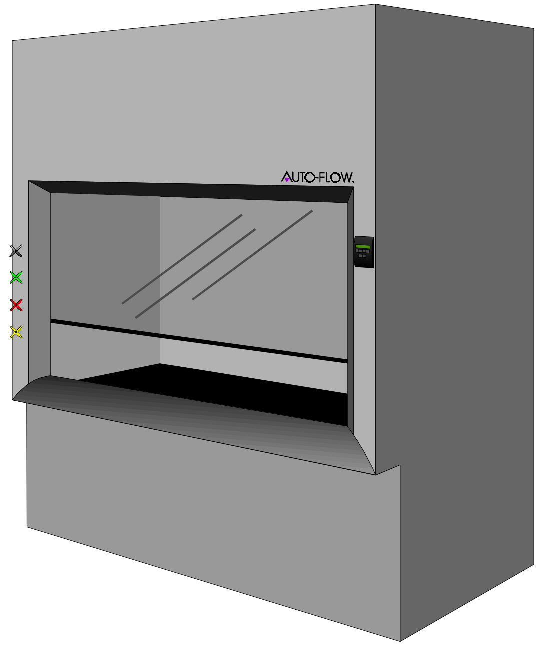
BENCH TYPE FUME HOOD
W/EXHAUST FLOW MEASUREMENT

NOTE:
SEE DRAWING A950053
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 3	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE BENCH
	DATE: 9-13-95	AIR FLOW TRACKING FLOW DIAGRAM
	SHEET OF	DRAWING NO. A940043

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #4

Single Walk-in or Distillation Fume Hood with Air Flow Tracking

In this Sequence:

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #4: Single Walk-in or Distillation Style Fume Hood with Air Flow Tracking

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has built-in local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the space pressure primary sensor method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

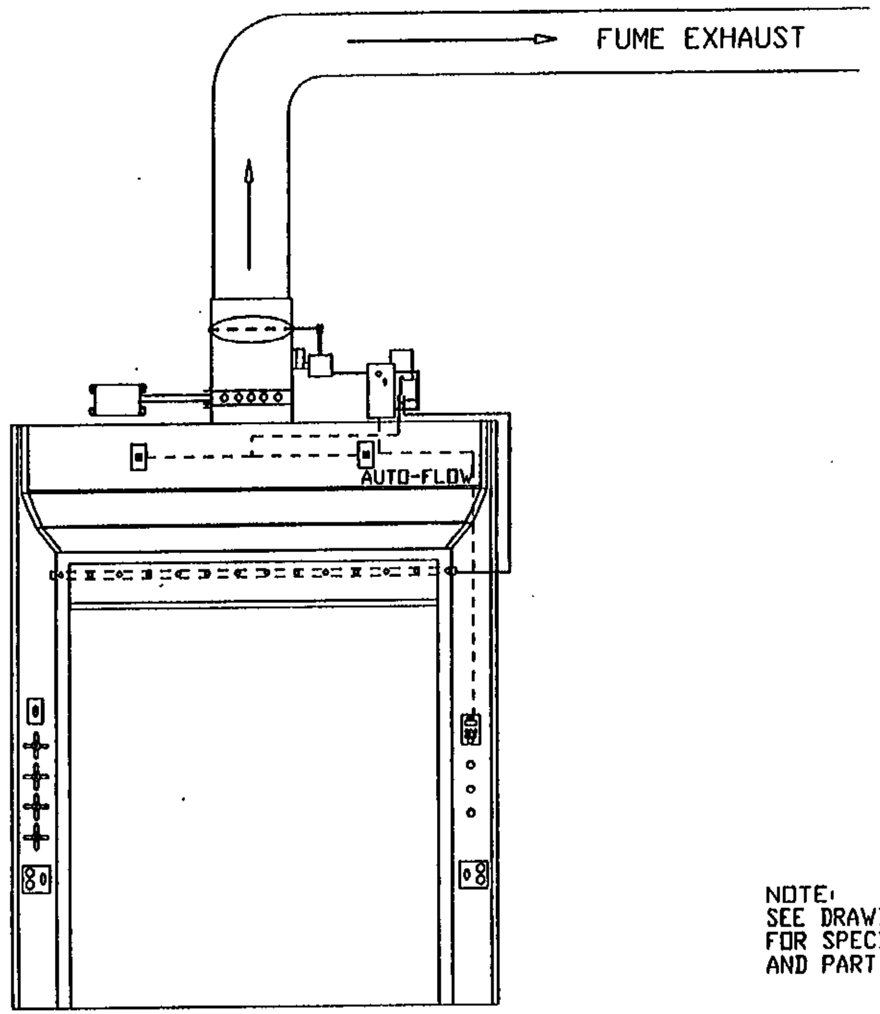
The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

Table 1			
	Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
	Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
	Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

SINGLE WALK-IN HOOD w/Air Flow Tracking

PROJECT: SAMPLE Standard Application #4				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP4	Controller	Hood Control	HC1	HC1-APP4-1	n/a	n/a	n/a	n/a		
APP4	Transmitter	Hood Face Velocity	FVR-1B	FVR-APP4-1	n/a	n/a	n/a	0.0 - 0.003 "wc		
APP4	Space Press. Prim.	Hood Face Velocity	SPP1-51	SPP-APP4-1	n/a	n/a	n/a	n/a		5-foot Walk-in Hood
APP4	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP4-1	n/a	n/a	n/a	n/a		
APP4	Damper & Actuator	Hood Exhaust	CPP-P-10-NO-HM	CPPX-APP4-1	2100	280	N/O	4-20 mA		5-foot Walk-in Hood
APP4	DP Transmitter	Hood Exhaust CFM	FTR-1.0	FTRX-APP4-1	2184	0	n/a	0.0 to 1.0"wc		



NOTE:
SEE DRAWING A950054
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

WALK-IN OR DISTILLATION
TYPE FUME HOOD W/EXHAUST
FLOW MEASUREMENT

TYPICAL FUME HOOD LAB APPLICATION # 4	DRAWN: LIP	AUTO-FLOW DMC TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE WALK IN HOOD AIR FLOW TRACKING FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940044

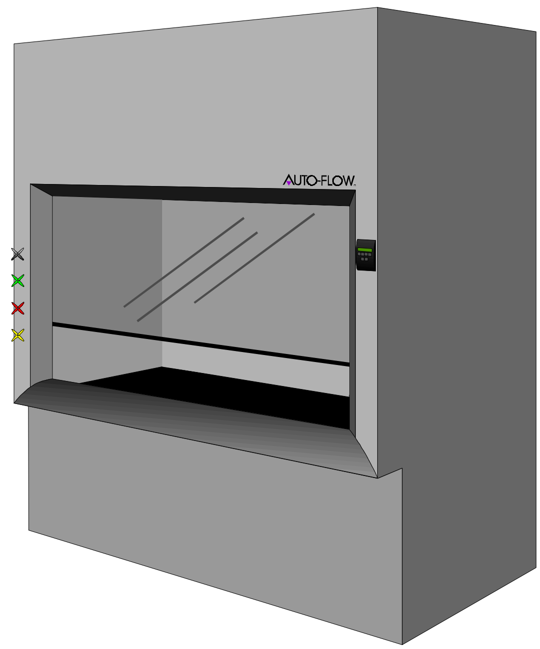
AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide

Application #5

Single Bench Fume Hood with
Auxiliary Makeup Supply Air



In this Sequence:

- *General*
- *Exhaust Control*
- *Auxiliary Makeup Air Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #5: Single Bench Fume Hood with Auxiliary Makeup Supply Air

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of displaying scaled point values and English language text point descriptors simultaneously
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Exhaust Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading acts as the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face

velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Auxiliary Makeup Air Control

The controller measures the exhaust air flow volume leaving the fume hood with a parallel plate pitot array in the fume hood exhaust duct. The controller also measures the auxiliary supply air being delivered to the hood with a parallel plate pitot array in the fume hood auxiliary supply air duct. These measurements are scaled into cubic feet per minute. The controller executes a process loop using a proportional, integral, derivative equation. The auxiliary supply air flow reading acts as the measured variable for the controller's PID loop. The setpoint for auxiliary supply air is seventy percent (adjustable) of the measured fume hood exhaust volume. The controller's PID output is characterized within the controller software in order to calculate an equal percentage control output to the fume hood auxiliary supply air damper. The fume hood auxiliary supply air damper is positioned as required by the controller with a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. If the supply air flow falls below the desired setpoint the controller modulates the normally closed fume hood auxiliary supply air damper toward the open position. If the supply air flow rises above the desired setpoint the controller modulates the normally closed fume hood auxiliary supply air damper toward the closed position. The fume hood exhaust flow measurement is also used by the laboratory pressure controller to calculate total lab exhaust volume (if required). The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

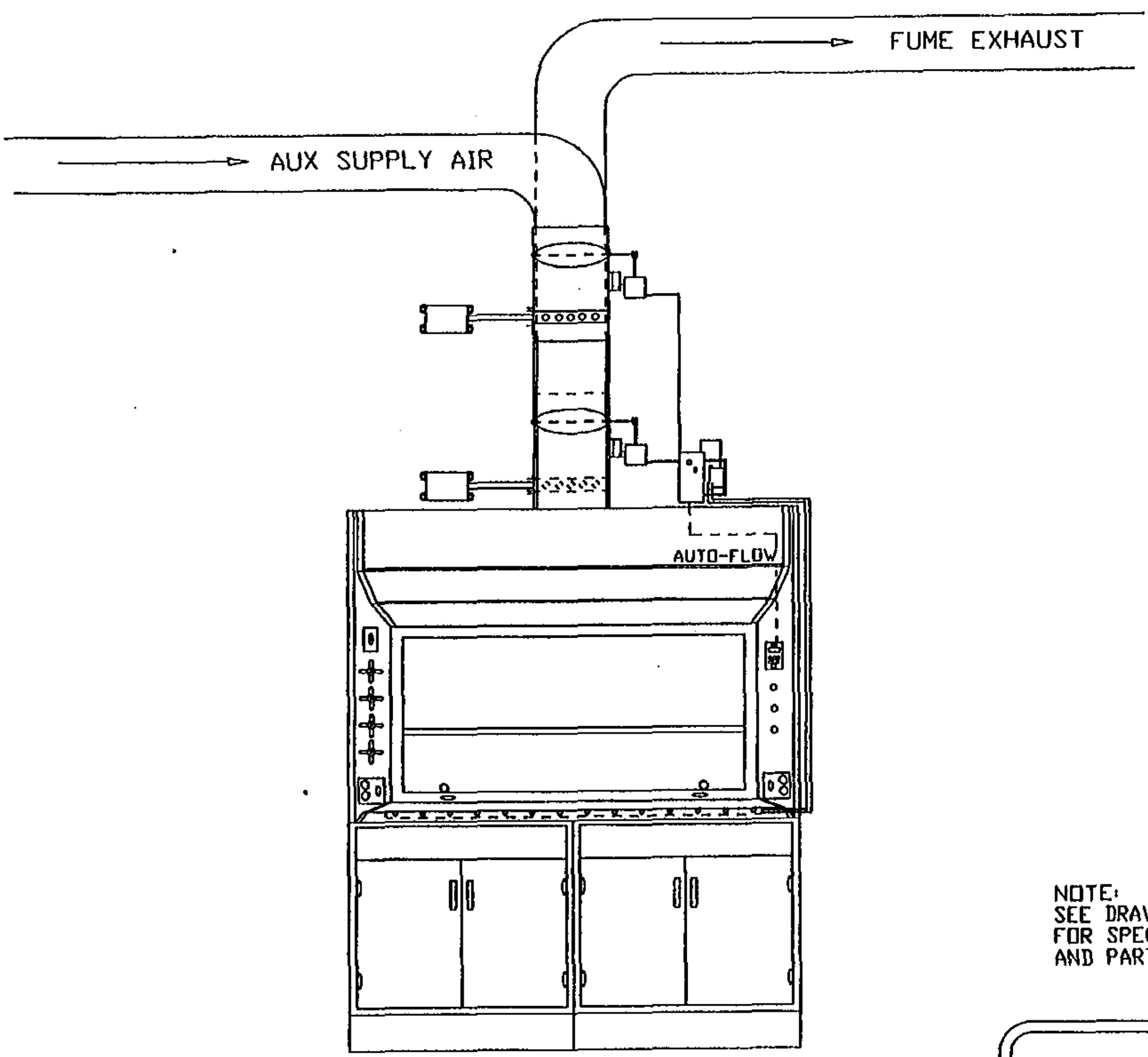
Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

The controller also allows for alarms on the exhaust and auxiliary supply air flow values based on user-adjustable limits. These alarms do not annunciate locally, they shallare transmitted over the communications network to the remote operator interface device.

SINGLE BENCH HOOD with Auxiliary Supply

PROJECT: SAMPLE Standard Application #5				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP5	Controller	Hood Control	HC1	HC1-APP5-1	n/a	n/a	n/a	n/a		
APP5	DP Transmitter	Hood Face Velocity	FVR-1A	FVR-APP5-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP5	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP5-1	n/a	n/a	n/a	n/a		4-foot Aux. Air Hood
APP5	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP5-1	n/a	n/a	n/a	n/a		
APP5	Damper & Actuator	Hood Exhaust	CPP-P-8-NO-HM	CPPX-APP5-1	750	150	N/O	4-20 mA		4-foot Aux. Air Hood
APP5	DP Transmitter	Hood Exhaust CFM	FTR-0.5	FTRX-APP5-1	988	0	n/a	0.0 to 0.5"wc		
APP5	Damper & Actuator	Hood Supply	CPP-P-6-NC-HM	CPPS-APP5-1	525	105	N/C	4-20 mA		4-foot Aux. Air Hood
APP5	DP Transmitter	Hood Supply CFM	FTR-0.5	FTRS-APP5-1	555	0	n/a	0.0 to 0.5"wc		



BENCH TYPE FUME HOOD
W/AUXILIARY SUPPLY MAKE-UP AIR

NOTE:
SEE DRAWING PACKAGE A950055
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 5	DRAWN: LIP ENGR: RVT CHKD: RVT DATE: 9-13-95 SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 SINGLE AUX AIR BENCH HOOD AIR FLOW DIAGRAM DRAWING NO. A940045

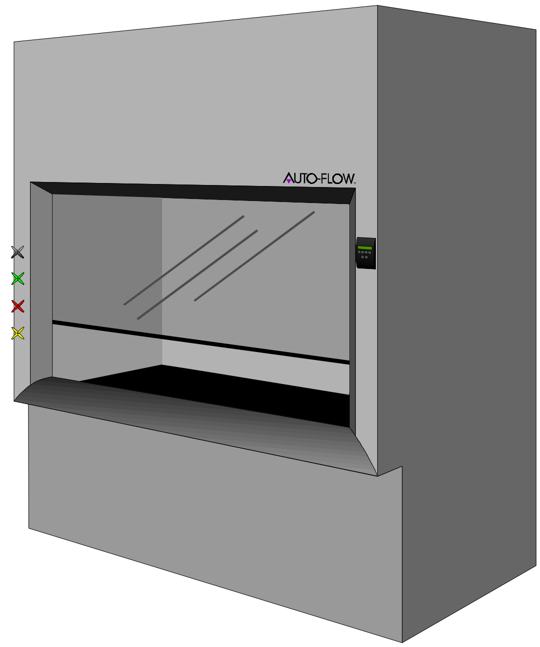
AUTO-FLOW

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide

Application #6

Single Walk-in or Distillation Fume Hood with Auxiliary Makeup Supply Air



In this Sequence:

- *General*
- *Exhaust Control*
- *Auxiliary Makeup Air Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #6: Single Walk-in or Distillation Fume Hood with Auxiliary Makeup Supply Air

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has built-in local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of displaying scaled point values and English language text point descriptors simultaneously
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Exhaust Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the space pressure primary sensor method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Auxiliary Makeup Air Control

The controller measures the exhaust air flow volume leaving the fume hood with a parallel plate pitot array in the fume hood exhaust duct. The controller also measures the auxiliary supply air being delivered to the hood with a parallel plate pitot array in the fume hood auxiliary supply air duct. These measurements are scaled into cubic feet per minute. The controller executes a process loop using a proportional, integral, derivative equation. The auxiliary supply air flow reading acts as the measured variable for the controller's PID loop. The setpoint for auxiliary supply air is seventy percent (adjustable) of the measured fume hood exhaust volume. The controller's PID output is characterized within the controller software in order to calculate an equal percentage control output to the fume hood auxiliary supply air damper. The fume hood auxiliary supply air damper is positioned as required by the controller with a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. If the supply air flow falls below the desired setpoint the controller modulates the normally closed fume hood auxiliary supply air damper toward the open position. If the supply air flow rises above the desired setpoint the controller modulates the normally closed fume hood auxiliary supply air damper toward the closed position. The fume hood exhaust flow measurement is also used by the laboratory pressure controller to calculate total lab exhaust volume (if required). The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

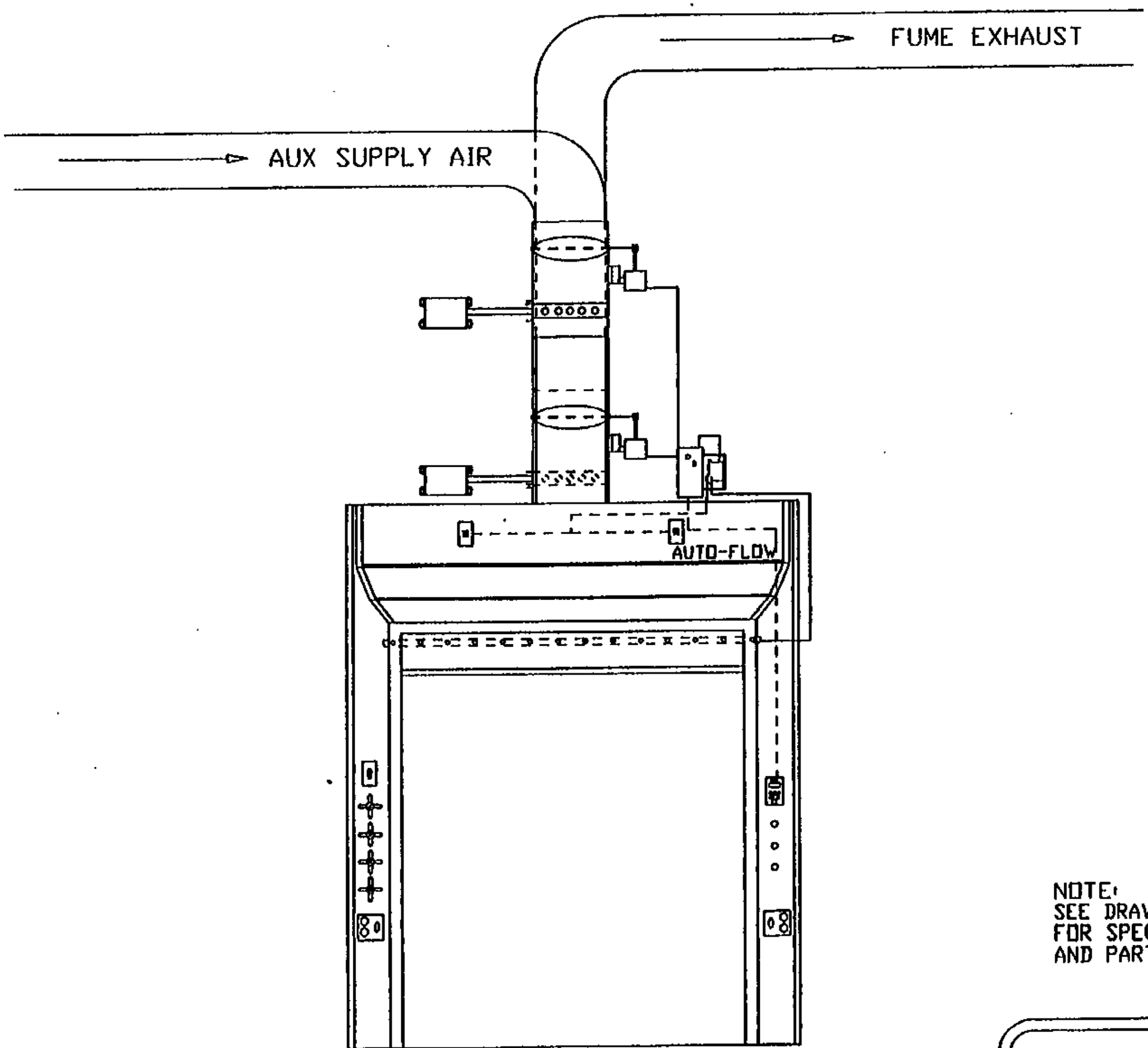
In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also allows for alarms on the exhaust and auxiliary supply air flow values based on user-adjustable limits. These alarms do not annunciate locally, they are transmitted over the communications network to the remote operator interface device.

Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

SINGLE WALK-IN HOOD w/Auxiliary Supply Air

PROJECT: SAMPLE Standard Application #6				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP6	Controller	Hood Control	HC1	HC1-APP6-1	n/a	n/a	n/a	n/a		
APP6	Transmitter	Hood Face Velocity	FVR-1B	FVR-APP6-1	n/a	n/a	n/a	0.0 - 0.003 "wc		
APP6	Space Press. Prim.	Hood Face Velocity	SPP1-51	SPP-APP6-1	n/a	n/a	n/a	n/a		5-foot Walk-in w/Aux.
APP6	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP6-1	n/a	n/a	n/a	n/a		
APP6	Damper & Actuator	Hood Exhaust	CPP-P-10-NO-HM	CPPX-APP6-1	2100	280	N/O	4-20 mA		5-foot Walk-in w/Aux.
APP6	DP Transmitter	Hood Exhaust CFM	FTR-1.0	FTRX-APP6-1	2184	0	n/a	0.0 to 1.0"wc		
APP6	Damper & Actuator	Hood Supply	CPP-P-8-NC-HM	CPPS-APP6-1	1470	200	N/C	4-20 mA		5-foot Walk-in w/Aux.
APP6	DP Transmitter	Hood Supply CFM	FTR-1.25	FTRS-APP6-1	1563	0	n/a	0.0 to 1.25"wc		



WALK-IN OR DISTILLATION TYPE FUME
HOOD W/AUXILIARY SUPPLY MAKE-UP AIR

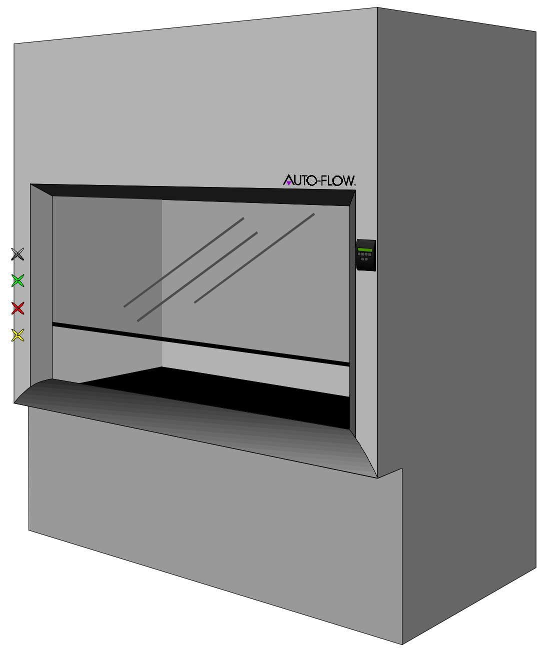
NOTE:
SEE DRAWING A950056
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 6	DRAWN: LHP	AUTO-FLOW
	ENGR: RVF	
	CHKD: RVF	SINGLE AUX AIR WALK-IN HOOD AIR FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940046

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #7

Single Supply for Pressure Control

In this Sequence:

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Alarming*

Bill of Material
Drawing

Application #7: Single Supply for Pressure Control

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels which supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network will have no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, and is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

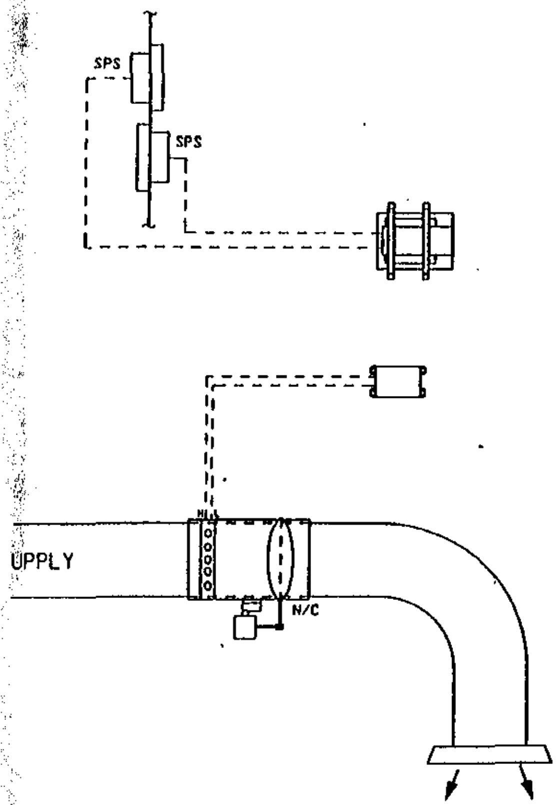
The controller measures the supply air flow delivered to the laboratory using a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. If the measured supply air flow volume falls below its desired minimum air flow rate, as required to maintain the necessary air changes per hour, the pressure control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume go above the desired maximum air flow rate the pressure control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Alarming

The controller provides the capability to alarm based on actuator failures related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarms involving the supply air flow or total pressure differential measurements that are based on user adjustable limits. These alarms are not annunciated locally, they are transmitted via the communications network to the remote operator interface device.

SINGLE SUPPLY PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #7				PROJECT NO. :						DATE
										05/09/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP7	Controller	Room Control	LC-1	LC1-APP7	n/a	n/a	n/a	n/a		
APP7	Damper & Actuato	Room Supply Contro	CPP-P-10-NC-IL	CPPS-APP7	1000	125	N/C	4-20 mA		
APP7	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP7	1000	0	n/a	0.0 to 0.25"wc		
APP7	Transmitter	Room Pressure	SPR-1A	SPR-APP7	n/a	n/a	n/a	0.0 to 0.01"wc		
APP7	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP7-1A	n/a	n/a	n/a			
				SPS-APP7-1B	n/a	n/a	n/a			

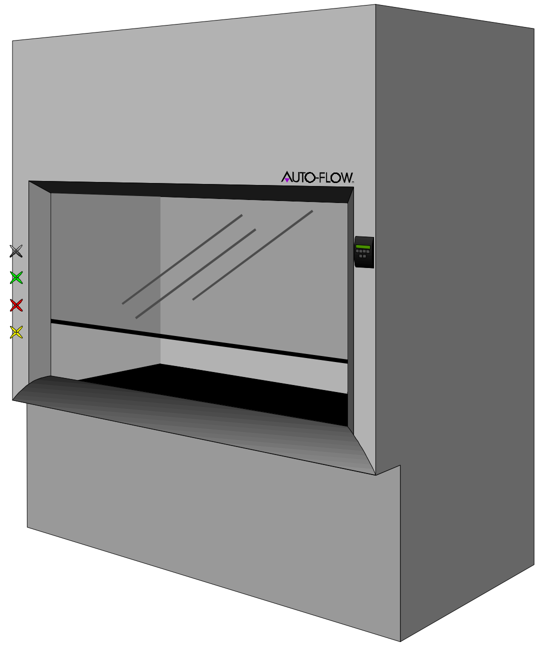


NOTE:
SEE DRAWING A950059
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 7	DRAWN: LIP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVF	
	CHKD: RVF	SINGLE SUPPLY PRESSURE CONTROL FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940047

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #8

Single Supply for Air Flow Control

In this Sequence:

- *General*
- *Air Flow Control*
- *Volume Limit Control*
- *Alarming*

Bill of Material
Drawing

Sequence of Operation

Application #8: Single Supply for Air Flow Control

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions independently of the network for all lab control aspects so that a failure of the communications network has no effect over laboratory pressure control.

Air Flow Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow is the measured variable for the controller's PID loop. The setpoint for supply air flow is reset from local fume hood controllers or remotely from the BAS system. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned as required by the controller by a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop a minimum of five times per second. If the supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If the supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

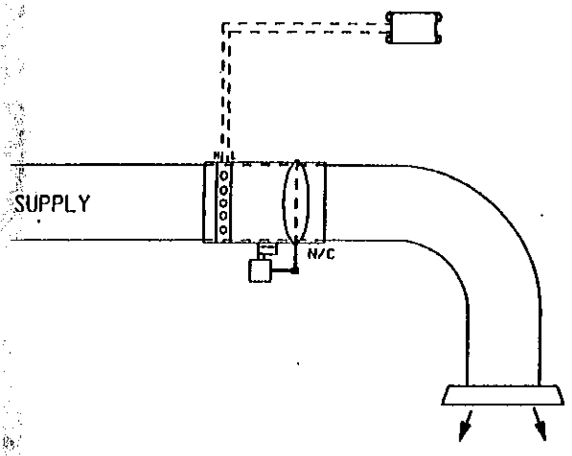
If the measured supply air flow volume falls below its desired minimum rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. If the measured supply air flow volume rises above its desired maximum air flow rate (adjustable) the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Alarming

The controller provides the capability to alarm based on actuator failures related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarms involving the supply air flow or total pressure differential measurements that are based on user adjustable limits. These alarms are not annunciated locally, they are transmitted via the communications network to the remote operator interface device.

SINGLE SUPPLY AIR FLOW CONTROL

PROJECT: SAMPLE Standard Application #8				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP8	Controller	Room Control	LC-1	LC1-APP8	n/a	n/a	n/a	n/a		
APP8	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP8	1000	125	N/C	4-20 mA		
APP8	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP8	1000	0	n/a	0.0 to 0.25"wc		

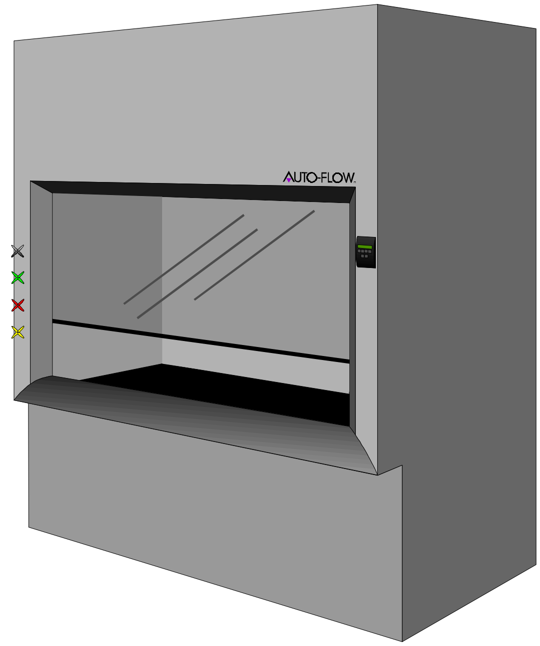


NOTE:
SEE DRAWING A9500510
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 8	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVF	
	CHKD: RVF	SINGLE SUPPLY AIR FLOW TRACKING FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940048

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #9

Single Supply/General Exhaust for Pressure Control with Temperature Override

In this Sequence:

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Override*
- *Alarming*

Bill of Material
Drawing

Application #9: Single Supply/General Exhaust for Pressure Control with Temperature Override

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop a minimum of five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes a complete control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Override

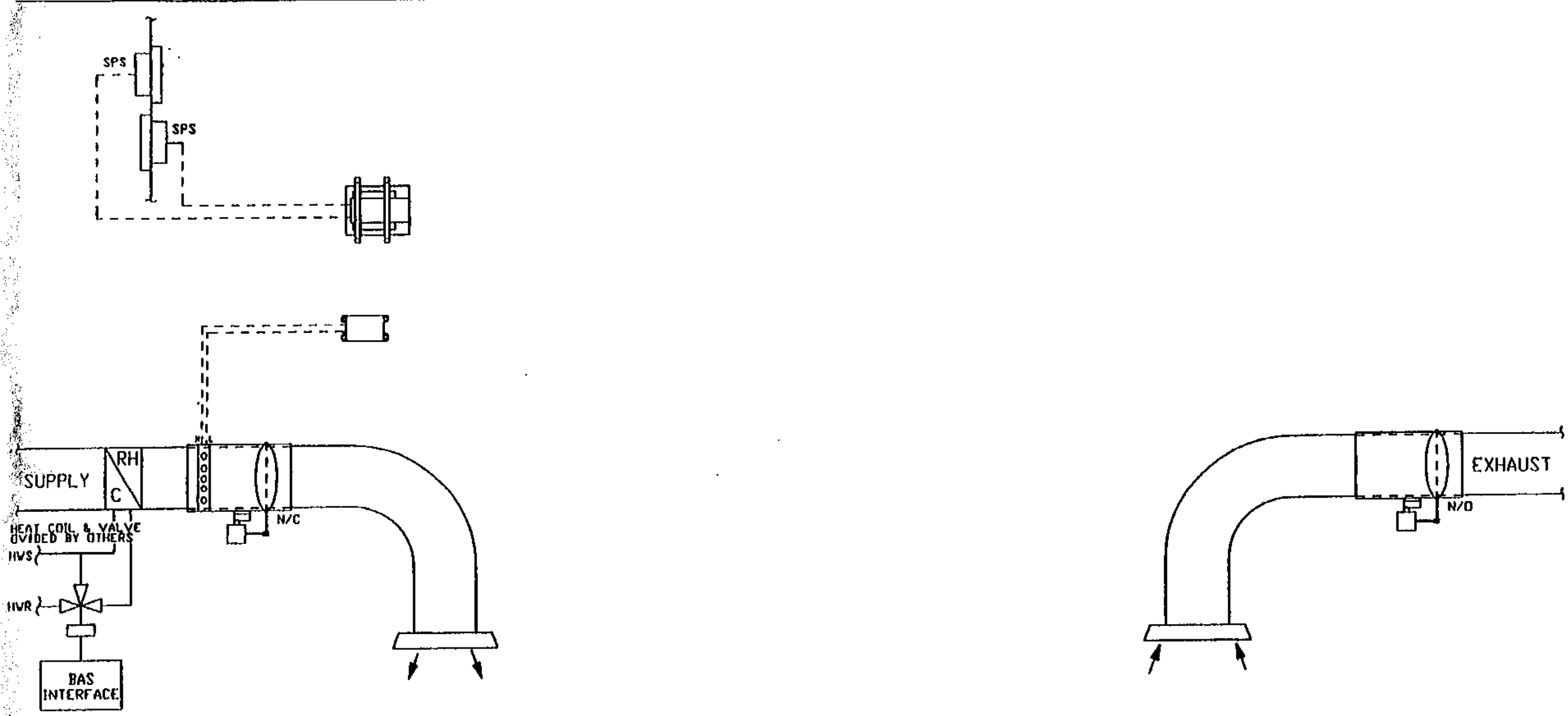
The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory temperature. As the supply override signal increases, the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate).

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for alarms on the supply air flow and general exhaust air flow measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #9				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP9	Controller	Room Control	LC-1	LC1-APP9	n/a	n/a	n/a	n/a		
APP9	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP9	1000	125	N/C	4-20 mA		
APP9	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP9	1000	0	n/a	0.0 to 0.25"wc		
APP9	Transmitter	Room Pressure	SPR-1A	SPR-APP9	n/a	n/a	n/a	0.0 to 0.01"wc		
APP9	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP9-1A	n/a	n/a	n/a			
				SPS-APP9-1B	n/a	n/a	n/a			
APP9	Damper & Actuator	Room Gen. Exh. Control	PDA-10-NO-IL	PDAX-APP9	1100	225	N/C	4-20 mA		



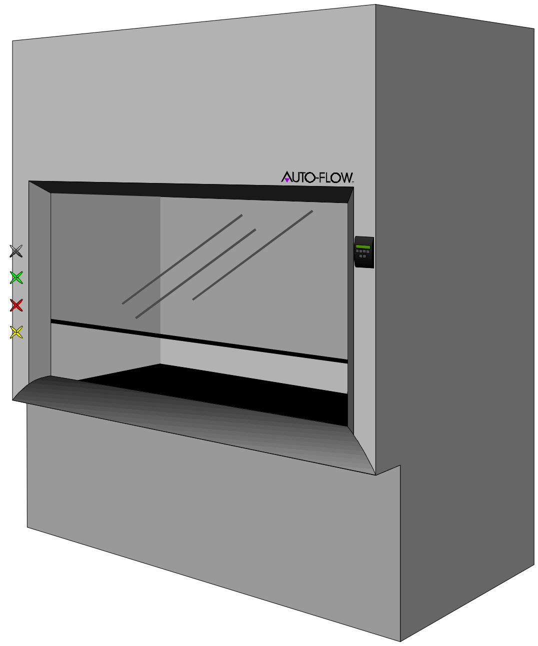
NOTE:
SEE DRAWINGS A9500513 & A9500515
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 9	DRAWN: LHP	AUTO-FLOW
	ENGR: RVT	SINGLE SUPPLY/EXHAUST
	CHKD: RVT	PRESSURE CONTROL FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A940049

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #10

Single Supply/General Exhaust for Air Flow Control with Temperature Override

In this Sequence:

- *General*
- *Air Flow Control*
- *Temperature Override*
- *Volume Limit Control*
- *Alarming*

Bill of Material
Drawing

Application #10: Single Supply/General Exhaust for Air Flow Control with Temperature Override

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in the laboratory supply air duct and it measures the exhaust air flow with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flow is the measured variable for one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal. The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Supply CFM + ΔCFM Setpoint

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Override

The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory temperature. As the supply override signal increases, the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate).

Volume Limit Control

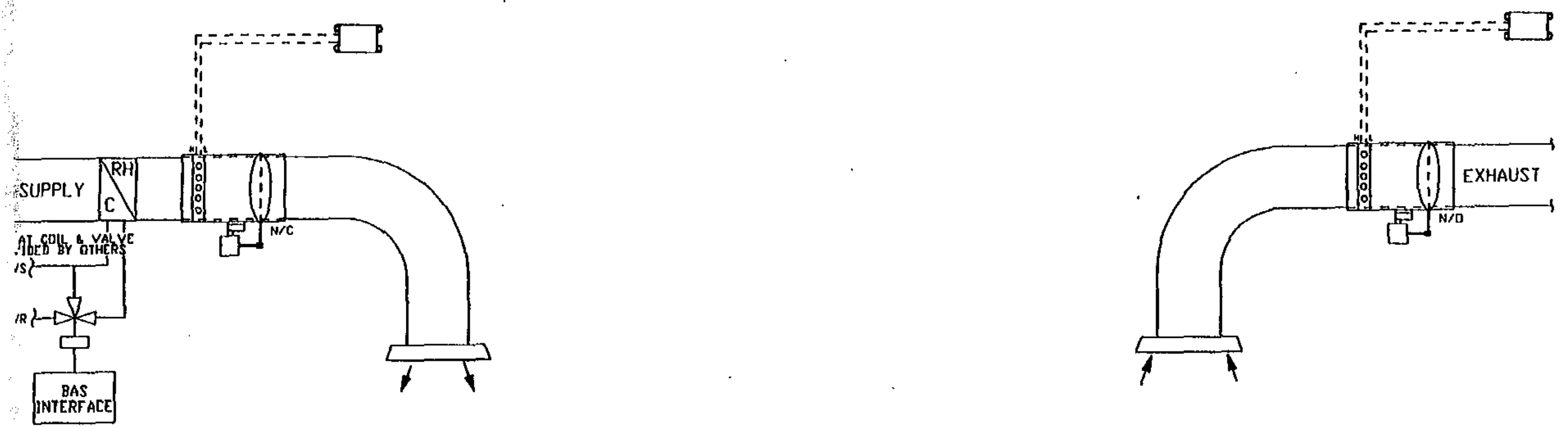
Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable), the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for alarms on the supply air flow and general exhaust air flow measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST AIR FLOW CONTROL

PROJECT: SAMPLE Standard Application #10				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP10	Controller	Room Control	LC-1	LC1-APP10	n/a	n/a	n/a	n/a		
APP10	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP10	1000	125	N/C	4-20 mA		
APP10	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP10	1000	0	n/a	0.0 to 0.25"wc		
APP10	Damper & Actuator	Room Gen. Exh. Control	CPP-P-10-NO-IL	CPPS-APP10	1100	225	N/C	4-20 mA		
APP10	DP Transmitter	Room Gen. Exh. CFM	FTR-0.5	FTRS-APP10	1415	0	n/a	0.0 to 0.5"wc		



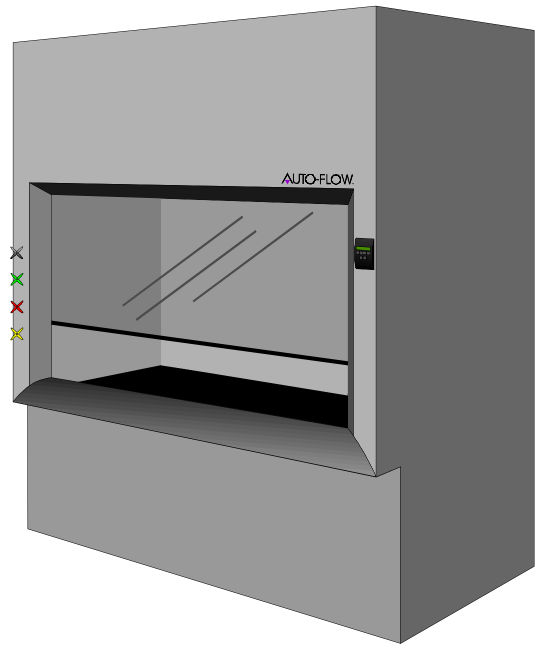
NOTE:
SEE DRAWINGS A9500514 & A9500516
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 10	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVF	
	CHKD: RVF	SINGLE SUPPLY/EXHAUST AIR FLOW TRACKING FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9100410

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #11

Single Supply/General Exhaust for Pressure Control with Full Temperature Control

In this Sequence:

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Control*
- *Emergency Mode*
- *Alarming*

Bill of Material
Drawing

Application #11: Single Supply/General Exhaust for Pressure Control with Full Temperature Control

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network will have no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is -0.005"wc with respect to the adjacent corridor, which is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. When total pressure differential rises above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes a control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) à Supply Air Flow Rate] à 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the general exhaust air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply).

Emergency Mode

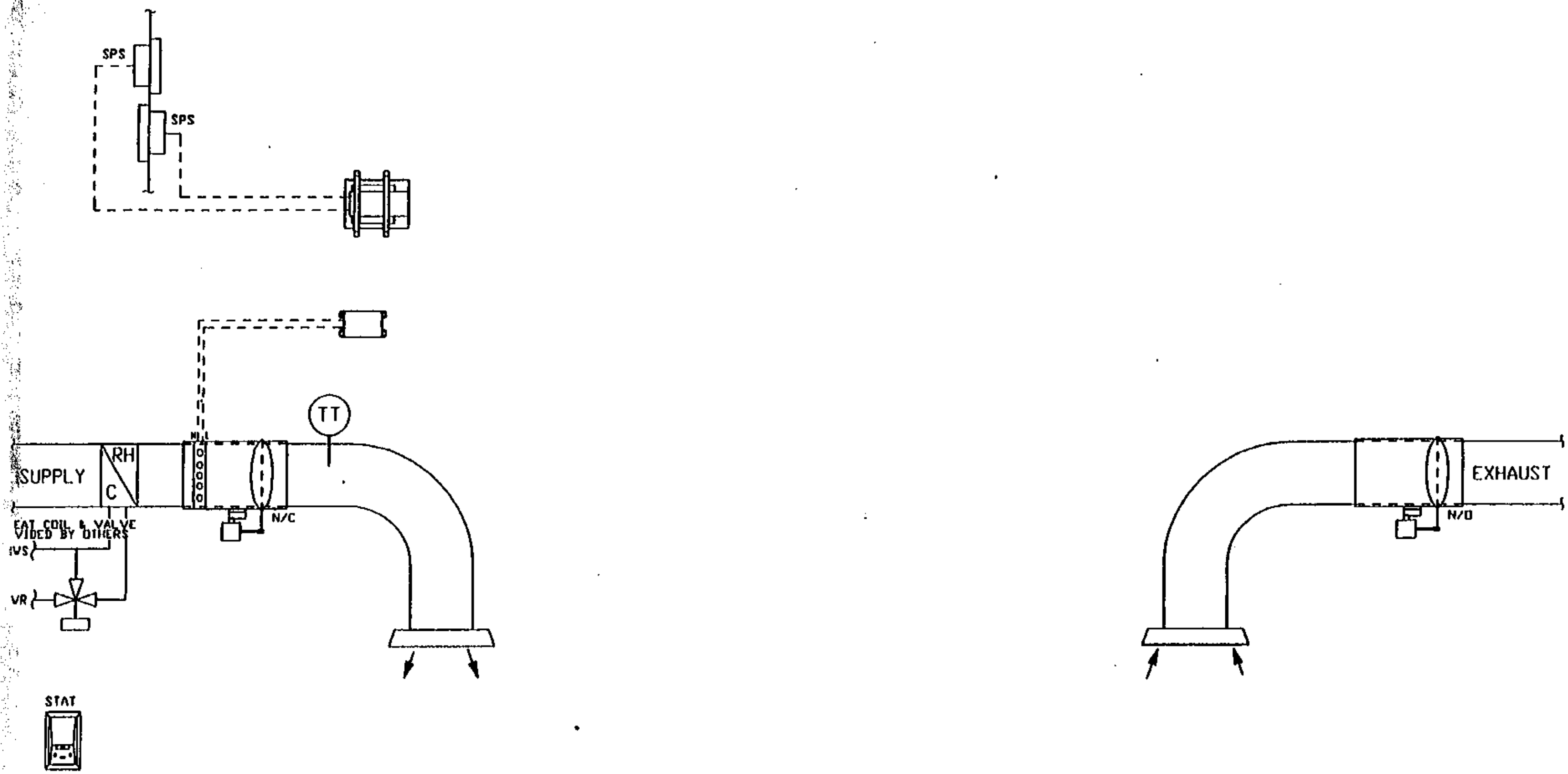
The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure, from any of the electronic actuators connected to the controller, related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the supply air flow, general exhaust air flow, supply duct temperature, space temperature or total pressure differential measurements based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST PRESSURE/TEMP CONTROL

PROJECT: SAMPLE Standard Application #11				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP11	Controller	Room Control	LC-1	LC1-APP11	n/a	n/a	n/a	n/a		
APP11	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP11	1000	125	N/C	4-20 mA		
APP11	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP11	1000	0	n/a	0.0 to 0.25"wc		
APP11	Transmitter	Room Pressure	SPR-1A	SPR-APP11	n/a	n/a	n/a	0.0 to 0.01"wc		
APP11	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP11-1A	n/a	n/a	n/a			
				SPS-APP11-1B	n/a	n/a	n/a			
APP11	Damper & Actuator	Room Gen. Exh. Control	PDA-10-NO-IL	PDAX-APP11	1100	225	N/C	4-20 mA		
APP11	Temp. Sensor	Space Temperature	STAT	STAT-APP11	n/a	n/a	n/a	-32 to 132 *F		

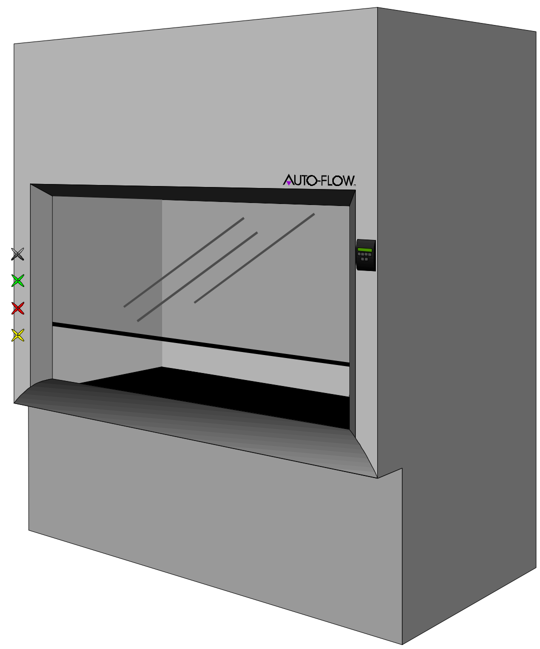


NOTE:
SEE DRAWINGS A9500511 & A9500515
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 11	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY/EXHAUST PRESSURE/TEMP FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400411

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #12

Single Supply/General Exhaust for Air Flow Control with Full Temperature Control

In this Sequence:

- *General*
- *Air Flow Control*
- *Temperature Control*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

Bill of Material
Drawing

Application #12: Single Supply/General Exhaust for Air Flow Control with Full Temperature Control

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels which supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct and measures the exhaust air flow leaving the space with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute. The controller executes its process loops with proportional, integral, and derivative control action. The supply air flow is the measured variable for one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature control. The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value which is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = (Current Supply CFM + ΔCFM Setpoint)

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller through an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. On a rise in general exhaust air flow above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures, combined with the measured supply air flow rate, are used to calculate the instantaneous BTUs used by the space to maintain temperature. The equation for this process is as follows

BTUs = [(Supply Discharge Temperature - Space Temperature) × Supply Air Flow Rate] × 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop to control the laboratory supply air damper. If BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop, controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint, the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop, controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. If the measured supply air flow volume rises above its desired maximum air flow rate the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Emergency Mode

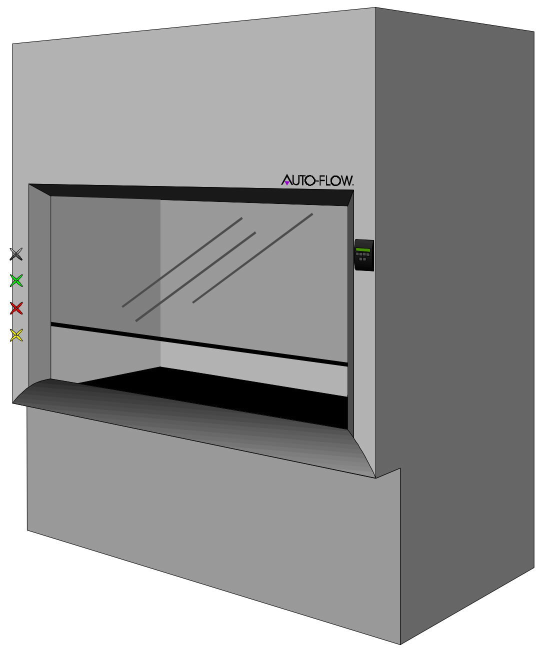
The controller has the capability to accept an external contact from an emergency push button to indicate the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure from any of the electronic actuators connected to it that is related to either loss of power or to actuator position feedback that does not meet commanded position. Additionally, the controller also allows for alarms related to the supply air flow, general exhaust air flow, supply duct temperature and space temperature measurements. The setpoints for these are alarms are based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST AIR FLOW/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #12				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP12	Controller	Room Control	LC-1	LC1-APP12	n/a	n/a	n/a	n/a		
APP12	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP12	1000	125	N/C	4-20 mA		
APP12	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP12	1000	0	n/a	0.0 to 0.25"wc		
APP12	Damper & Actuator	Room Gen. Exh. Control	CPP-P-10-NO-IL	CPPS-APP12	1100	225	N/C	4-20 mA		
APP12	DP Transmitter	Room Gen. Exh. CFM	FTR-0.5	FTRS-APP12	1415	0	n/a	0.0 to 0.5"wc		
APP12	Temp. Sensor	Space Temperature	STAT	STAT-APP12	n/a	n/a	n/a	-32 to 132 *F		



Application #13

Single Supply for Pressure Control with Single Bench Fume Hood

In this Sequence:

LABORATORY

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Alarming*

FUME HOOD

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #13: Single Supply for Pressure Control with Single Bench Fume Hood

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading acts as the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory using a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. If the measured supply air flow volume falls below its desired minimum air flow rate, as required to maintain the necessary air changes per hour, the pressure control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume go above the desired maximum air flow rate the pressure control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Alarming

The controller provides the capability to alarm based on actuator failures related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarms involving the supply air flow or total pressure differential measurements that are based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted via the communications network to the remote operator interface device.

FUME HOOD

General

The fume hood is equipped with a stand alone networkable microprocessor- based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key

- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, which is adjustable either locally or remotely. The controller's PID output is calculated by the controller software in order to calculate an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller, after an adjustable time delay, generates a local alarm as described in the alarming section.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

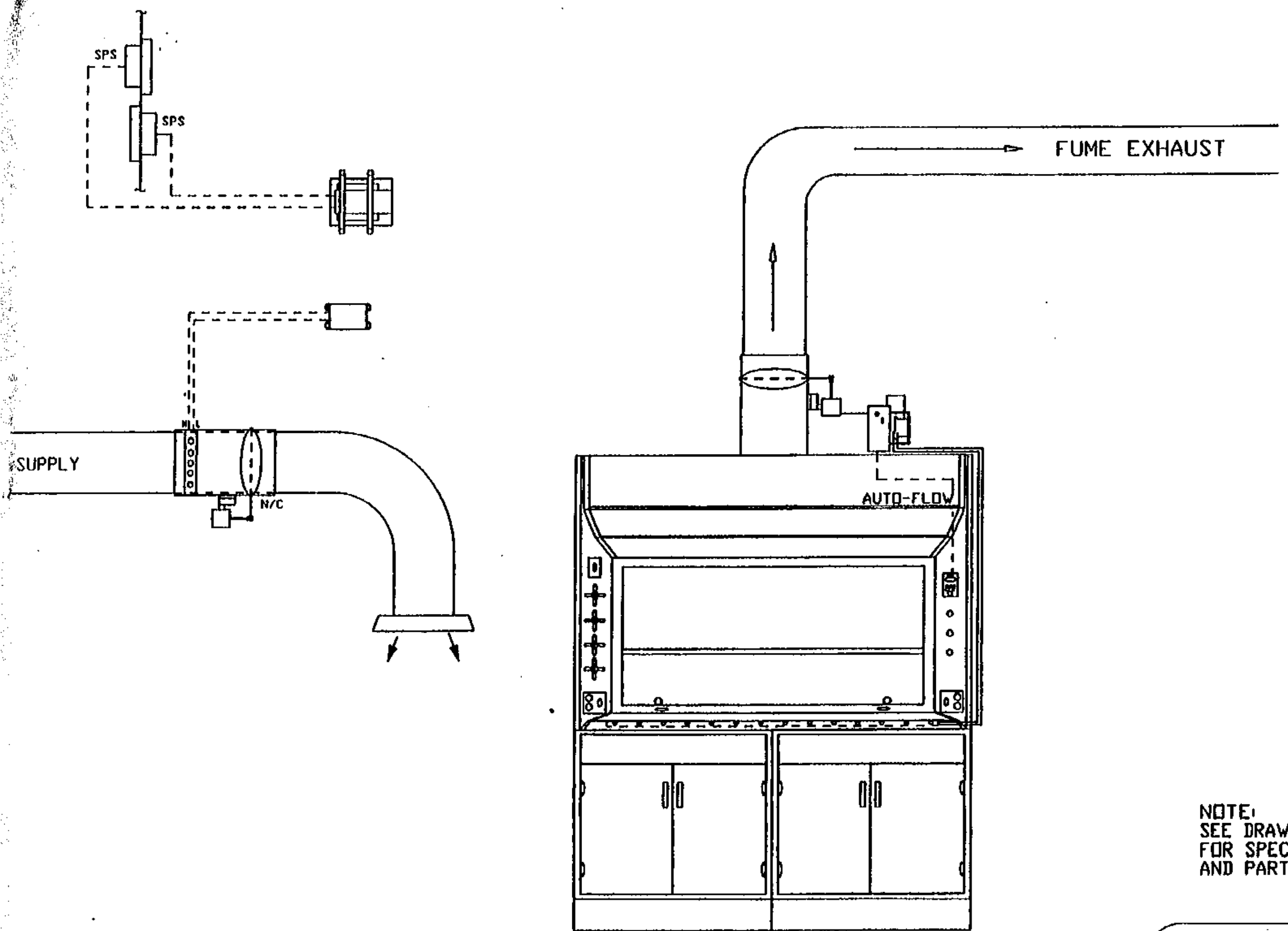
The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

Table 1	**Velocity Unsafe**	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
	Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
	Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse.Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

SINGLE BENCH HOOD & SINGLE SUPPLY PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #13				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP13	Controller	Room Control	LC-1	LC1-APP13	n/a	n/a	n/a	n/a		
APP13	Damper & Actuator	Room Supply Control	CPP-P-8-NC-IL	CPPS-APP13	650	80	N/C	4-20 mA		
APP13	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP13	698	0	n/a	0.0 to 0.25"wc		
APP13	Transmitter	Room Pressure	SPR-1A	SPR-APP13	n/a	n/a	n/a	0.0 to 0.01"wc		
APP13	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP13-1A	n/a	n/a	n/a			
				SPS-APP13-1B	n/a	n/a	n/a			
APP13	Controller	Hood Control	HC1	HC1-APP13-1	n/a	n/a	n/a	n/a		
APP13	Transmitter	Hood Face Velocity	FVR-1A	FVR-APP13-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP13	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP13-1	n/a	n/a	n/a	n/a		4-foot Hood
APP13	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP13-1	n/a	n/a	n/a	n/a		
APP13	Damper & Actuator	Hood Exhaust	PDA-8-NO-HM	PDAX-APP13-1	750	150	N/O	4-20 mA		4-foot Hood



BENCH TYPE FUME HOOD

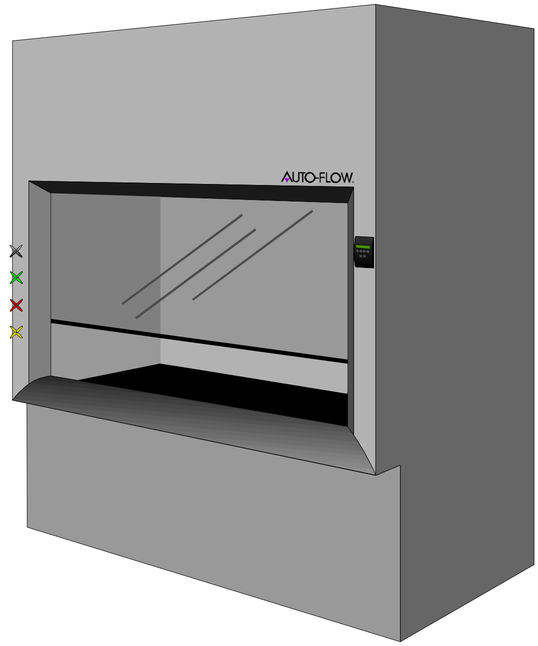
NOTE:
SEE DRAWINGS A950051 & A950059
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 13	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY,SINGLE BENCH HOOD PRESSURE CONTROL FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400413

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #14

Single Supply for Air Flow Control with Single Bench Fume Hood

In this Sequence:

LABORATORY

- *General*
- *Air Flow Control*
- *Volume Limit Control*
- *Alarming*

FUME HOOD

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #14: Single Supply for Air Flow Control with Single Bench Fume Hood

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions independently of the network for all lab control aspects so that a failure of the communications network has no effect over laboratory pressure control.

Air Flow Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into units of cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow is the measured variable for the controller's PID loop. The setpoint for supply air flow is reset to satisfy the fume hood exhaust volume as read from the cascaded output of the fume hood controller minus a set user-adjustable differential volume. The controller's PID output is used to control the laboratory supply damper. The laboratory supply damper is positioned as required by the controller by an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of five times per second. If the supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If the supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

If the measured supply air flow volume falls below its desired minimum rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. If the measured supply air flow volume rises above its desired maximum air flow rate (adjustable) the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Alarming

The controller provides the capability to alarm based on actuator failures related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarms involving the supply air flow or total pressure differential measurements that are based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted via the communications network to the remote operator interface device.

FUME HOOD

General

The fume hood is equipped with a stand alone networkable microprocessor- based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set at100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood via a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute (CFM) for use by the laboratory pressure controller in calculating total lab exhaust volume.The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or to the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

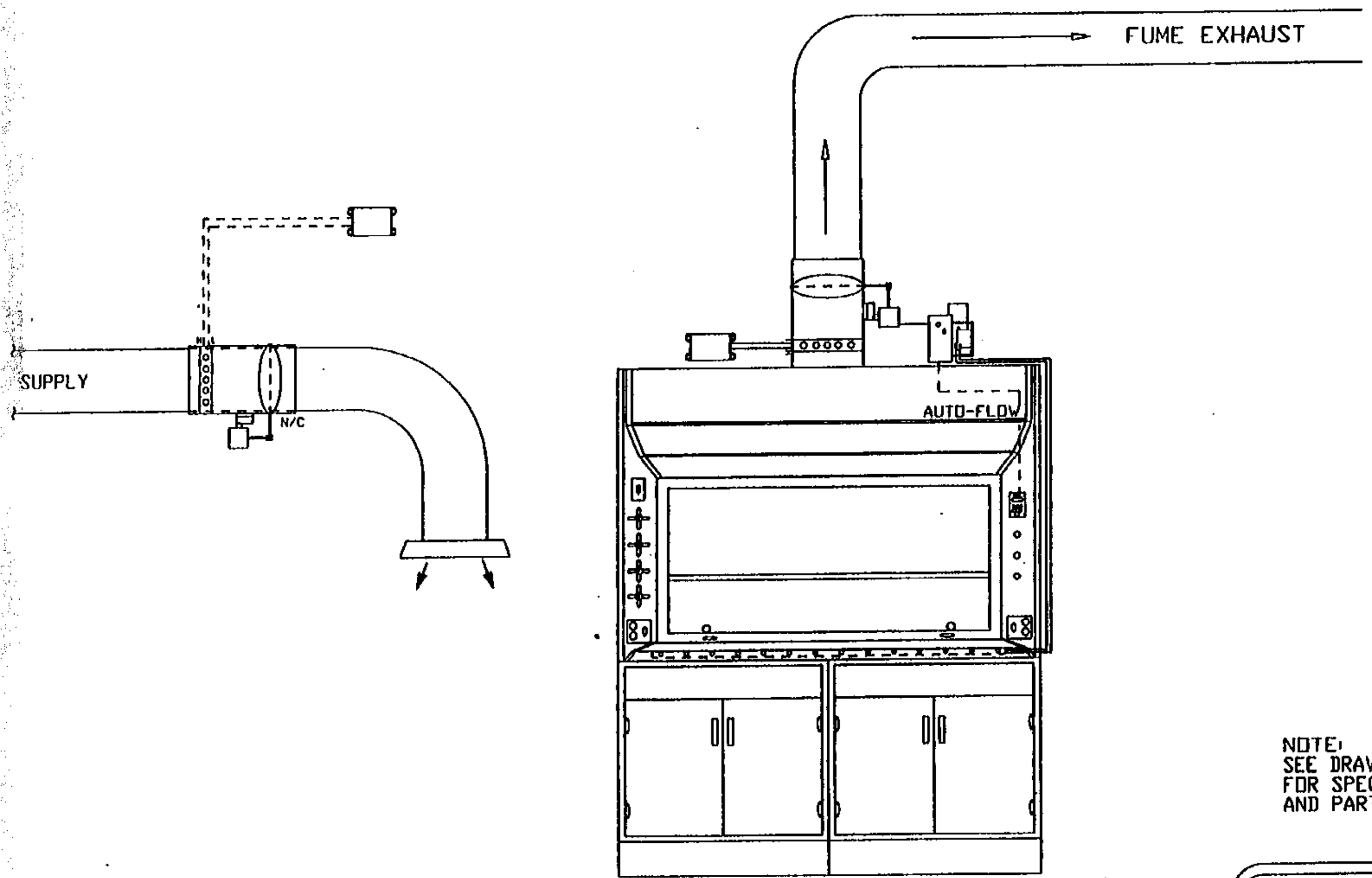
Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

Table 1

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value that is based on user-adjustable limits. This alarm is not annunciated locally, but is transmitted over the communications network to the remote operator interface device.

SINGLE BENCH HOOD & SINGLE SUPPLY AIR FLOW CONTROL

PROJECT: SAMPLE Standard Application #14				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP14	Controller	Room Control	LC-1	LC1-APP14	n/a	n/a	n/a	n/a		
APP14	Damper & Actuator	Room Supply Control	CPP-P-8-NC-IL	CPPS-APP14	650	80	N/C	4-20 mA		
APP14	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP14	698	0	n/a	0.0 to 0.25"wc		
APP14	Controller	Hood Control	HC1	HC1-APP14-1	n/a	n/a	n/a	n/a		
APP14	DP Transmitter	Hood Face Velocity	FVR-1A	FVR-APP14-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP14	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP14-1	n/a	n/a	n/a	n/a		4-foot Hood
APP14	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP14-1	n/a	n/a	n/a	n/a		
APP14	Damper & Actuator	Hood Exhaust	CPP-P-8-NO-HM	CPPX-APP14-1	750	150	N/O	4-20 mA		4-foot Hood
APP14	DP Transmitter	Hood Exhaust CFM	FTR-0.5	FTRX-APP14-1	988	0	n/a	0.0 to 0.5"wc		



BENCH TYPE FUME HOOD

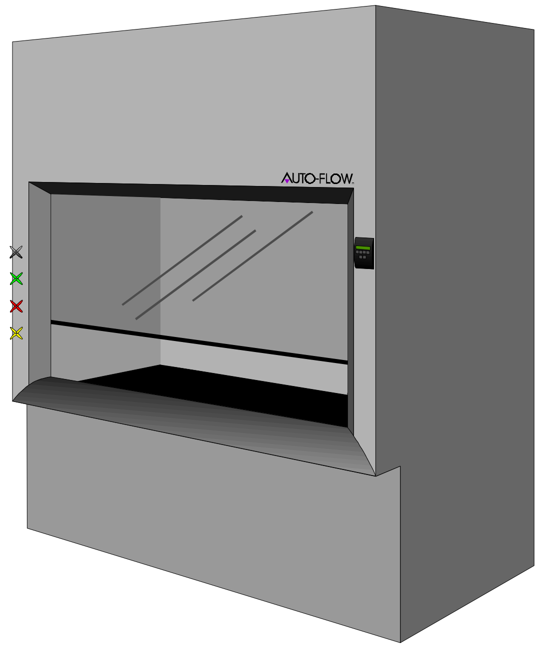
NOTE:
SEE DRAWINGS A950053 & A9500510
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 14	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY, SINGLE BENCH HOOD
	DATE: 9-13-95	AIR FLOW TRACKING FLOW DIAGRAM
	SHEET OF	DRAWING NO. A9400414

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #15

Single Supply/General Exhaust for Pressure Control with Temperature Override and Single Bench Fume Hood

In this Sequence:

LABORATORY
- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Override*
- *Emergency Mode*
- *Alarming*

FUME HOOD
- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #15: Single Supply/General Exhaust for Pressure Control with Temperature Override and Single Bench Fume Hood

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Override

The controller accepts an input from the Building Automation System (BAS) to determine the amount of supply flow override required to maintain the desired temperature in the laboratory. As the supply override signal increases the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate).

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button used to indicate the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure, from any of the electronic actuators connected to the controller, related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the supply air flow, general exhaust air flow, supply duct temperature, space temperature or total pressure differential measurements based on user-adjustable limits. These alarms are not annuciated locally, they are transmitted over the communications network to the remote operator interface device.

FUME HOOD

General

The fume hood is equipped with a stand alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

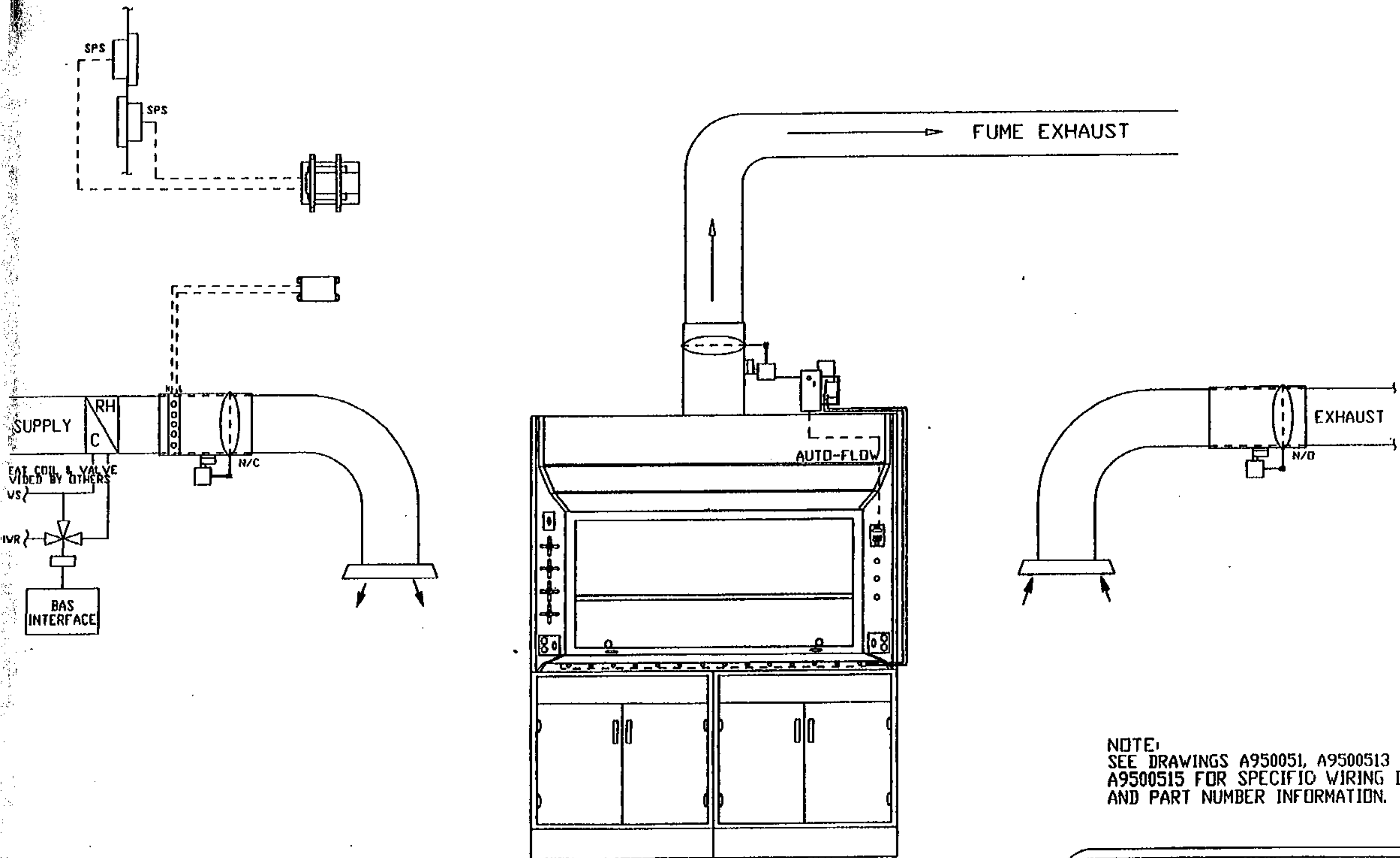
The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

Table 1	**Velocity Unsafe**	<80 FPM or >120 FPM	Red LED and continuous audible alarm
	Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
	Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

SINGLE BENCH HOOD & SINGLE SUPPLY/GENERAL EXHAUST PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #15				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP15	Controller	Room Control	LC-1	LC1-APP15	n/a	n/a	n/a	n/a		
APP15	Damper & Actuator	Room Supply Control	CPP-P-8-NC-IL	CPPS-APP15	650	80	N/C	4-20 mA		
APP15	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP15	698	0	n/a	0.0 to 0.25"wc		
APP15	Transmitter	Room Pressure	SPR-1A	SPR-APP15	n/a	n/a	n/a	0.0 to 0.01"wc		
APP15	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP15-1A	n/a	n/a	n/a			
				SPS-APP15-1B	n/a	n/a	n/a			
APP15	Damper & Actuator	General Exhaust	PDA-8-NO-IL	PDAX-APP15	650	0	N/O	4-20 mA		
APP15	Controller	Hood Control	HC1	HC1-APP15-1	n/a	n/a	n/a	n/a		
APP15	Transmitter	Hood Face Velocity	FVR-1A	FVR-APP15-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP15	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP15-1	n/a	n/a	n/a	n/a		4-foot Hood
APP15	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP15-1	n/a	n/a	n/a	n/a		
APP15	Damper & Actuator	Hood Exhaust	PDA-8-NO-HM	PDAX-APP15-1	750	150	N/O	4-20 mA		4-foot Hood



BENCH TYPE FUME HOOD

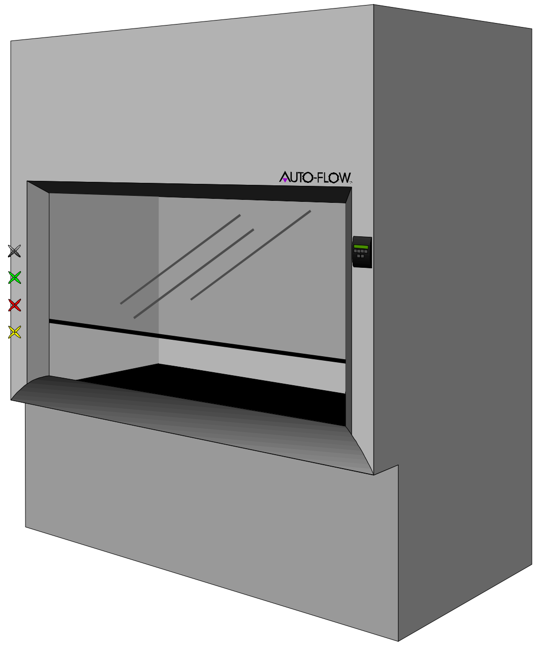
NOTE:
SEE DRAWINGS A950051, A9500513 &
A9500515 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 15	DRAWN: LHP	AUTO-FLOW
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY, SINGLE BENCH HOOD PRESSURE CONTROL W/TEMP OVERRIDE FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400415

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #16

Single Supply/General Exhaust for Air Flow Control with Temperature Override and Single Bench Hood

In this Sequence:

LABORATORY

- *General*
- *Air Flow Control*
- *Temperature Overrride*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

FUME HOOD

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #16: Single Supply/General Exhaust for Air Flow Control with Temperature Override and Single Bench Hood

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in the laboratory supply air duct and it measures the exhaust air flow with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flow acts as the measured variable for the one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal or the air flow rate required to satisfy the fume hood makeup air volume, whichever is greater. The supply makeup air flow rate is determined by the following equation:

Supply Make-Up Flow Setpoint CFM = (Total Hood Exhaust Air Flow CFM + Minimum General Exhaust Air Flow CFM - Desired Differential CFM Setpoint)

The controller's PID output is used to control output to the laboratory supply air damper. The laboratory supply air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of five times per second. When supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the open position. When supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the closed position.

The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Supply CFM + ΔCFM Setpoint - Total Hood Exhaust CFM

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Override

The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory temperature. As the supply override signal increases, the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable), the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for the alarming of the supply air flow and general exhaust air flow measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted via the communications network to the remote operator interface device.

FUME HOOD

General

The fume hood is equipped with a stand-alone networkable microprocessor- based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of visually displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect onfume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

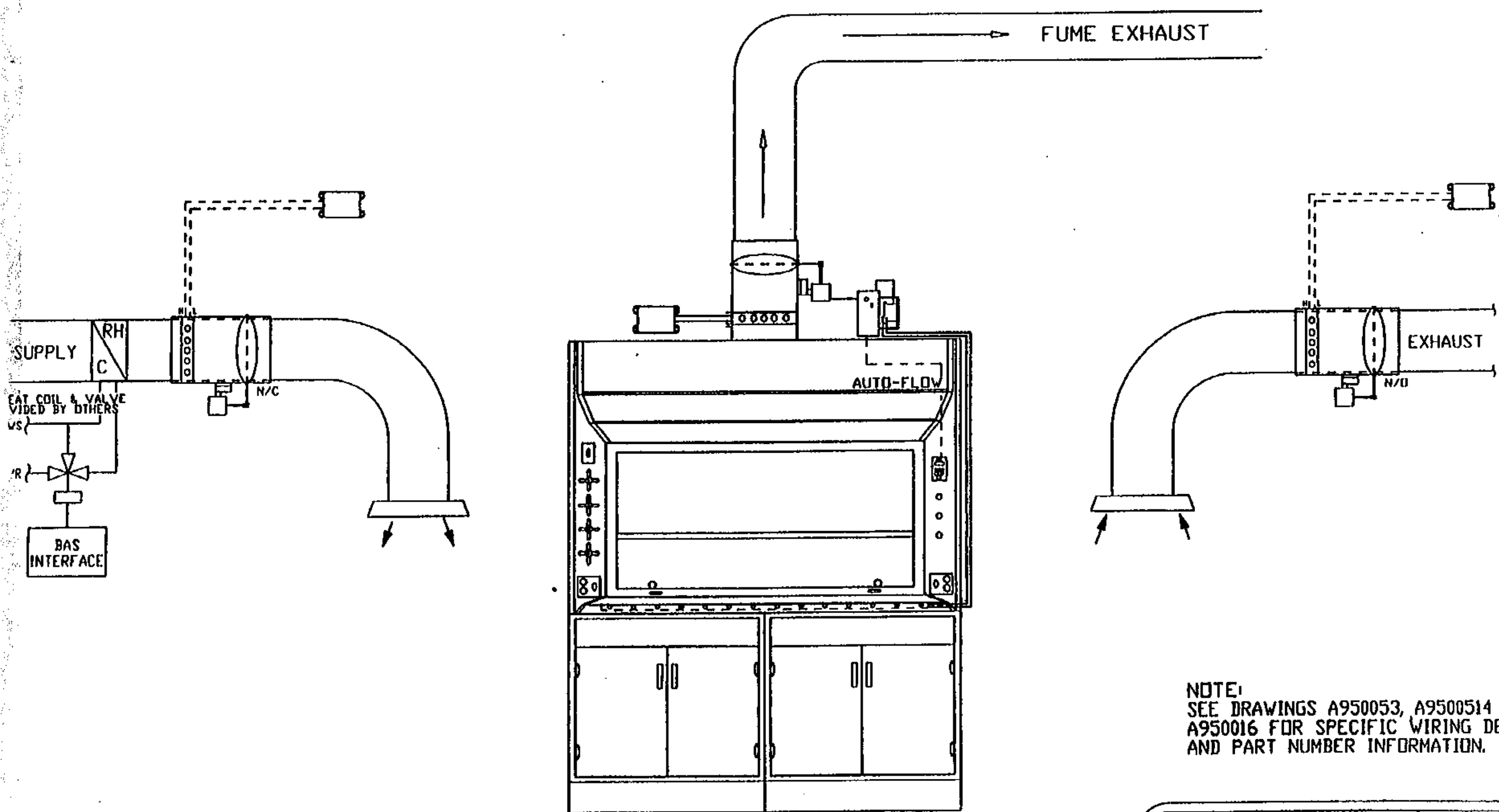
Table 1	**Velocity Unsafe**	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
	Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
	Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

SINGLE BENCH HOOD & SINGLE SUPPLY/GENERAL EXHAUST AIR FLOW CONTROL

PROJECT: SAMPLE Standard Application #16 | **PROJECT NO. :** | **DATE** 05/06/2000

ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP16	Controller	Room Control	LC-1	LC1-APP16	n/a	n/a	n/a	n/a		
APP16	Damper & Actuator	Room Supply Control	CPP-P-8-NC-IL	CPPS-APP16	650	80	N/C	4-20 mA		
APP16	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP16	698	0	n/a	0.0 to 0.25"wc		
APP16	Damper & Actuator	Room Gen. Exh. Control	CPP-P-8-NO-IL	CPPX-APP16	650	0	N/C	4-20 mA		
APP16	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRX-APP16	698	0	n/a	0.0 to 0.25"wc		
APP16	Controller	Hood Control	HC1	HC1-APP16-1	n/a	n/a	n/a	n/a		
APP16	DP Transmitter	Hood Face Velocity	FVR-1A	FVR-APP16-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP16	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP16-1	n/a	n/a	n/a	n/a		4-foot Hood
APP16	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP16-1	n/a	n/a	n/a	n/a		
APP16	Damper & Actuator	Hood Exhaust	CPP-P-8-NO-HM	CPPX-APP16-1	750	150	N/O	4-20 mA		4-foot Hood
APP16	DP Transmitter	Hood Exhaust CFM	FTR-0.5	FTRX-APP16-1	988	0	n/a	0.0 to 0.5"wc		



NOTE:
SEE DRAWINGS A950053, A9500514 &
A950016 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

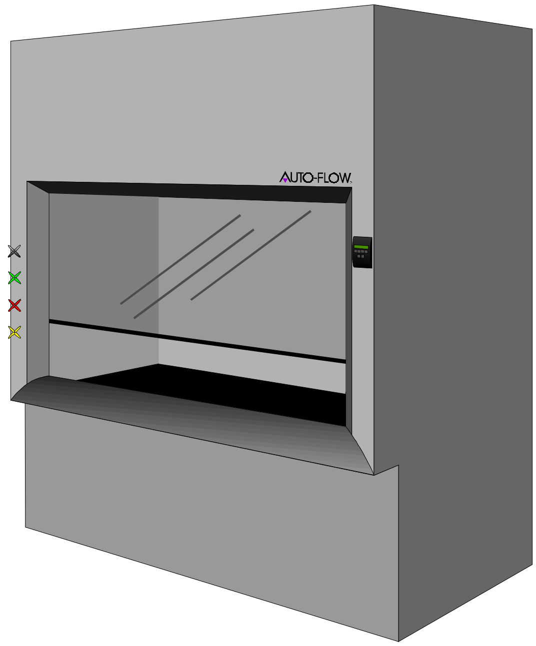
BENCH TYPE FUME HOOD

TYPICAL FUME HOOD LAB APPLICATION H 16	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVF	
	CHKD: RVF	SINGLE SUPPLY, SINGLE BENCH HOOD AIR FLOW TRACKING W/TEMP OVERRIDE FLOW DIAGRAM
	DATE: 9-12-95	
	SHEET OF	DRAWING NO. A9400416

AUTO-FLOW

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #17

Single Supply/General Exhaust for Pressure Control with Full Temperature Control and Single Bench Fume Hood

In this Sequence:

LABORATORY

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Control*
- *Emergency Mode*
- *Alarming*

FUME HOOD

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #17: Single Supply/General Exhaust for Pressure Control with Full Temperature Control and Single Bench Fume Hood

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading acts as the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTU's = [(Supply Discharge Temperature - Space Temperature) $\times$ Supply Air Flow Rate] $\times$ 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the general exhaust air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate).

As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply).

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on actuator failures related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarms involving the supply air flow or total pressure differential measurements that are based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted via the communications network to the remote operator interface device.

FUME HOOD

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as astand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculate by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In this mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming
The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

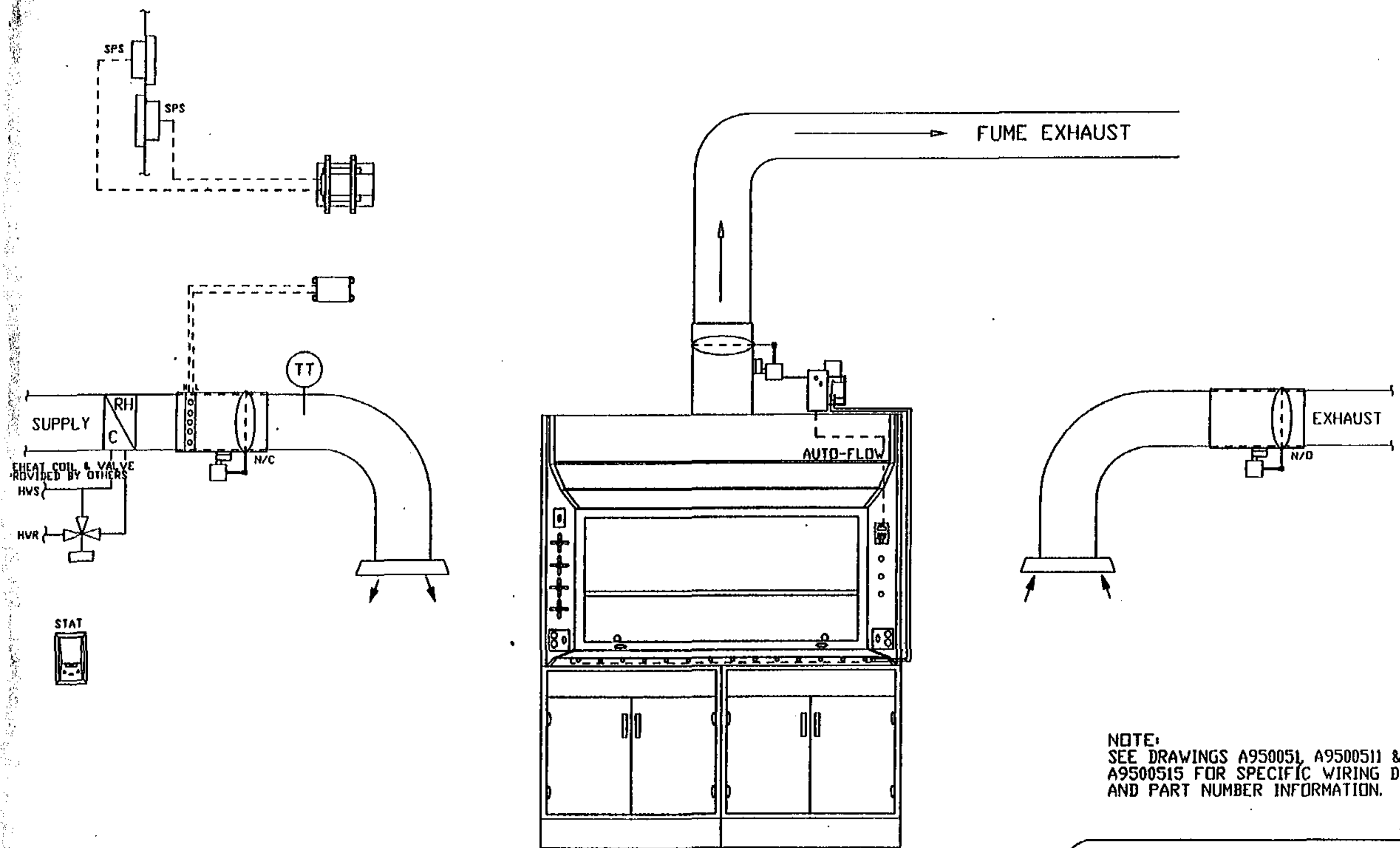
Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

SINGLE BENCH HOOD & SINGLE SUPPLY/GENERAL EXHAUST PRESSURE/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #17				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP17	Controller	Room Control	LC-1	LC1-APP17	n/a	n/a	n/a	n/a		
APP17	Damper & Actuator	Room Supply Control	CPP-P-8-NC-IL	CPPS-APP17	650	80	N/C	4-20 mA		
APP17	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP17	698	0	n/a	0.0 to 0.25"wc		
APP17	Transmitter	Room Pressure	SPR-1A	SPR-APP17	n/a	n/a	n/a	0.0 to 0.01"wc		
APP17	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP17-1A	n/a	n/a	n/a			
				SPS-APP17-1B	n/a	n/a	n/a			
APP17	Temp. Sensor	Space Temperature	STAT	STAT-APP17	n/a	n/a	n/a	-32 to 132 *F		
APP17	Damper & Actuator	General Exhaust	PDA-8-NO-IL	PDAX-APP17	650	0	N/O	4-20 mA		
APP17	Controller	Hood Control	HC1	HC1-APP17-1	n/a	n/a	n/a	n/a		
APP17	Transmitter	Hood Face Velocity	FVR-1A	FVR-APP17-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP17	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP17-1	n/a	n/a	n/a	n/a		4-foot Hood
APP17	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP17-1	n/a	n/a	n/a	n/a		
APP17	Damper & Actuator	Hood Exhaust	PDA-8-NO-HM	PDAX-APP17-1	750	150	N/O	4-20 mA		4-foot Hood



NOTE:
SEE DRAWINGS A950051, A9500511 &
A9500515 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

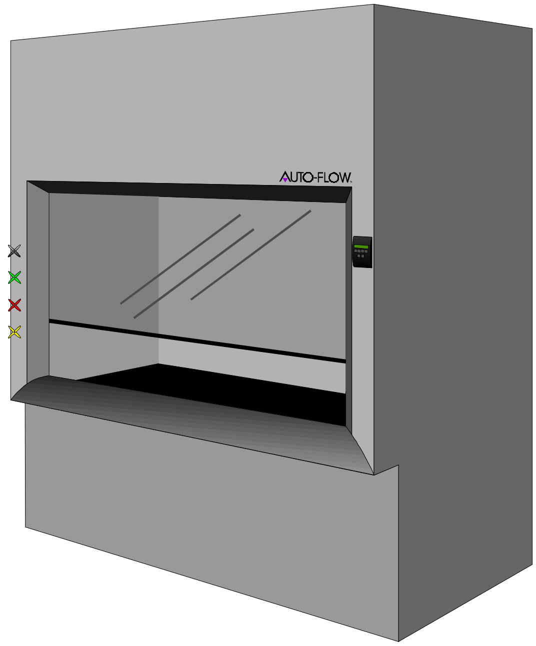
BENCH TYPE FUME HOOD

TYPICAL FUME HOOD LAB APPLICATION # 17	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY/SINGLE BENCH HOOD PRESSURE/TEMP CONTROL FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400417

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #18

Single Supply/General Exhaust for Air Flow Control with Full Temperature Control and Single Bench Hood

In this Sequence:

LABORATORY

- *General*
- *Air Flow Control*
- *Temperature Control*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

FUME HOOD

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Sequence of Operation

Application #18: Single Supply/General Exhaust for Air Flow Control with Full Temperature Control and Single Bench Hood

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct and measures the exhaust air flow leaving the space with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute. The controller executes its process loops with proportional, integral, and derivative control action. The supply air flow is the measured variable for the one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal or the air flow rate required to satisfy the fume hood makeup air volume, whichever is greater. The supply makeup air flow rate is determined by the following equation:

Supply Makeup Flow Setpoint CFM = (Total Hood Exhaust Air Flow CFM + Minimum General Exhaust Air Flow CFM - Desired Differential CFM Setpoint)

The controller's PID output is used to control output to the laboratory supply air damper. The laboratory supply air damperis positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the open position. When supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the closed position.

The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value which is adjustable by the user. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = (Current Supply CFM + Differential CFM Setpoint - Total Hood Exhaust CFM)

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller through an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. On a rise in general exhaust air flow above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTU's = [(Supply Discharge Temperature - Space Temperature) $\times$ Supply Air Flow Rate] $\times$ 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the general exhaust air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the laboratory supply air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable), the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for the alarming of the supply air flow and general exhaust air flow measurements based on user adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

FUME HOOD

General

The fume hood is equipped with a stand alone networkable microprocessor- based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The

Table 1

damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

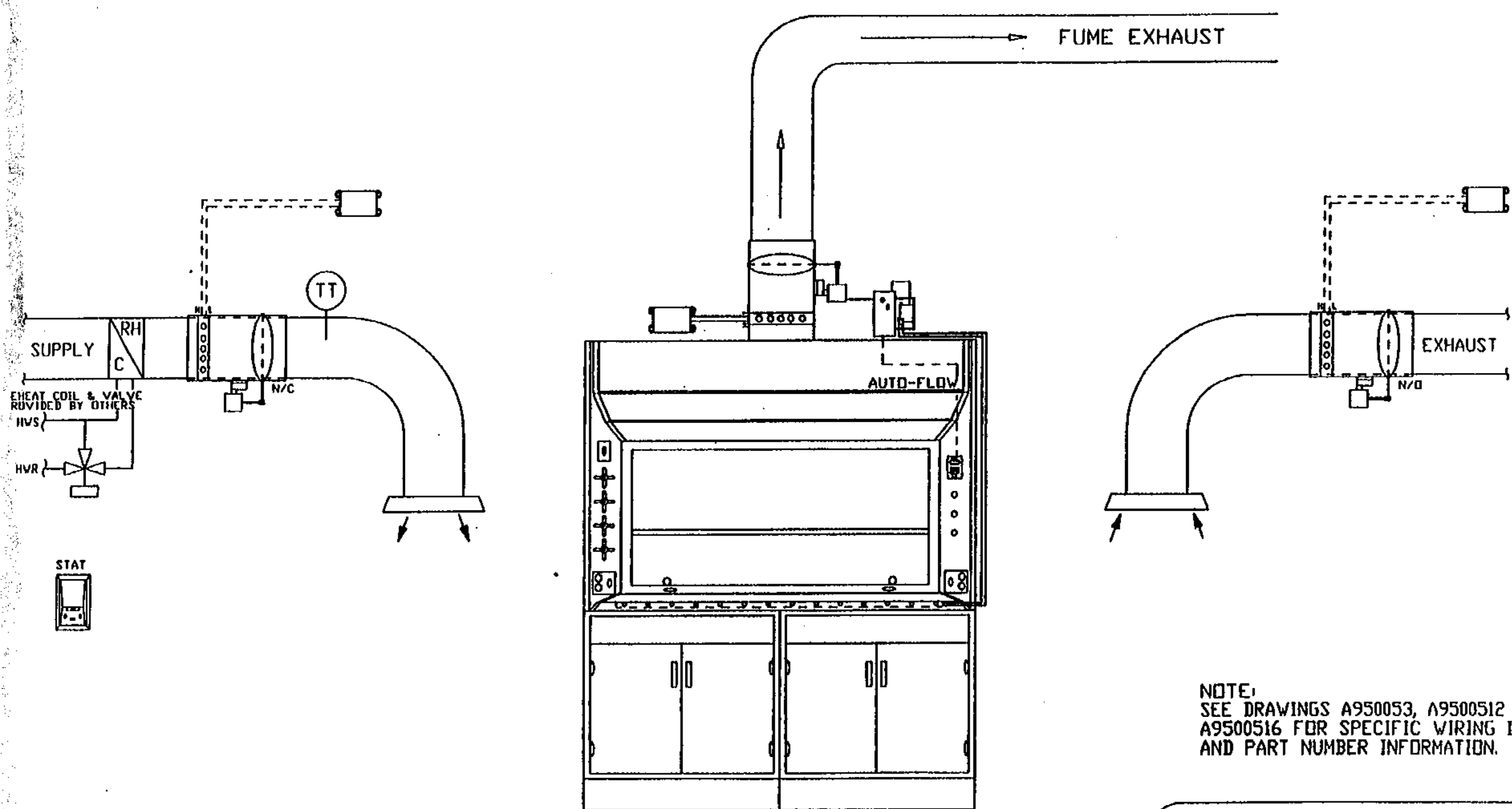
In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the red controller display's LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

SINGLE BENCH HOOD & SINGLE SUPPLY/GENERAL EXHAUST AIR FLOW/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #18				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP18	Controller	Room Control	LC-1	LC1-APP18	n/a	n/a	n/a	n/a		
APP18	Damper & Actuator	Room Supply Control	CPP-P-8-NC-IL	CPPS-APP18	650	80	N/C	4-20 mA		
APP18	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP18	698	0	n/a	0.0 to 0.25"wc		
APP18	Damper & Actuator	Room Gen. Exh. Control	CPP-P-8-NO-IL	CPPX-APP18	650	0	N/C	4-20 mA		
APP18	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRX-APP18	698	0	n/a	0.0 to 0.25"wc		
APP18	Temp. Sensor	Space Temperature	STAT	STAT-APP18	n/a	n/a	n/a	-32 to 132 *F		
APP18	Controller	Hood Control	HC1	HC1-APP18-1	n/a	n/a	n/a	n/a		
APP18	DP Transmitter	Hood Face Velocity	FVR-1A	FVR-APP18-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP18	Air Foil Pitot	Hood Face Velocity	AFP2-36	AFP-APP18-1	n/a	n/a	n/a	n/a		4-foot Hood
APP18	Tubing Kit	Hood Face Velocity	TBK-1	TBK-APP18-1	n/a	n/a	n/a	n/a		
APP18	Damper & Actuator	Hood Exhaust	CPP-P-8-NO-HM	CPPX-APP18-1	750	150	N/O	4-20 mA		4-foot Hood
APP18	DP Transmitter	Hood Exhaust CFM	FTR-0.5	FTRX-APP18-1	988	0	n/a	0.0 to 0.5"wc		



BENCH TYPE FUME HOOD

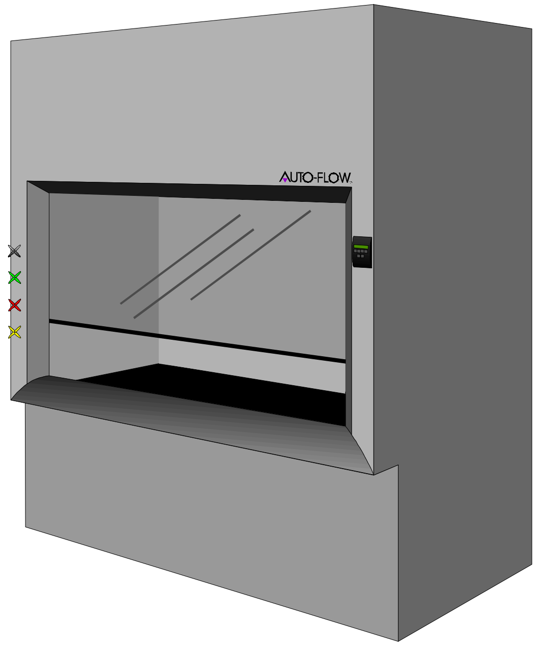
NOTE:
SEE DRAWINGS A950053, A9500512 & A9500516 FOR SPECIFIC WIRING DETAILS AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 18	DRAWN: LHP	AUTO-FLOW
	ENGR: RVF	
	CHKD: RVF	SINGLE SUPPLY, SINGLE BENCH HOOD AIR FLOW TRACKING W/TEMP CONTROL FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400418

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #19

Single Supply/General Exhaust for Pressure Control with Temperature Override and Dual Bench Fume Hoods

In this Sequence:

LABORATORY

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Override*
- *Emergency Mode*
- *Alarming*

FUME HOODS

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #19: Single Supply/General Exhaust for Pressure Control with Temperature Override and Dual Bench Fume Hoods

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect over laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes a control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Override

The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory temperature. As the supply override signal increases, the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate).

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure, from any of the electronic actuators connected to the controller, related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the supply air flow or total pressure differential measurements based on user-adjustable limits. These alarms are not annuciated locally, they are transmitted over the communications network to the remote operator interface device.

FUME HOODS

General

The fume hood is equipped with a stand alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, which is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Sequence of Operation

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

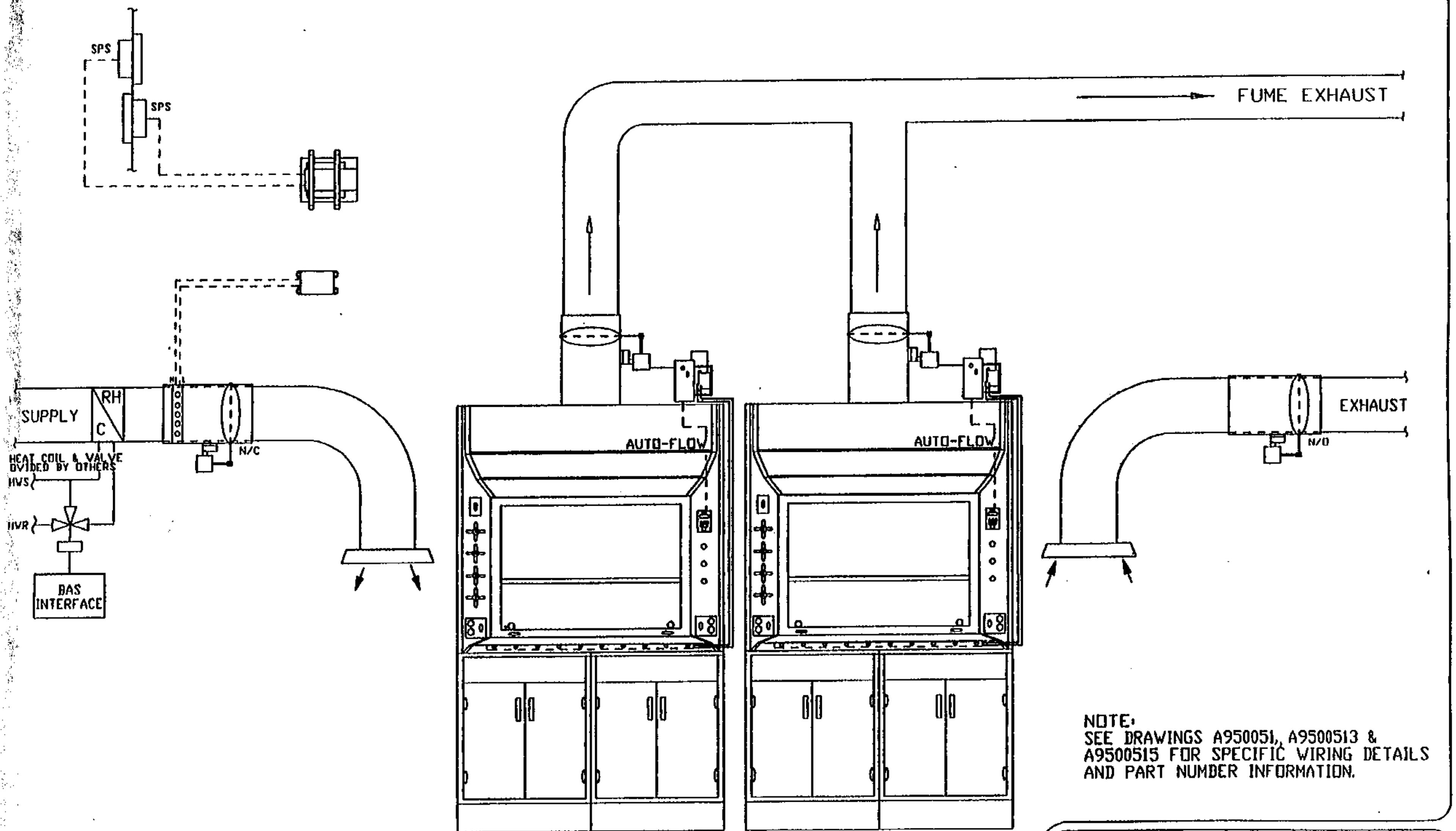
Table 1	**Velocity Unsafe**	<80 FPM or >120 FPM	Red LED and continuous audible alarm
	Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
	Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

DUAL BENCH FUME HOODS & SINGLE SUPPLY/GENERAL EXHAUST PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #19 | **PROJECT NO. :** | **DATE** 05/06/2000

ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP19	Controller	Room Control	LC-1	LC1-APP19	n/a	n/a	n/a	n/a		
APP19	Damper & Actuator	Room Supply Control	CPP-P-12-NC-IL	CPPS-APP19	1750	220	N/C	4-20 mA		
APP19	DP Transmitter	Room Supply CFM	FTR-0.5	FTRS-APP19	2220	0	n/a	0.0 to 0.5"wc		
APP19	Transmitter	Room Pressure	SPR-1A	SPR-APP19	n/a	n/a	n/a	0.0 to 0.01"wc		
APP19	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP19-1A	n/a	n/a	n/a			
				SPS-APP19-1B	n/a	n/a	n/a			
APP19	Damper & Actuator	General Exhaust	PDA-8-NO-IL	PDAX-APP19	760	0	N/O	4-20 mA		
APP19	Controller	Hood #1 Control	HC1	HC1-APP19-1	n/a	n/a	n/a	n/a		
APP19	Transmitter	Hood #1 Face Velocity	FVR-1A	FVR-APP19-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP19	Air Foil Pitot	Hood #1 Face Velocity	AFP2-36	AFP-APP19-1	n/a	n/a	n/a	n/a		4-foot Hood
APP19	Tubing Kit	Hood #1 Face Velocity	TBK-1	TBK-APP19-1	n/a	n/a	n/a	n/a		
APP19	Damper & Actuator	Hood #1 Exhaust	PDA-8-NO-HM	PDAX-APP19-1	750	150	N/O	4-20 mA		4-foot Hood
APP19	Controller	Hood #2 Control	HC1	HC1-APP19-2	n/a	n/a	n/a	n/a		
APP19	Transmitter	Hood #2 Face Velocity	FVR-1A	FVR-APP19-2	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP19	Air Foil Pitot	Hood #2 Face Velocity	AFP2-48	AFP-APP19-2	n/a	n/a	n/a	n/a		5-foot Hood
APP19	Tubing Kit	Hood #2 Face Velocity	TBK-1	TBK-APP19-2	n/a	n/a	n/a	n/a		
APP19	Damper & Actuator	Hood #2 Exhaust	PDA-8-NO-HM	PDAX-APP19-2	1000	200	N/O	4-20 mA		5-foot Hood



NOTE:
SEE DRAWINGS A950051, A9500513 &
A9500515 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

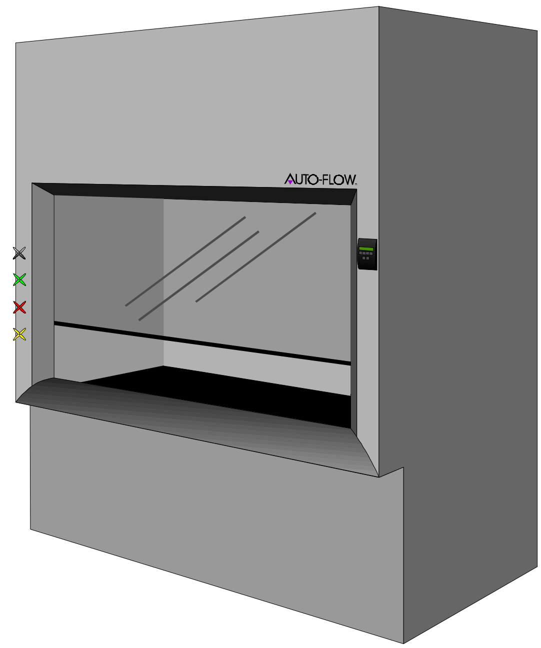
2 BENCH TYPE FUME HOODS

TYPICAL FUME HOOD LAB APPLICATION # 19	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY/EXHAUST,DUAL BENCH HOOD PRESSURE CONTROL W/TEMP OVERRIDE FLOW DIAGRAM
	DATE: 9-11-95	
	SHEET OF	DRAWING NO. A9400419

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #20

Single Supply/General Exhaust for Air Flow Control with Temperature Override and Dual Bench Hoods

In this Sequence:

LABORATORY

- *General*
- *Air Flow Control*
- *Temperature Override*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

FUME HOODS

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material

Drawing

Application #20: Single Supply/General Exhaust for Air Flow Control with Temperature Override and Dual Bench Hoods

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in the laboratory supply air duct and it measures the exhaust air flow with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flow acts as the measured variable for the one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal or the air flow rate required to satisfy the fume hood makeup air volume, whichever is greater. The supply makeup air flow rate is determined by the following equation:

Supply Make-Up Flow Setpoint CFM = (Total Hood Exhaust Air Flow CFM + Minimum General Exhaust Air Flow CFM - Desired Differential CFM Setpoint)

The controller's PID output is used to control output to the laboratory supply air damper. The laboratory supply air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the open position. When supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the closed position.

The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Supply CFM + ΔCFM Setpoint-Total Hood Exhaust CFM

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Override

The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory temperature. As the supply override signal increases, the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable), the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for the alarming of the supply air flow and general exhaust air flow measurements based on user adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

FUME HOODS

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

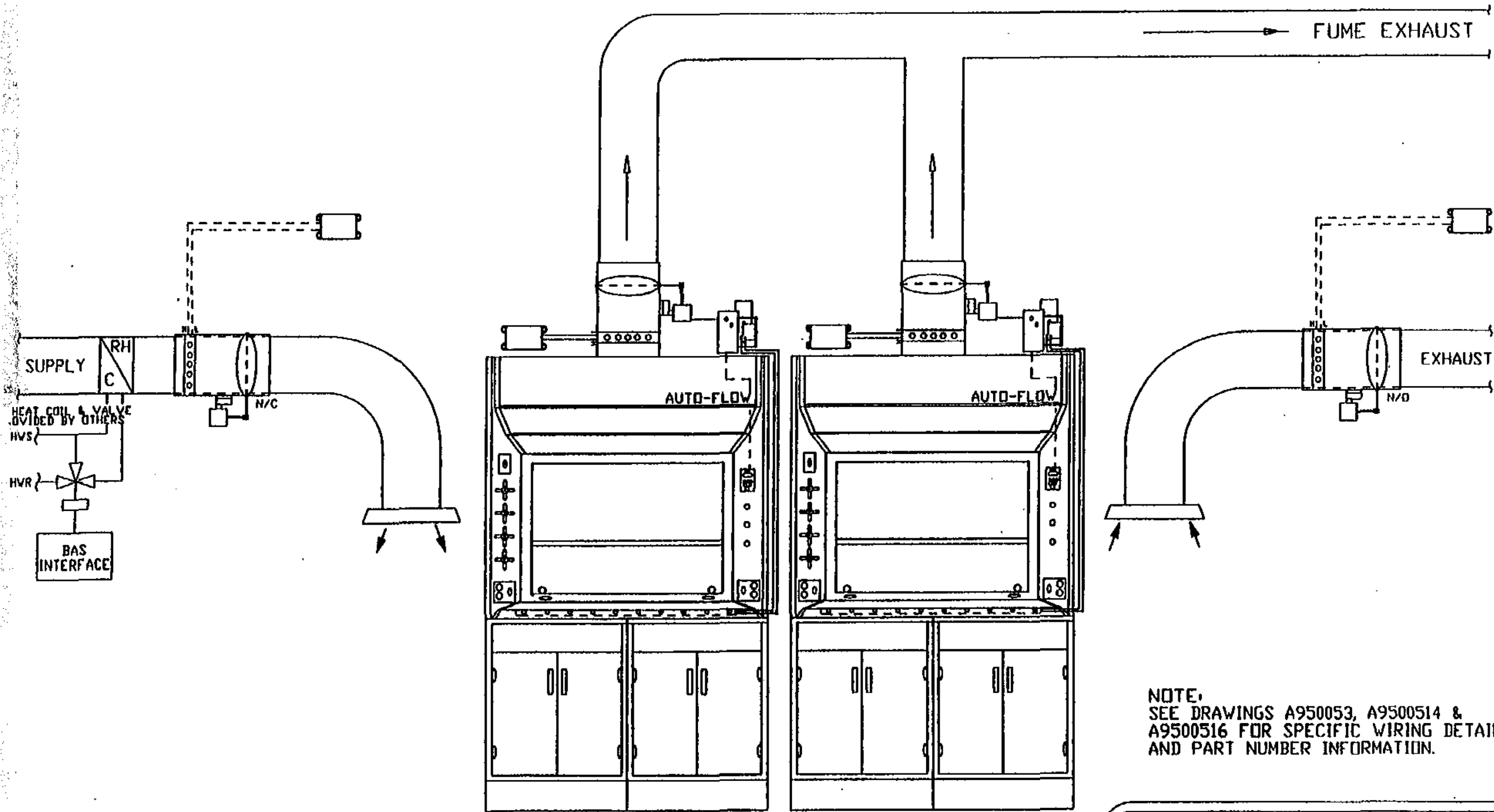
The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

Table 1	**Velocity Unsafe**	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
	Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
	Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user-adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

DUAL BENCH FUME HOODS & SINGLE SUPPLY/GENERAL EXHAUST AIR FLOW CONTROL

PROJECT: SAMPLE Standard Application #20				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP20	Controller	Room Control	LC-1	LC1-APP20	n/a	n/a	n/a	n/a		
APP20	Damper & Actuator	Room Supply Control	CPP-P-14-NC-IL	CPPS-APP20	2000	250	N/C	4-20 mA		
APP20	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP20	2140	0	n/a	0.0 to 0.25"wc		
APP20	Damper & Actuator	Room Gen. Exh. Control	CPP-P-10-NO-IL	CPPX-APP20	1090	0	N/C	4-20 mA		
APP20	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRX-APP20	1092	0	n/a	0.0 to 0.25"wc		
APP20	Controller	Hood #1 Control	HC1	HC1-APP20-1	n/a	n/a	n/a	n/a		
APP20	DP Transmitter	Hood #1 Face Velocity	FVR-1A	FVR-APP20-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP20	Air Foil Pitot	Hood #1 Face Velocity	AFP2-36	AFP-APP20-1	n/a	n/a	n/a	n/a		4-foot Hood
APP20	Tubing Kit	Hood #1 Face Velocity	TBK-1	TBK-APP20-1	n/a	n/a	n/a	n/a		
APP20	Damper & Actuator	Hood #1 Exhaust	CPP-P-8-NO-HM	CPPX-APP20-1	750	150	N/O	4-20 mA		4-foot Hood
APP20	DP Transmitter	Hood #1 Exhaust CFM	FTR-0.5	FTRX-APP20-1	988	0	n/a	0.0 to 0.5"wc		
APP20	Controller	Hood #2 Control	HC1	HC1-APP20-2	n/a	n/a	n/a	n/a		
APP20	DP Transmitter	Hood #2 Face Velocity	FVR-1A	FVR-APP20-2	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP20	Air Foil Pitot	Hood #2 Face Velocity	AFP2-60	AFP-APP20-2	n/a	n/a	n/a	n/a		6-foot Hood
APP20	Tubing Kit	Hood #2 Face Velocity	TBK-1	TBK-APP20-2	n/a	n/a	n/a	n/a		
APP20	Damper & Actuator	Hood #2 Exhaust	CPP-P-10-NO-HM	CPPX-APP20-2	1250	250	N/O	4-20 mA		6-foot Hood
APP20	DP Transmitter	Hood #2 Exhaust CFM	FTR-0.5	FTRX-APP20-2	1544	0	n/a	0.0 to 0.5"wc		



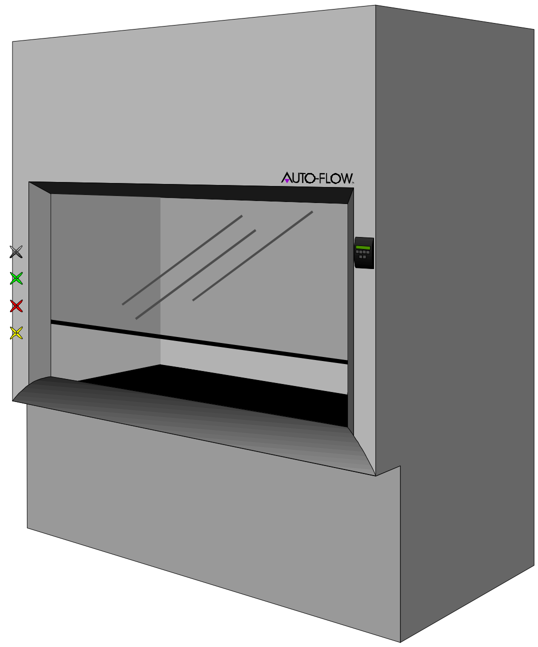
NOTE:
SEE DRAWINGS A950053, A9500514 &
A9500516 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

2 BENCH TYPE FUME HOODS

TYPICAL FUME HOOD LAB APPLICATION # 20	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY/EXHAUST,DUAL BENCH HOOD AIR FLOW TRACKING W/TEMP OVERRIDE FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400420

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #21

Single Supply/General Exhaust for Pressure Control with Full Temperature Control and Dual Bench Fume Hoods

In this Sequence:

LABORATORY

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Control*
- *Emergency Mode*
- *Alarming*

FUME HOODS

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #21: Single Supply/General Exhaust for Pressure Control with Full Temperature Control and Dual Bench Fume Hoods

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes a complete control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) $\times$ Supply Air Flow Rate] $\times$ 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop to control the general exhaust air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply).

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for the alarming of the supply air flow and general exhaust air flow measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

FUME HOODS

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, which is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

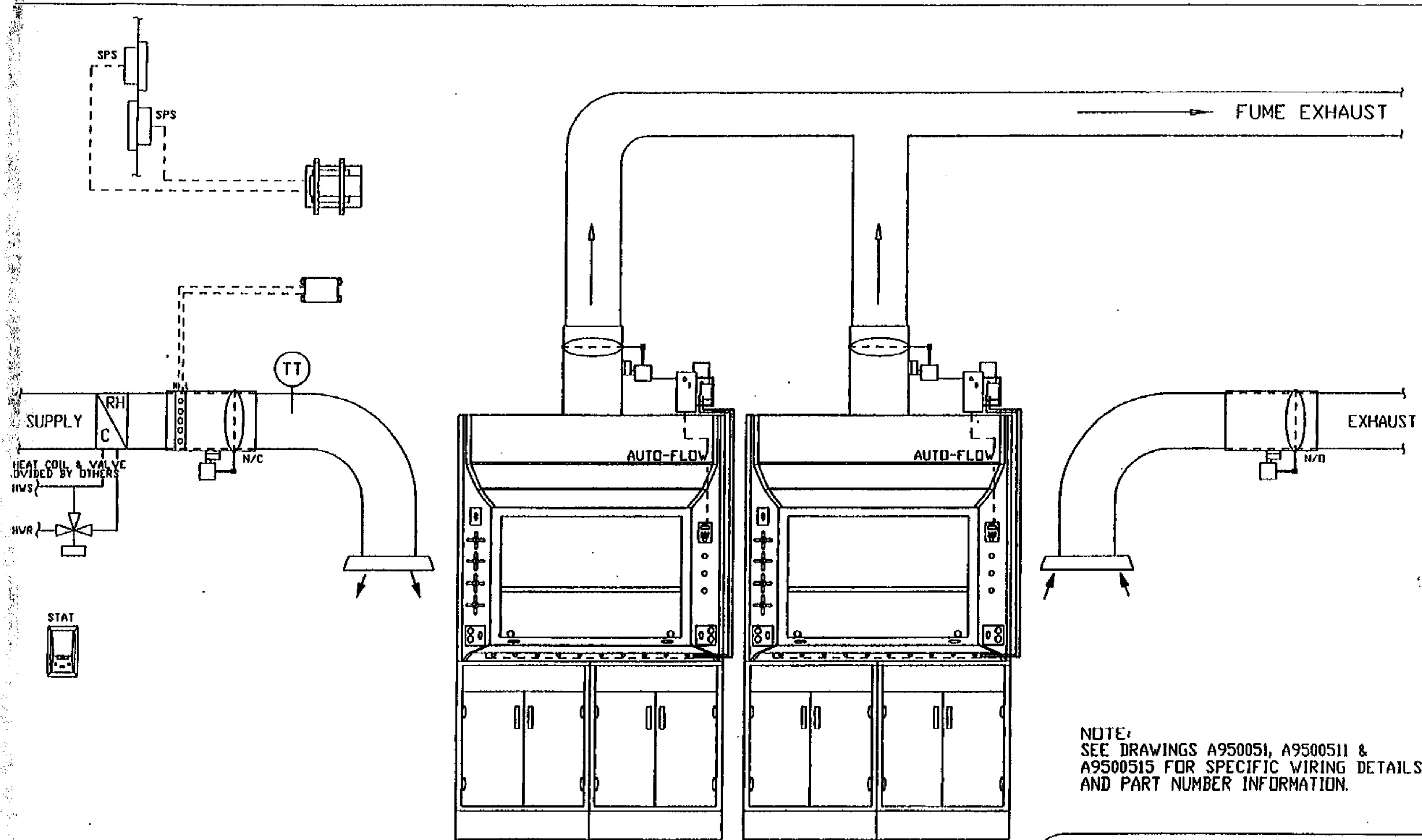
In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

DUAL BENCH FUME HOODS & SINGLE SUPPLY/GENERAL EXHAUST PRESSURE/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #21				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP21	Controller	Room Control	LC-1	LC1-APP21	n/a	n/a	n/a	n/a		
APP21	Damper & Actuator	Room Supply Control	CPP-P-14-NC-IL	CPPS-APP21	2250	220	N/C	4-20 mA		
APP21	DP Transmitter	Room Supply CFM	FTR-0.5	FTRS-APP21	3030	0	n/a	0.0 to 0.5"wc		
APP21	Transmitter	Room Pressure	SPR-1A	SPR-APP21	n/a	n/a	n/a	0.0 to 0.01"wc		
APP21	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP21-1A	n/a	n/a	n/a			
				SPS-APP21-1B	n/a	n/a	n/a			
APP21	Temp. Sensor	Space Temperature	STAT	STAT-APP21	n/a	n/a	n/a	-32 to 132 *F		
APP21	Damper & Actuator	General Exhaust	PDA-10-NO-IL	PDAX-APP21	1090	0	N/O	4-20 mA		
APP21	Controller	Hood #1 Control	HC1	HC1-APP21-1	n/a	n/a	n/a	n/a		
APP21	Transmitter	Hood #1 Face Velocity	FVR-1A	FVR-APP21-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP21	Air Foil Pitot	Hood #1 Face Velocity	AFP2-60	AFP-APP21-1	n/a	n/a	n/a	n/a		6-foot Hood
APP21	Tubing Kit	Hood #1 Face Velocity	TBK-1	TBK-APP21-1	n/a	n/a	n/a	n/a		
APP21	Damper & Actuator	Hood #1 Exhaust	PDA-10-NO-HM	PDAX-APP21-1	1250	250	N/O	4-20 mA		6-foot Hood
APP21	Controller	Hood #2 Control	HC1	HC1-APP21-2	n/a	n/a	n/a	n/a		
APP21	Transmitter	Hood #2 Face Velocity	FVR-1A	FVR-APP21-2	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP21	Air Foil Pitot	Hood #2 Face Velocity	AFP2-48	AFP-APP21-2	n/a	n/a	n/a	n/a		5-foot Hood
APP21	Tubing Kit	Hood #2 Face Velocity	TBK-1	TBK-APP21-2	n/a	n/a	n/a	n/a		
APP21	Damper & Actuator	Hood #2 Exhaust	PDA-8-NO-HM	PDAX-APP21-2	1000	200	N/O	4-20 mA		5-foot Hood



NOTE:
SEE DRAWINGS A950051, A9500511 &
A9500515 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

2 BENCH TYPE FUME HOODS

TYPICAL FUME HOOD LAB APPLICATION # 21	DRAWN: LIP ENGR: RVF CHKD: RVF DATE: 9-13-95 SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 SINGLE SUPPLY/EXHAUST/DUAL BENCH HOOD PRESSURE/TEMP CONTROL FLOW DIAGRAM DRAWING NO. A9400421

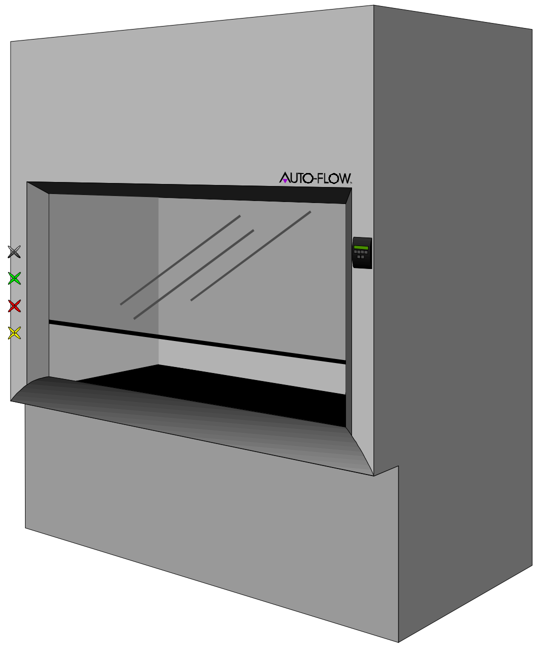
AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide

Application #22

Single Supply/General Exhaust for Air Flow Control with Full Temperature Control and Dual Bench Hoods



In this Sequence:

LABORATORY

- *General*
- *Air Flow Control*
- *Temperature Control*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

FUME HOODS

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material

Drawing

Sequence of Operation

Application #22: Single Supply/General Exhaust for Air Flow Control with Full Temperature Control and Dual Bench Hoods

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in the laboratory supply air duct and it measures the exhaust air flow with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flow is the measured variable for the one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal or the air flow rate required to satisfy the fume hood makeup air volume, whichever is greater. The supply makeup air flow rate is determined by the following equation:

Supply Make-Up Flow Setpoint CFM = (Total Hood Exhaust Air Flow CFM + Minimum General Exhaust Air Flow CFM - Desired Differential CFM Setpoint)

The controller's PID output is used to control output to the laboratory supply air damper. The laboratory supply air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop of five times per second. When supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the open position. When supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply air damper toward the closed position.

The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Supply CFM + ΔCFM Setpoint-Total Hood Exhaust CFM

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) à Supply Air Flow Rate] à 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the laboratory supply air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable), the supply flow control PID loop is overridden and the laboratory supply damper is controlled to maintain the desired maximum air flow.

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for the alarming of the supply air flow and general exhaust air flow measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

FUME HOODS

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect over fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, which is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

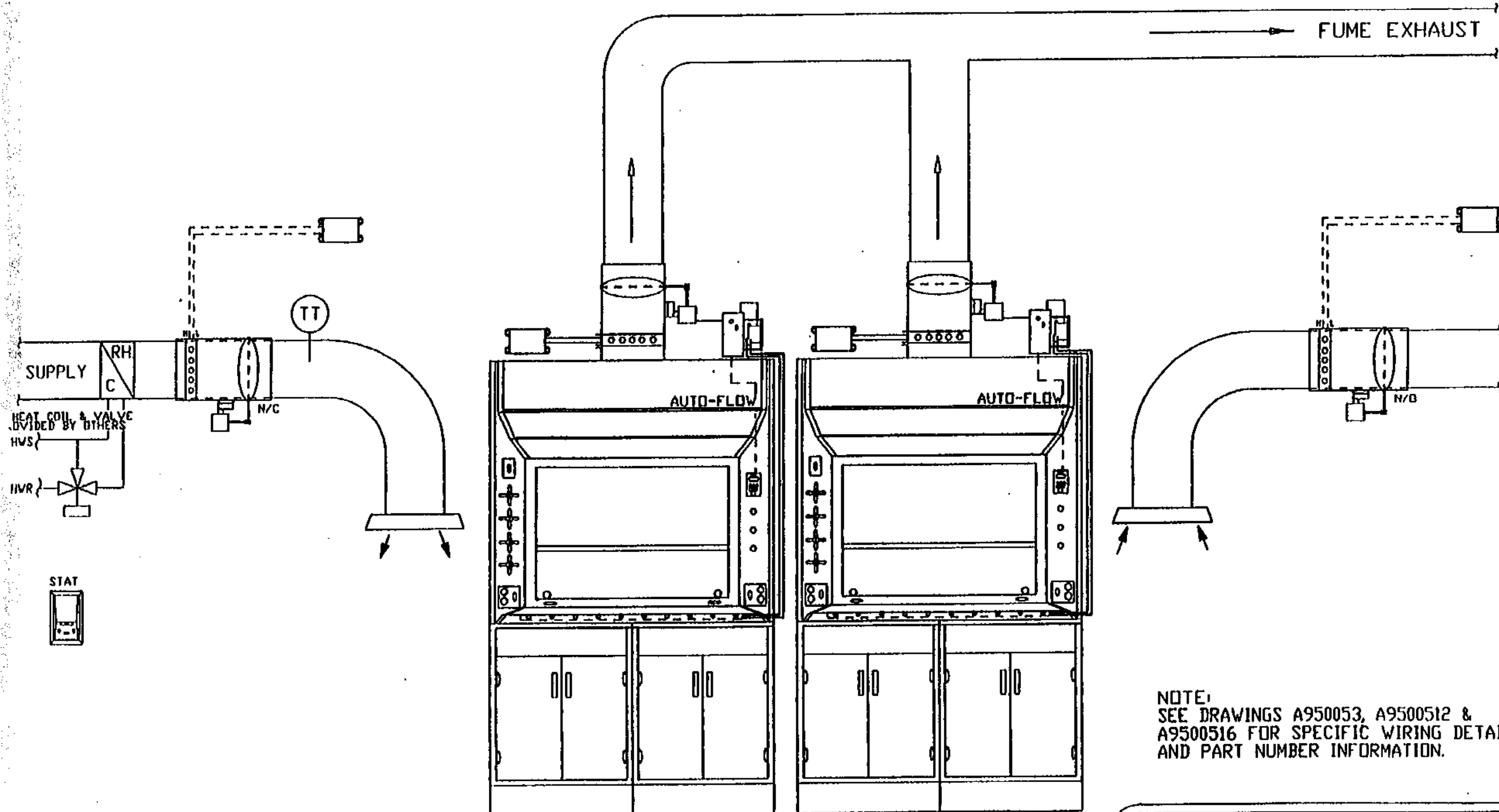
The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

Table 1	**Velocity Unsafe**	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
	Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
	Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user-adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

DUAL BENCH FUME HOODS & SINGLE SUPPLY/GENERAL EXHAUST AIR FLOW/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #22				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP22	Controller	Room Control	LC-1	LC1-APP22	n/a	n/a	n/a	n/a		
APP22	Damper & Actuator	Room Supply Control	CPP-P-14-NC-IL	CPPS-APP22	2000	250	N/C	4-20 mA		
APP22	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP22	2140	0	n/a	0.0 to 0.25"wc		
APP22	Damper & Actuator	Room Gen. Exh. Control	CPP-P-10-NO-IL	CPPX-APP22	1090	0	N/C	4-20 mA		
APP22	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRX-APP22	1092	0	n/a	0.0 to 0.25"wc		
APP22	Temp. Sensor	Space Temperature	STAT	STAT-APP22	n/a	n/a	n/a	-32 to 132 *F		
APP22	Controller	Hood #1 Control	HC1	HC1-APP22-1	n/a	n/a	n/a	n/a		
APP22	DP Transmitter	Hood #1 Face Velocity	FVR-1A	FVR-APP22-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP22	Air Foil Pitot	Hood #1 Face Velocity	AFP2-36	AFP-APP22-1	n/a	n/a	n/a	n/a		4-foot Hood
APP22	Tubing Kit	Hood #1 Face Velocity	TBK-1	TBK-APP22-1	n/a	n/a	n/a	n/a		
APP22	Damper & Actuator	Hood #1 Exhaust	CPP-P-8-NO-HM	CPPX-APP22-1	750	150	N/O	4-20 mA		4-foot Hood
APP22	DP Transmitter	Hood #1 Exhaust CFM	FTR-0.5	FTRX-APP22-1	988	0	n/a	0.0 to 0.5"wc		
APP22	Controller	Hood #2 Control	HC1	HC1-APP22-2	n/a	n/a	n/a	n/a		
APP22	DP Transmitter	Hood #2 Face Velocity	FVR-1A	FVR-APP22-2	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP22	Air Foil Pitot	Hood #2 Face Velocity	AFP2-60	AFP-APP22-2	n/a	n/a	n/a	n/a		6-foot Hood
APP22	Tubing Kit	Hood #2 Face Velocity	TBK-1	TBK-APP22-2	n/a	n/a	n/a	n/a		
APP22	Damper & Actuator	Hood #2 Exhaust	CPP-P-10-NO-HM	CPPX-APP22-2	1250	250	N/O	4-20 mA		6-foot Hood
APP22	DP Transmitter	Hood #2 Exhaust CFM	FTR-0.5	FTRX-APP22-2	1544	0	n/a	0.0 to 0.5"wc		



NOTE:
SEE DRAWINGS A950053, A9500512 &
A9500516 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

2 BENCH TYPE FUME HOODS

TYPICAL FUME HOOD LAB APPLICATION # 22	DRAWN: ENGR: CHKD: DATE: SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 SINGLE SUPPLY/EXHAUST, DUAL BENCH HOOD AIR FLOW TRACKING/TEMP CONTROL FLOW DIAGRAM DRAWING NO. A9400422

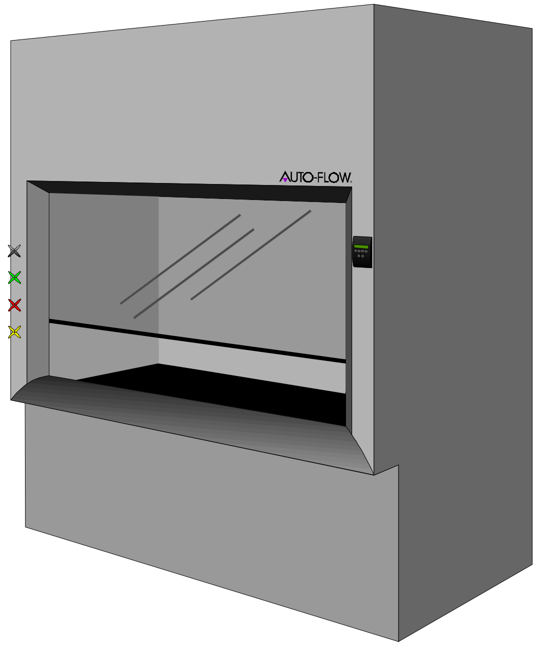
AUTO-FLOW

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide

Application #23

Single Supply/General Exhaust for Pressure Control with Temperature Override and Pressure Controlled Internal Office



In this Sequence:

- *General*
- *Lab Pressure Control*
- *Lab Office Pressure Control*
- *Lab Volume Limit Control*
- *Lab Office Volume Limit Control*
- *Lab Temperature Override*
- *Lab Office Temperature Override*
- *Alarming*

Bill of Material
Drawing

Application #23: Single Supply/General Exhaust for Pressure Control with Temperature Override and Pressure Controlled Internal Lab Office

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Lab Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading acts as the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Lab Office Pressure Control

The total pressure differential is measured between the laboratory office space and the surrounding laboratory. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is + 0.005"wc with respect to the surrounding laboratory, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory office supply damper. The laboratory office supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory office supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory office supply damper toward the closed position.

Lab Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Lab Office Volume Limit Control

The controller measures the supply air flow being delivered to the laboratory office using a parallel plate pitot array in the laboratory office supply air duct. This measurement is scaled into cubic feet per minute. The setpoint for supply air flow rate is that which maintains the desired minimum air changes per hour. The setpoint is adjustable either locally or remotely. The controller resets the total pressure differential PID loop setpoint in order to maintain the minimum or maximum supply flow limits. When the supply air flow rate falls below the desired minimum setpoint the controller resets the desired differential setpoint upward in order to increase supply flow. When the supply air flow rate rises above the desired minimum setpoint the controller resets the desired setpoint downward in order to decrease supply air flow.

Lab Temperature Override

The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory temperature. As the supply override signal increases, the controller increases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate).

Lab Office Temperature Override

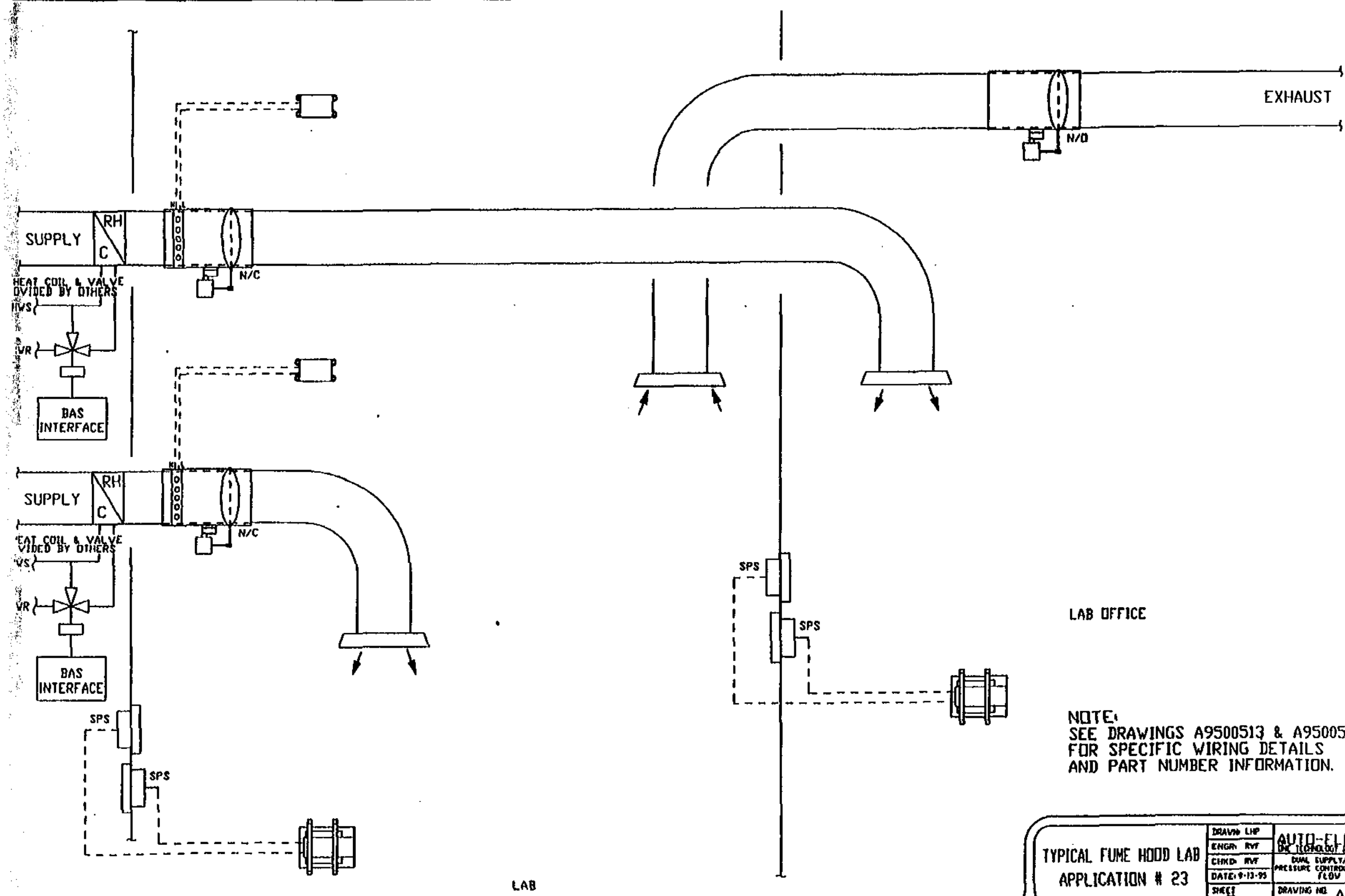
The controller accepts an input from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired laboratory office temperature. As the supply override signal increases the controller increases the minimum supply air flow setpoint associated with the reset of the differential setpoint. As the supply override signal decreases the controller decreases the minimum supply air flow setpoint associated with the reset of the differential setpoint.

Alarming

The controller provides the capability to alarm based on an actuator failure, related to either loss of power or actuator position feedback not meeting its commanded position. Additionally the controller also allows for the alarming of either of the supply air flows or total pressure differential measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST & SINGLE SUPPLY LAB OFFICE PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #23				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP23	Controller	Room Control	LC-1	LC1-APP23	n/a	n/a	n/a	n/a		
APP23	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP23-1	900	115	N/C	4-20 mA		
APP23	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP23-1	1092	0	n/a	0.0 to 0.25"wc		
APP23	Transmitter	Room Pressure	SPR-1A	SPR-APP23-1	n/a	n/a	n/a	0.0 to 0.01"wc		
APP23	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP23-1A	n/a	n/a	n/a			
				SPS-APP23-1B	n/a	n/a	n/a			
APP23	Damper & Actuator	Room Gen. Exh. Control	PDA-12-NO-IL	PDAX-APP23-1	1570	300	N/C	4-20 mA		
APP23	Damper & Actuator	Office Supply Control	CPP-P-8-NC-IL	CPPS-APP23-2	500	60	N/C	4-20 mA		
APP23	DP Transmitter	Office Supply CFM	FTR-0.25	FTRS-APP23-2	698	0	n/a	0.0 to 0.25"wc		
APP23	Transmitter	Office Pressure	SPR-1A	SPR-APP23-2	n/a	n/a	n/a	0.0 to 0.01"wc		
APP23	Press. Sensor Pair	Office Pressure	SPS-2T	SPS-APP23-2A	n/a	n/a	n/a			
				SPS-APP23-2B	n/a	n/a	n/a			



NOTE:
SEE DRAWINGS A9500513 & A9500515
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 23	DRAWN: LHP	AUTO-FLOW
	ENGR: RVF	
	CHKD: RVF	DUAL SUPPLY/SINGLE EXHAUST PRESSURE CONTROL W/TEMP OVERRIDE FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400423

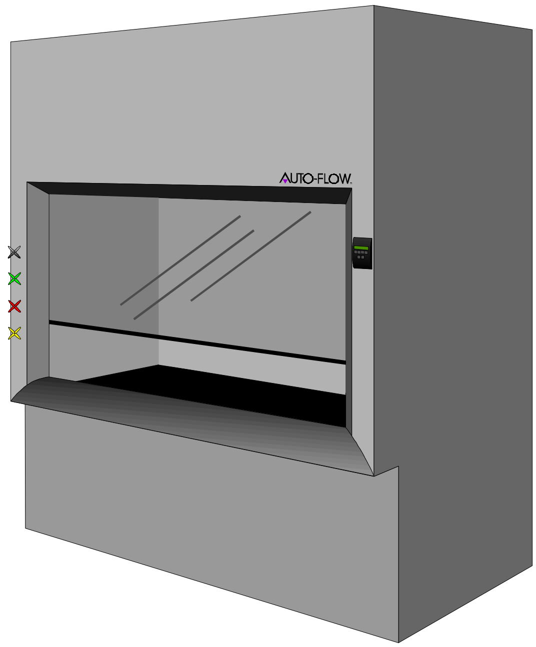
AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide

Application #24

Single Supply/General Exhaust for Air Flow Control with Temperature Override and Flow Controlled Internal Lab Office



In this Sequence:

- *General*
- *Lab Air Flow Control*
- *Lab Office Air Flow Control*
- *Temperature Override*
- *Volume Limit Control*
- *Alarming*

Bill of Material
Drawing

Application #24: Single Supply/General Exhaust for Air Flow Control with Temperature Override and Flow Controlled Internal Lab Office

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Lab Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in the laboratory supply air duct and it measures the exhaust air flow with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flow is the measured variable for one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal. The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user-adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Supply CFM + Current Office Supply CFM + ΔCFM Setpoint

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Lab Office Air Flow Control

The controller measures the supply air flow delivered to the laboratory office with a parallel plate pitot array in the laboratory office supply air duct. This measurement is scaled into units of cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The lab office supply air flow is the measured variable for the one of the controller's PID loops. The setpoint for lab office supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal. The damper actuator incorporates internal feedback for positive positioning. If the laboratory office supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory office supply air damper toward the open position. If the laboratory office supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory office supply air damper toward the closed position.

Temperature Override

The controller accepts inputs from the Building Automation System (BAS) which determines the amount of supply flow override required to maintain the desired temperature in the laboratory and the laboratory office. As either supply override signal increases the controller increases the respective minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply). As the supply override signal decreases, the controller decreases the respective minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate).

Volume Limit Control

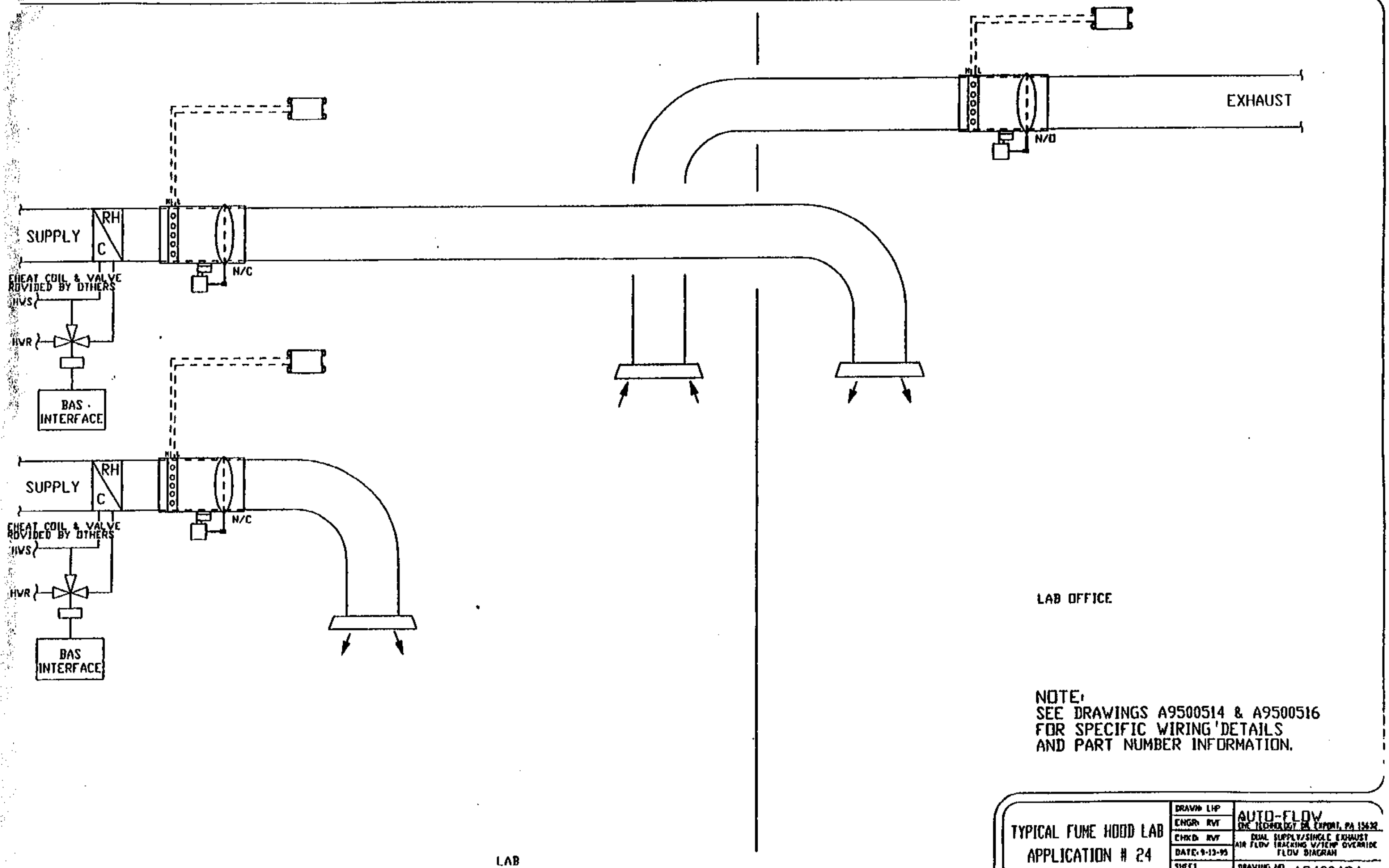
Should either laboratory or laboratory office measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the respective supply flow control PID loop is overridden and the respective supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable) the respective supply flow control PID loop is overridden and the respective supply damper is controlled to maintain the desired maximum air flow.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for alarms on either of the supply air flows and the general exhaust air flow measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST & SINGLE SUPPLY LAB OFFICE AIR FLOW CONTROL

PROJECT: SAMPLE Standard Application #24				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP24	Controller	Room Control	LC-1	LC1-APP24	n/a	n/a	n/a	n/a		
APP24	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP24-1	900	115	N/C	4-20 mA		
APP24	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP24-1	1092	0	n/a	0.0 to 0.25"wc		
APP24	Damper & Actuator	Room Gen. Exh. Control	CPP-P-12-NO-IL	CPPX-APP24-1	1570	300	N/C	4-20 mA		
APP24	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRS-APP24-1	1570	0	n/a	0.0 to 0.25"wc		
APP24	Damper & Actuator	Office Supply Control	CPP-P-8-NC-IL	CPPS-APP24-2	500	60	N/C	4-20 mA		
APP24	DP Transmitter	Office Supply CFM	FTR-0.25	FTRS-APP24-2	698	0	n/a	0.0 to 0.25"wc		



NOTE:
SEE DRAWINGS A9500514 & A9500516
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 24	DRAWN: LHP	AUTO-FLOW
	ENGR: RVT	
	CHKD: RVT	DUAL SUPPLY/SINGLE EXHAUST AIR FLOW TRACKING W/TEMP OVERRIDE FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400424

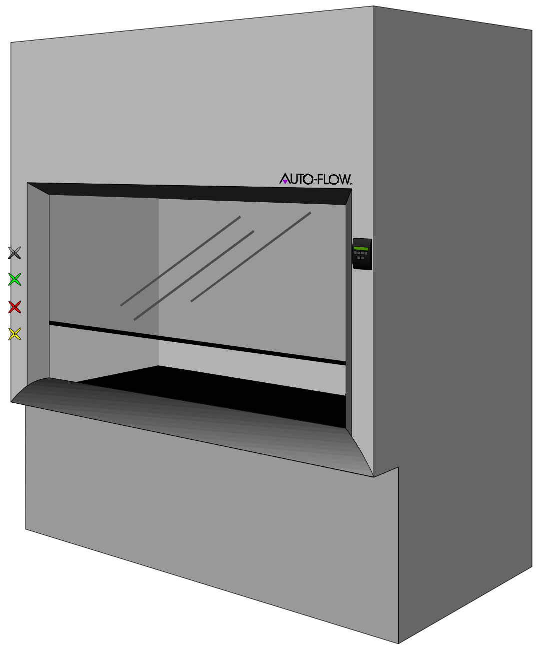
AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide

Application #25

Single Supply/General Exhaust for Pressure Control with Full Temperature Control and Internal Lab Office with Pressure Control and Full Temperature Control



In this Sequence:

- *General*
- *Lab Pressure Control*
- *Lab Office Presssure Control*
- *Lab Volume Limit Control*
- *Lab Office Volume Limit Control*
- *Lab Temperature Control*
- *Lab Office Temperature Control*
- *Emergency Mode*
- *Alarming*

Bill of Material

Drawing

Application #25: Single Supply/General Exhaust for Pressure Control with Full Temperature Control and Internal Lab Office with Pressure Control and Full Temperature Control

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Lab Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Lab Office Pressure Control

The total pressure differential is measured between the laboratory office space and the surrounding laboratory. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is + 0.005"wc with respect to the surrounding laboratory, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory office supply damper. The laboratory office supply damper is positioned by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory office supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory office supply damper toward the closed position.

Lab Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in the laboratory supply air duct. This measurement is scaled into cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The supply air flow reading is the measured variable for the controller's PID loop. The setpoint for supply air flow rate is that which maintains the desired minimum number of air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes a control loop five times per second. When the supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Lab Office Volume Limit Control

The controller measures the supply air flow being delivered to the laboratory office using a parallel plate pitot array in the laboratory office supply air duct. This measurement is scaled into cubic feet per minute. The setpoint for supply air flow rate is that which maintains the desired minimum air changes per hour. The setpoint is adjustable either locally or remotely. The controller resets the total pressure differential PID loop setpoint in order to maintain the minimum or maximum supply flow limits. When the supply air flow rate falls below the desired minimum setpoint the controller resets the desired differential setpoint upward in order to increase supply flow. When the supply air flow rate rises above the desired minimum setpoint the controller resets the desired setpoint downward in order to decrease supply air flow.

Lab Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) à Supply Air Flow Rate] à 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the general exhaust air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply).

Lab Office Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory office space and the temperature of the laboratory office space itself. These temperatures combined with the measured laboratory office supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain temperature. The equation for this process is as follows:

BTU's =[(Supply Discharge Temperature - Space Temperature) à Supply Air Flow Rate] à 1.085

One of the controllers PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum laboratory office supply flow setpoint and the associated PID loop. If the BTUs fall below the required setpoint the controller decreases the minimum laboratory office supply air flow toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum laboratory office supply air flow setpoint toward its maximum value (the maximum design CFM for the lab office supply).

Emergency Mode

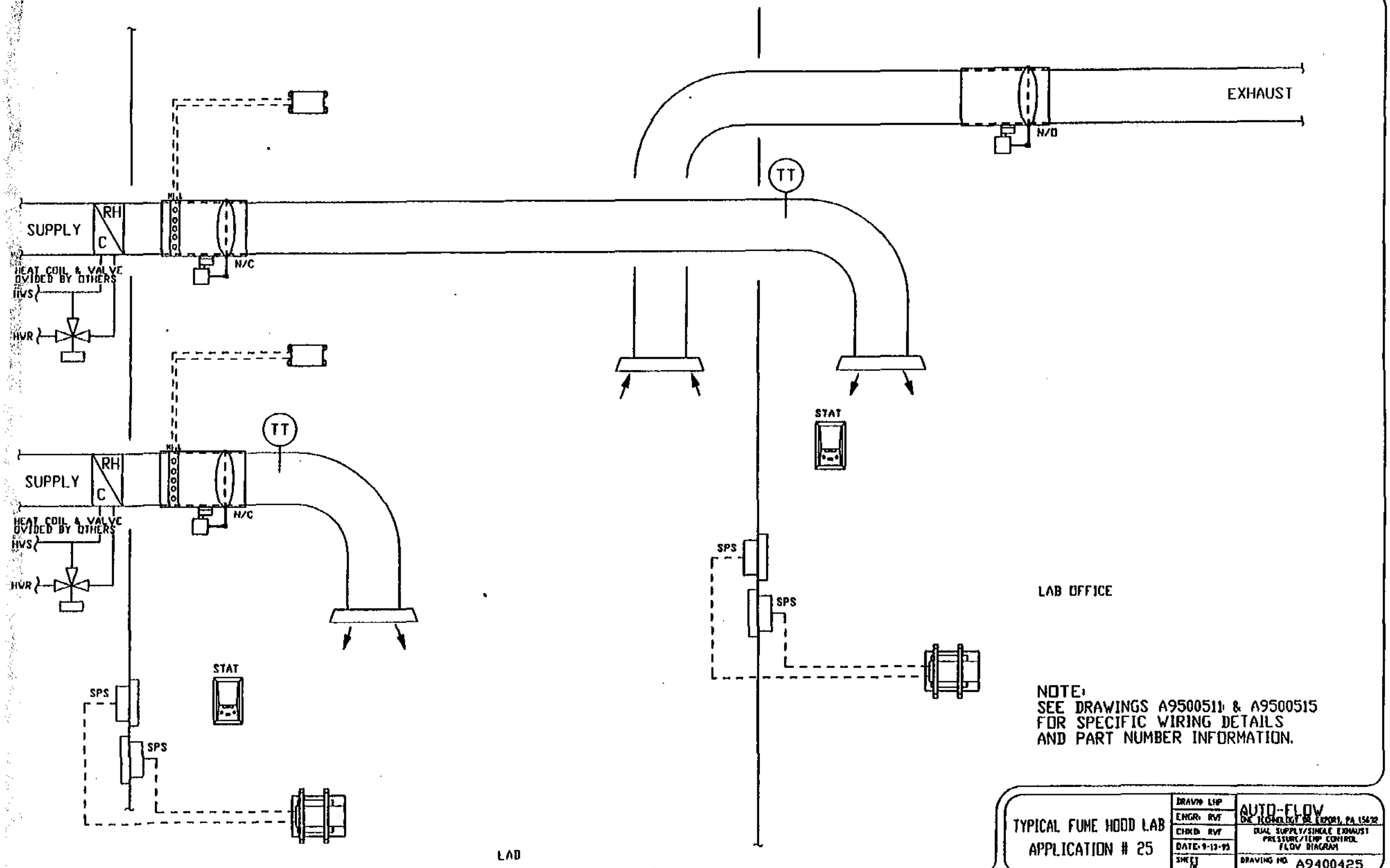
The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure, from any of the electronic actuators connected to the controller, related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the supply air flow, general exhaust air flow, supply duct temperature, space temperature or total pressure differential measurements based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST & SINGLE SUPPLY LAB OFFICE PRESSURE/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #25				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP25	Controller	Room Control	LC-2	LC2-APP25	n/a	n/a	n/a	n/a		
APP25	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP25-1	900	115	N/C	4-20 mA		
APP25	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP25-1	1092	0	n/a	0.0 to 0.25"wc		
APP25	Transmitter	Room Pressure	SPR-1A	SPR-APP25-1	n/a	n/a	n/a	0.0 to 0.01"wc		
APP25	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP25-1A	n/a	n/a	n/a			
				SPS-APP25-1B	n/a	n/a	n/a			
APP25	Temp. Sensor	Space Temperature	STAT	STAT-APP25-1	n/a	n/a	n/a	-32 to 132 *F		
APP25	Damper & Actuator	Room Gen. Exh. Control	PDA-12-NO-IL	PDAX-APP25-1	1570	300	N/C	4-20 mA		
APP25	Damper & Actuator	Office Supply Control	CPP-P-8-NC-IL	CPPS-APP25-2	500	60	N/C	4-20 mA		
APP25	DP Transmitter	Office Supply CFM	FTR-0.25	FTRS-APP25-2	698	0	n/a	0.0 to 0.25"wc		
APP25	Transmitter	Office Pressure	SPR-1A	SPR-APP25-2	n/a	n/a	n/a	0.0 to 0.01"wc		
APP25	Press. Sensor Pair	Office Pressure	SPS-2T	SPS-APP25-2A	n/a	n/a	n/a			
				SPS-APP25-2B	n/a	n/a	n/a			
APP25	Temp. Sensor	Space Temperature	STAT	STAT-APP25-2	n/a	n/a	n/a	-32 to 132 *F		



NOTE:
SEE DRAWINGS A9500511 & A9500515
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

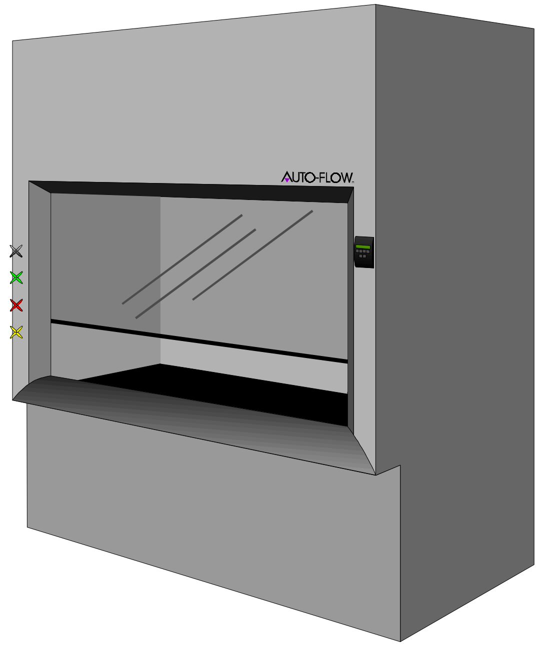
TYPICAL FUME HOOD LAB APPLICATION # 25	DRAWN: LHP	AUTO-FLOW
	ENGR: RVF	DUAL SUPPLY/SINGLE EXHAUST PRESSURE/TEMP CONTROL FLOW DIAGRAM
	CHKD: RVF	
	DATE: 9-13-95	
	SHEET	DRAWING NO. A9400425

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide

Application #26

Single Supply/General Exhaust for Air Flow Control with Full Temperature Control and Internal Lab Office with Air Flow Control and Full Temperature Control



In this Sequence:

- *General*
- *Lab Air Flow Control*
- *Lab Office Air Flow Control*
- *Lab Temperature Control*
- *Lab Office Temperature Control*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

Bill of Material
Drawing

Application #26: Single Supply/General Exhaust for Air Flow Control with Full Temperature Control and Internal Lab Office with Air Flow Control and Full Temperature Control

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network will have no effect on laboratory pressure control.

Lab Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in the laboratory supply air duct and it measures the exhaust air flow with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flow acts as the measured variable for one of the controller's PID loops. The setpoint for supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal. The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Lab Supply CFM + Current Lab Office CFM + ΔCFM Setpoint

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Lab Office Air Flow Control

The controller measures the supply air flow delivered to the laboratory office with a parallel plate pitot array in the laboratory office supply air duct. This measurement is scaled into units of cubic feet per minute. The controller executes a process loop using proportional, integral, and derivative control action. The lab office supply air flow is the measured variable for one of the controller's PID loops. The setpoint for lab office supply air flow is the minimum air flow rate required for the desired air changes per hour, reset from the temperature override signal. The damper actuator incorporates internal feedback for positive positioning. If the laboratory office supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory office supply air damper toward the open position. If the laboratory office supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory office supply air damper toward the closed position.

Lab Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) $\times$ Supply Air Flow Rate] $\times$ 1.085

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the laboratory supply air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the supply air damper toward its maximum value (the maximum design CFM for the lab supply).

Lab Office Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory office space and the temperature of the laboratory office space itself. These temperatures combined with the measured laboratory office supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) × Supply Air Flow Rate] × 1.085.

One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coil. Additionally the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum laboratory office supply flow setpoint and the associated PID loop. If the BTUs fall below the required setpoint the controller decreases the minimum laboratory office supply air flow toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If the calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum laboratory office supply air flow setpoint toward its maximum value (the maximum design CFM for the lab office supply).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, the respective supply flow control PID loop is overridden and the respective supply damper is controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable), the respective supply flow control PID loop is overridden and the respective supply damper is controlled to maintain the desired maximum air flow.

Emergency Mode

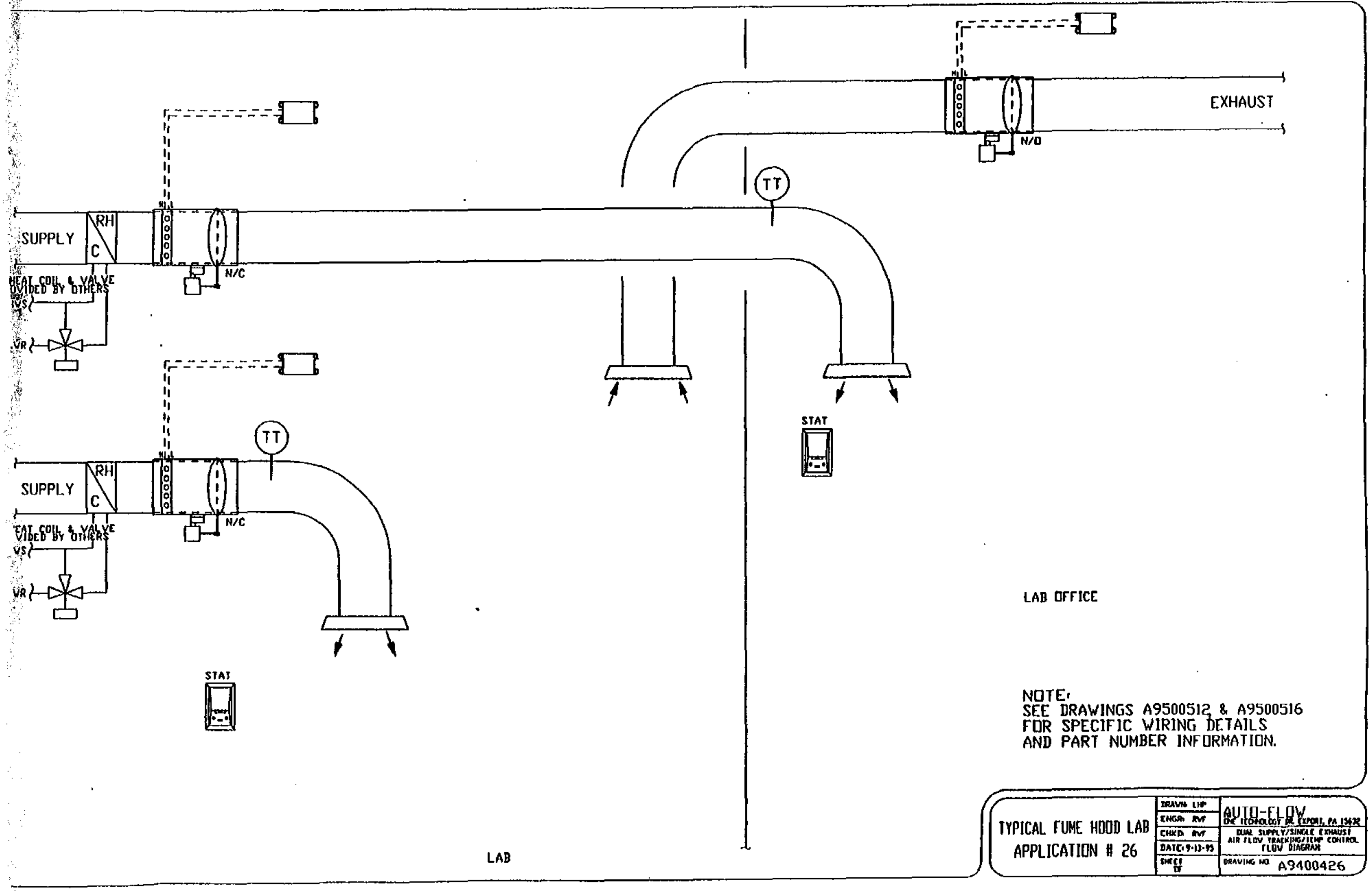
The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure, from any of the electronic actuators connected to the controller, related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the supply air flow, general exhaust air flow, supply duct temperature, space temperature or total pressure differential measurements based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted over the communications network to the remote operator interface device.

SINGLE SUPPLY/GENERAL EXHAUST & SINGLE SUPPLY LAB OFFICE AIR FLOW/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #26				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP26	Controller	Room Control	LC-2	LC2-APP26	n/a	n/a	n/a	n/a		
APP26	Damper & Actuator	Room Supply Control	CPP-P-10-NC-IL	CPPS-APP26-1	900	115	N/C	4-20 mA		
APP26	DP Transmitter	Room Supply CFM	FTR-0.25	FTRS-APP26-1	1092	0	n/a	0.0 to 0.25"wc		
APP26	Temp. Sensor	Space Temperature	STAT	STAT-APP26-1	n/a	n/a	n/a	-32 to 132 *F		
APP26	Damper & Actuator	Room Gen. Exh. Control	CPP-P-12-NO-IL	CPPX-APP26-1	1570	300	N/C	4-20 mA		
APP26	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRS-APP26-1	1570	0	n/a	0.0 to 0.25"wc		
APP26	Damper & Actuator	Office Supply Control	CPP-P-8-NC-IL	CPPS-APP26-2	500	60	N/C	4-20 mA		
APP26	DP Transmitter	Office Supply CFM	FTR-0.25	FTRS-APP26-2	698	0	n/a	0.0 to 0.25"wc		
APP26	Temp. Sensor	Space Temperature	STAT	STAT-APP26-2	n/a	n/a	n/a	-32 to 132 *F		

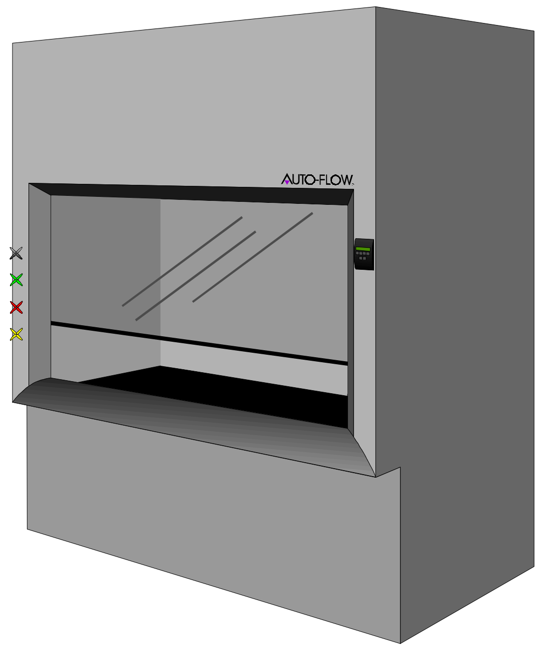


NOTE:
SEE DRAWINGS A9500512 & A9500516
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 26	DRAWN: LHP	AUTO-FLOW
	ENGR: RVF	DUAL SUPPLY/SINGLE EXHAUST AIR FLOW TRACKING/TEMP CONTROL FLOW DIAGRAM
	CHKD: RVF	
	DATE: 9-13-95	
	SHEET OF	DRAWING NO A9400426

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #27

Dual Supply Single General Exhaust for Pressure Control with Full Temperature Control and Four Bench Fume Hoods

In this Sequence:

LABORATORY

- *General*
- *Pressure Control*
- *Volume Limit Control*
- *Temperature Control*
- *Emergency Mode*
- *Alarming*

FUME HOODS

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Sequence of Operation

Application #27: Dual Supply Single General Exhaust for Pressure Control with Full Temperature Control and Four Bench Fume Hoods

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading acts as the measured variable for the controller's PID loop. The setpoint for total pressure differential is -0.005"wc with respect to the adjacent corridor, which is adjustable either locally or remotely. The controller's PID output is used to control each output to the laboratory supply dampers. The laboratory supply dampers are positioned as required by the controller by electronic damper actuators. The damper actuators incorporate internal feedback for positive positioning. The controller executes its control loop five times per second. When total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. When total pressure differential rises above the desired setpoint the controller modulates the normally closed laboratory supply dampers toward the closed position.

Volume Limit Control

The controller measures the supply air flow delivered to the laboratory with a parallel plate pitot array in each of the laboratory supply air ducts. This measurement is scaled into cubic feet per minute. The controller executes a process loop using a proportional, integral, and derivative control action. The total supply air flow reading acts as the measured variable for the controller's PID loop. The setpoint for total supply air flow rate shall be that which maintains the desired minimum air changes per hour. The setpoint is adjustable either locally or remotely. The controller's PID output is used to control the output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes a control loop five times per second. When the total supply air flow rate falls below the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the open position. Opening the damper causes a drop in total pressure differential that results in an increase in supply air delivered to the laboratory. When the total supply air flow rate goes above the desired minimum setpoint the controller modulates the normally open laboratory general exhaust damper toward the closed position. This action results in an increase in total pressure differential causing a reduction in the supply air delivered to the lab.

Temperature Control

The controller measures the temperature of the supply air in each of the supply ducts serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) à Supply Air Flow Rate] à 1.085

This equation is calculated for each supply duct serving the lab space and summed to provide a total BTU result. One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. This BTU setpoint is used in conjunction with the calculated current BTUs and a PID loop to control the laboratory supply duct reheat coils. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and the associated PID loop controlling the general exhaust air damper. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the output to the reheat coil valve toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil output toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the PID loop controlling the general exhaust air damper toward its maximum value (the maximum design CFM for the lab supply).

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure, from any of the electronic actuators connected to the controller, related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the supply air flow, supply duct temperature, space temperature or total pressure differential measurements based on user-adjustable limits. These alarms are not annunciated locally, they are transmitted over the communications network to the remote operator interface device.

FUME HOODS

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

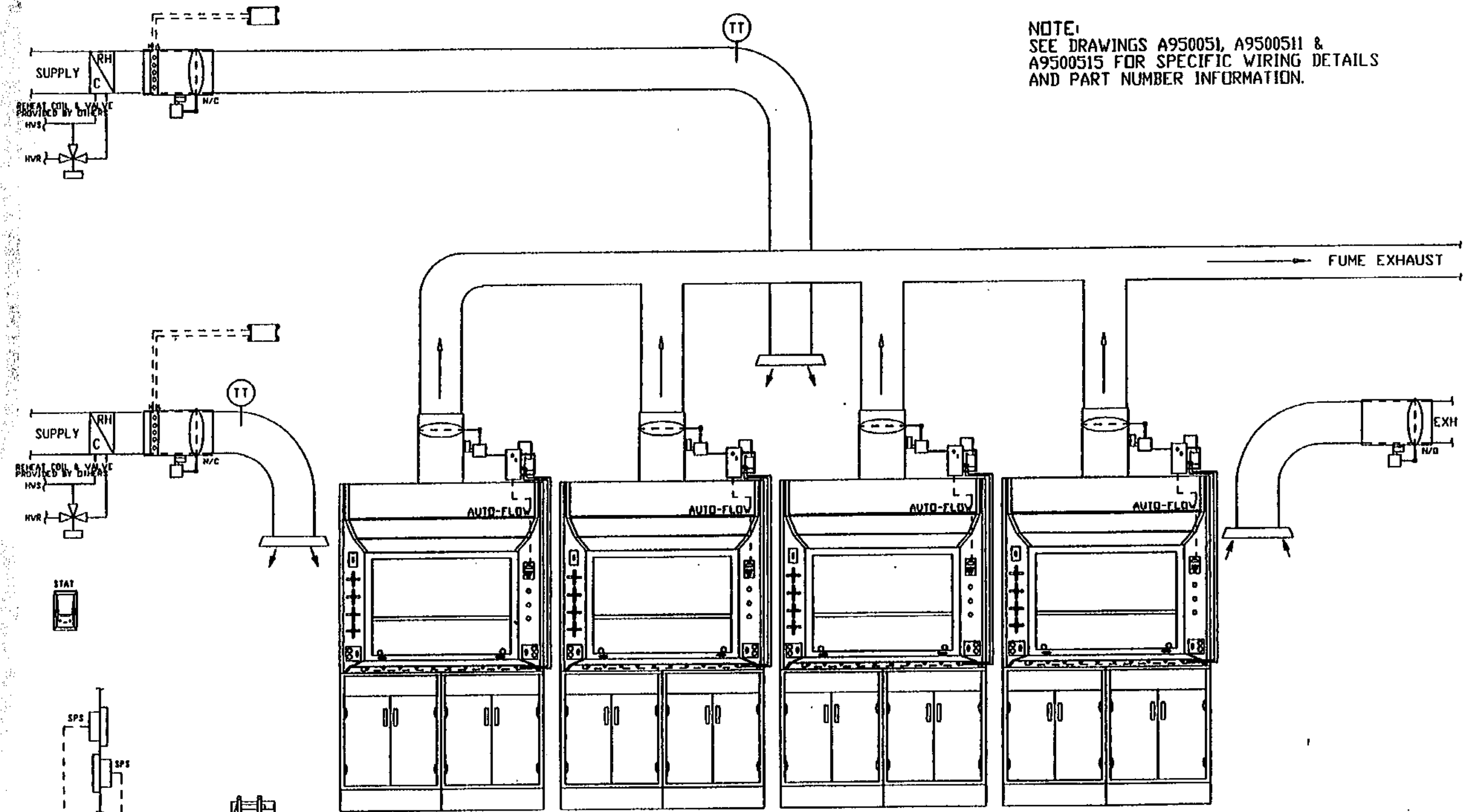
Table 1	**Velocity Unsafe**	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
	Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
	Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pushing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm.

FOUR BENCH FUME HOODS & DUAL SUPPLY SINGLE GENERAL EXHAUST PRESSURE/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #27				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP27	Controller	Room Control	LC-2	LC2-APP27	n/a	n/a	n/a	n/a		
APP27	Damper & Actuator	Room Supply #1 Control	CPP-P-14-NC-IL	CPPS-APP27-S1	2250	220	N/C	4-20 mA		
APP27	DP Transmitter	Room Supply #1 CFM	FTR-0.5	FTRS-APP27-S1	3030	0	n/a	0.0 to 0.5"wc		
APP27	Damper & Actuator	Room Supply #2 Control	CPP-P-14-NC-IL	CPPS-APP27-S2	2250	220	N/C	4-20 mA		
APP27	DP Transmitter	Room Supply #2 CFM	FTR-0.5	FTRS-APP27-S2	3030	0	n/a	0.0 to 0.5"wc		
APP27	Transmitter	Room Pressure	SPR-1A	SPR-APP27	n/a	n/a	n/a	0.0 to 0.01"wc		
APP27	Press. Sensor Pair	Room Pressure	SPS-2T	SPS-APP27-1A	n/a	n/a	n/a			
				SPS-APP27-1B	n/a	n/a	n/a			
APP27	Temp. Sensor	Space Temperature	STAT	STAT-APP27	n/a	n/a	n/a	-32 to 132 *F		
APP27	Damper & Actuator	General Exhaust	PDA-10-NO-IL	PDAX-APP27	1090	0	N/O	4-20 mA		
APP27	Controller	Hood #1 Control	HC1	HC1-APP27-1	n/a	n/a	n/a	n/a		
APP27	Transmitter	Hood #1 Face Velocity	FVR-1A	FVR-APP27-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP27	Air Foil Pitot	Hood #1 Face Velocity	AFP2-60	AFP-APP27-1	n/a	n/a	n/a	n/a		6-foot Hood
APP27	Tubing Kit	Hood #1 Face Velocity	TBK-1	TBK-APP27-1	n/a	n/a	n/a	n/a		
APP27	Damper & Actuator	Hood #1 Exhaust	PDA-10-NO-HM	PDAX-APP27-1	1250	250	N/O	4-20 mA		6-foot Hood
APP27	Controller	Hood #2 Control	HC1	HC1-APP27-2	n/a	n/a	n/a	n/a		
APP27	Transmitter	Hood #2 Face Velocity	FVR-1A	FVR-APP27-2	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP27	Air Foil Pitot	Hood #2 Face Velocity	AFP2-48	AFP-APP27-2	n/a	n/a	n/a	n/a		5-foot Hood
APP27	Tubing Kit	Hood #2 Face Velocity	TBK-1	TBK-APP27-2	n/a	n/a	n/a	n/a		
APP27	Damper & Actuator	Hood #2 Exhaust	PDA-8-NO-HM	PDAX-APP27-2	1000	200	N/O	4-20 mA		5-foot Hood
APP27	Controller	Hood #3 Control	HC1	HC1-APP27-3	n/a	n/a	n/a	n/a		
APP27	Transmitter	Hood #3 Face Velocity	FVR-1A	FVR-APP27-3	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP27	Air Foil Pitot	Hood #3 Face Velocity	AFP2-60	AFP-APP27-3	n/a	n/a	n/a	n/a		6-foot Hood
APP27	Tubing Kit	Hood #3 Face Velocity	TBK-1	TBK-APP27-3	n/a	n/a	n/a	n/a		
APP27	Damper & Actuator	Hood #3 Exhaust	PDA-10-NO-HM	PDAX-APP27-3	1250	250	N/O	4-20 mA		6-foot Hood
APP27	Controller	Hood #4 Control	HC1	HC1-APP27-4	n/a	n/a	n/a	n/a		
APP27	Transmitter	Hood #4 Face Velocity	FVR-1A	FVR-APP27-4	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP27	Air Foil Pitot	Hood #4 Face Velocity	AFP2-48	AFP-APP27-4	n/a	n/a	n/a	n/a		5-foot Hood
APP27	Tubing Kit	Hood #4 Face Velocity	TBK-1	TBK-APP27-4	n/a	n/a	n/a	n/a		
APP27	Damper & Actuator	Hood #4 Exhaust	PDA-8-NO-HM	PDAX-APP27-4	1000	200	N/O	4-20 mA		5-foot Hood

NOTE:
SEE DRAWINGS A950051, A9500511 &
A9500515 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.



4 BENCH TYPE FUME HOODS

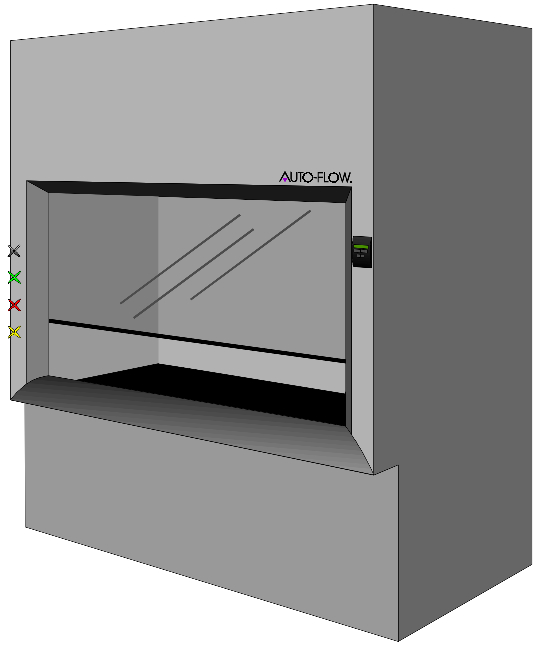
TYPICAL FUME HOOD LAB
APPLICATION # 27

DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
ENGR: RVF	
CHKD: RVF	DUAL SUPPLY/SINGLE EXHAUST/OUR BENCH HOODS PRESSURE/TEMP CONTROL FLOW DIAGRAM
DATE: 9-13-95	
SHEET OF	DRAWING NO. A9400427

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #28

Dual Supply Single General Exhaust for Air Flow Control with Full Temperature Control and Four Bench Hoods

In this Sequence:

LABORATORY

- *General*
- *Air Flow Control*
- *Temperature Control*
- *Volume Limit Control*
- *Emergency Mode*
- *Alarming*

FUME HOODS

- *General*
- *Control*
- *Exhaust Air Flow Monitoring*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #28: Dual Supply Single General Exhaust for Air Flow Control with Full Temperature Control and Four Bench Hoods

LABORATORY

General

The laboratory is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on laboratory pressure control.

Air Flow Control

The controller measures the laboratory supply air flow with a parallel plate pitot array in both of the laboratory supply air ducts and measures the exhaust air flow leaving the space with a parallel plate pitot array in the laboratory general exhaust duct. These measurements are scaled into cubic feet per minute (CFM). The controller executes its process loops using proportional, integral, and derivative control action. The supply air flows are the measured variables for two of the controller's PID loops. The setpoint for each supply air flow is half of the minimum air flow rate required for the desired air changes per hour, reset from the temperature control signal or half of the air flow rate required to satisfy the fume hood makeup air volume, whichever is greater. The supply makeup air flow rate is determined by the following equation:

Supply Makeup Flow Setpoint CFM = (Total Hood Exhaust Air Flow CFM + Minimum General Exhaust Air Flow CFM - Desired Differential CFM Setpoint)

The controller's PID outputs are used to control output to each of the laboratory supply air dampers. The laboratory supply air dampers are positioned as required by the controller with electronic damper actuators. The damper actuators incorporate internal feedback for positive positioning. The controller executes its control loop five times per second. When supply air flow falls below the desired setpoint the controller modulates the normally closed laboratory supply air dampers toward the open position. When supply air flow rises above the desired setpoint the controller modulates the normally closed laboratory supply air dampers toward the closed position.

The exhaust air flow setpoint is based on a calculation derived to maintain a constant differential CFM. This differential CFM is the mathematical result of the total exhaust air leaving the space minus the total supply air entering the space. The differential CFM setpoint is a constant value that is user adjustable. The exhaust air flow setpoint is based on the following equation:

Exhaust CFM Setpoint = Current Supply CFM + ΔCFM Setpoint-Total Hood Exhaust CFM

The exhaust air flow PID is controlled to maintain this differential CFM. The controller's PID output is used to control output to the laboratory general exhaust air damper. The laboratory general exhaust air damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop five times per second. When general exhaust air flow falls below the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the open position. When general exhaust air flow rises above the desired setpoint the controller modulates the normally open laboratory general exhaust air damper toward the closed position.

Temperature Control

The controller measures the temperature of the supply air in the supply duct serving the laboratory space and the temperature of the laboratory space itself. These temperatures combined with the measured supply air flow rate are used to calculate the instantaneous BTUs used by the space to maintain its temperature. The equation for this process is as follows:

BTUs = [(Supply Discharge Temperature - Space Temperature) à Supply Air Flow Rate] à 1.085

This equation is calculated twice, one for each supply duct. One of the controller's PID loops is used in conjunction with the measured space temperature and its required setpoint to determine the desired instantaneous BTU setpoint. Half of this BTU setpoint is used in conjunction with the respective calculated current BTUs and a PID loop to control each of the laboratory supply duct reheat coils. Additionally, the BTU setpoint and calculated current BTUs work in a reset fashion with the minimum supply flow setpoint and each of the associated PID loops controlling the laboratory supply air dampers. If the BTUs fall below the required setpoint the controller decreases the minimum supply air flow setpoint associated with the respective PID loop controlling each of the supply air dampers toward its minimum value (the minimum design CFM for the required air change rate). As the calculated BTUs continue to fall below the required setpoint the controller modulates the outputs to the reheat coil valves toward the open position. If calculated BTUs rise above the desired setpoint the controller modulates the reheat coil outputs toward the closed position. On a continued rise above the desired setpoint the controller resets the minimum supply air flow setpoint associated with the respective PID loop controlling each of the supply air dampers toward its maximum value (the maximum design CFM for the lab supply).

Volume Limit Control

Should the measured supply air flow volume fall below its desired minimum air flow rate (adjustable) as required to maintain the necessary air changes per hour, each of the supply flow control PID loops is overridden and the laboratory supply dampers are controlled to maintain the desired minimum air flow. Should the measured supply air flow volume rise above its desired maximum air flow rate (adjustable) each of the supply flow control PID loops is overridden and the laboratory supply dampers are controlled to maintain the desired maximum air flow.

Emergency Mode

The controller has the capability to accept an external contact from an emergency push button which indicates the emergency purge mode. In this mode the laboratory general exhaust air and supply air dampers are overridden to a fixed (user-adjustable) position and an alarm is transmitted over the communications network to the remote operator interface device. These dampers remain in this position until the emergency push button is reset to its normal state.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback not meeting its commanded position. Additionally, the controller also allows for alarms on the supply air flows, general exhaust air flow, supply duct temperatures and space temperature measurements based on user-adjustable limits. These alarms are not annunciated locally. They are transmitted over the communications network to the remote operator interface device.

FUME HOODS

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has built-in local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LED(s) capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading acts as the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, which is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm. When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If the face velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the laboratory pressure controller in calculating total lab exhaust volume. The controller provides a dedicated input and output for receiving a cascaded flow signal from another fume hood controller, adding its own exhaust flow value and transmitting a totalized signal to either another fume hood controller or the laboratory pressure controller.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

Alarming

The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

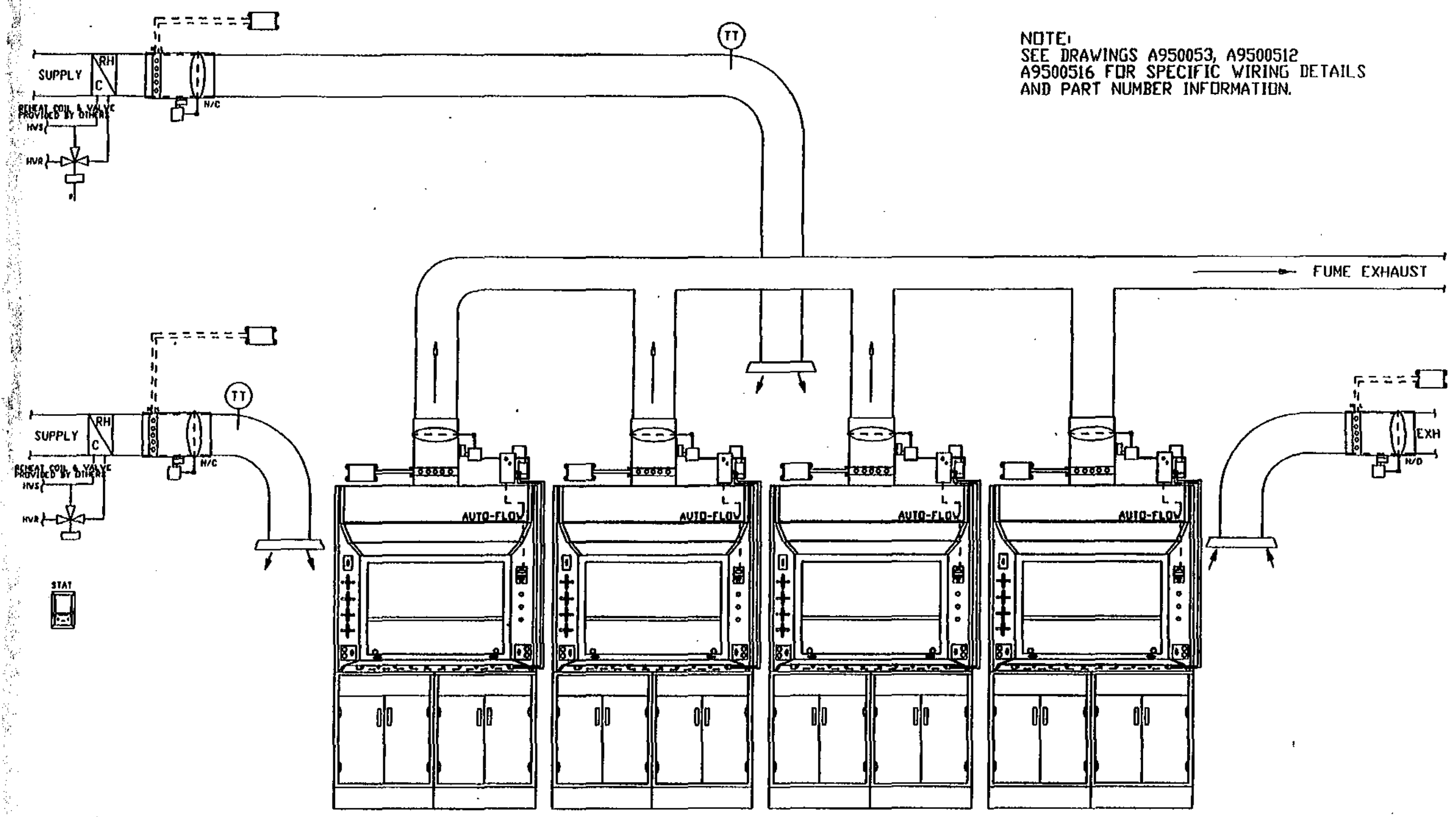
Table 1	**Velocity Unsafe**	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
	Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
	Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.

FOUR BENCH FUME HOODS & DUAL SUPPLY SINGLE GENERAL EXHAUST AIR FLOW/TEMPERATURE CONTROL

PROJECT: SAMPLE Standard Application #28				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP28	Controller	Room Control	LC-2	LC2-APP28	n/a	n/a	n/a	n/a		
APP28	Damper & Actuator	Room Supply #1 Control	CPP-P-14-NC-IL	CPPS-APP28-S1	2000	250	N/C	4-20 mA		
APP28	DP Transmitter	Room Supply #1 CFM	FTR-0.25	FTRS-APP28-S1	2140	0	n/a	0.0 to 0.25"wc		
APP28	Damper & Actuator	Room Supply #2 Control	CPP-P-14-NC-IL	CPPS-APP28-S2	2000	250	N/C	4-20 mA		
APP28	DP Transmitter	Room Supply #2 CFM	FTR-0.25	FTRS-APP28-S2	2140	0	n/a	0.0 to 0.25"wc		
APP28	Damper & Actuator	Room Gen. Exh. Control	CPP-P-10-NO-IL	CPPX-APP28	1090	0	N/C	4-20 mA		
APP28	DP Transmitter	Room Gen. Exh. CFM	FTR-0.25	FTRX-APP28	1092	0	n/a	0.0 to 0.25"wc		
APP28	Temp. Sensor	Space Temperature	STAT	STAT-APP28	n/a	n/a	n/a	-32 to 132 *F		
APP28	Controller	Hood #1 Control	HC1	HC1-APP28-1	n/a	n/a	n/a	n/a		
APP28	DP Transmitter	Hood #1 Face Velocity	FVR-1A	FVR-APP28-1	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP28	Air Foil Pitot	Hood #1 Face Velocity	AFP2-36	AFP-APP28-1	n/a	n/a	n/a	n/a		4-foot Hood
APP28	Tubing Kit	Hood #1 Face Velocity	TBK-1	TBK-APP28-1	n/a	n/a	n/a	n/a		
APP28	Damper & Actuator	Hood #1 Exhaust	CPP-P-8-NO-HM	CPPX-APP28-1	750	150	N/O	4-20 mA		4-foot Hood
APP28	DP Transmitter	Hood #1 Exhaust CFM	FTR-0.5	FTRX-APP28-1	988	0	n/a	0.0 to 0.5"wc		
APP28	Controller	Hood #2 Control	HC1	HC1-APP28-2	n/a	n/a	n/a	n/a		
APP28	DP Transmitter	Hood #2 Face Velocity	FVR-1A	FVR-APP28-2	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP28	Air Foil Pitot	Hood #2 Face Velocity	AFP2-60	AFP-APP28-2	n/a	n/a	n/a	n/a		6-foot Hood
APP28	Tubing Kit	Hood #2 Face Velocity	TBK-1	TBK-APP28-2	n/a	n/a	n/a	n/a		
APP28	Damper & Actuator	Hood #2 Exhaust	CPP-P-10-NO-HM	CPPX-APP28-2	1250	250	N/O	4-20 mA		6-foot Hood
APP28	DP Transmitter	Hood #2 Exhaust CFM	FTR-0.5	FTRX-APP28-2	1544	0	n/a	0.0 to 0.5"wc		
APP28	Controller	Hood #3 Control	HC1	HC3-APP28-3	n/a	n/a	n/a	n/a		
APP28	DP Transmitter	Hood #3 Face Velocity	FVR-1A	FVR-APP28-3	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP28	Air Foil Pitot	Hood #3 Face Velocity	AFP2-36	AFP-APP28-3	n/a	n/a	n/a	n/a		4-foot Hood
APP28	Tubing Kit	Hood #3 Face Velocity	TBK-1	TBK-APP28-3	n/a	n/a	n/a	n/a		
APP28	Damper & Actuator	Hood #3 Exhaust	CPP-P-8-NO-HM	CPPX-APP28-3	750	150	N/O	4-20 mA		4-foot Hood
APP28	DP Transmitter	Hood #3 Exhaust CFM	FTR-0.5	FTRX-APP28-3	988	0	n/a	0.0 to 0.5"wc		
APP28	Controller	Hood #4 Control	HC1	HC1-APP28-4	n/a	n/a	n/a	n/a		
APP28	DP Transmitter	Hood #4 Face Velocity	FVR-1A	FVR-APP28-4	n/a	n/a	n/a	0.0 - 0.0015 "wc		
APP28	Air Foil Pitot	Hood #4 Face Velocity	AFP2-60	AFP-APP28-4	n/a	n/a	n/a	n/a		6-foot Hood
APP28	Tubing Kit	Hood #4 Face Velocity	TBK-1	TBK-APP28-4	n/a	n/a	n/a	n/a		
APP28	Damper & Actuator	Hood #4 Exhaust	CPP-P-10-NO-HM	CPPX-APP28-4	1250	250	N/O	4-20 mA		6-foot Hood
APP28	DP Transmitter	Hood #4 Exhaust CFM	FTR-0.5	FTRX-APP28-4	1544	0	n/a	0.0 to 0.5"wc		

NOTE:
SEE DRAWINGS A950053, A9500512
A9500516 FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.



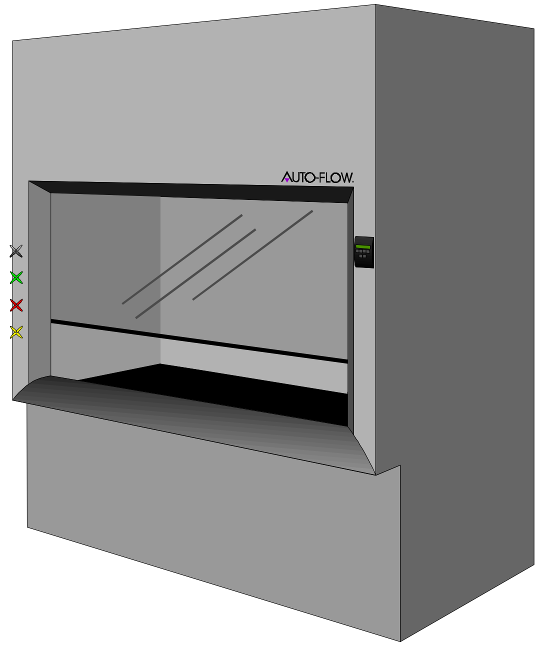
4 BENCH TYPE FUME HOODS

TYPICAL FUME HOOD LAB APPLICATION # 28	DRAWN: LVP ENGR: RVT CHKD: RVT DATE: 9-13-95 SHEET OF	AUTO-FLOW DRAWING NO. A9400428

AUTO-FLOW

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #29

Constant Volume On/Off or
Switched Setpoint Control

In this Sequence:

- *General*
- *Air Flow Control*
- *Alarming*

Bill of Material
Drawing

Application #29: Constant Volume
On/Off or Switched Setpoint Control

General

The constant volume device is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions independently of the network for all lab control aspects so that a failure of the communications network has no effect over control.

Air Flow Control

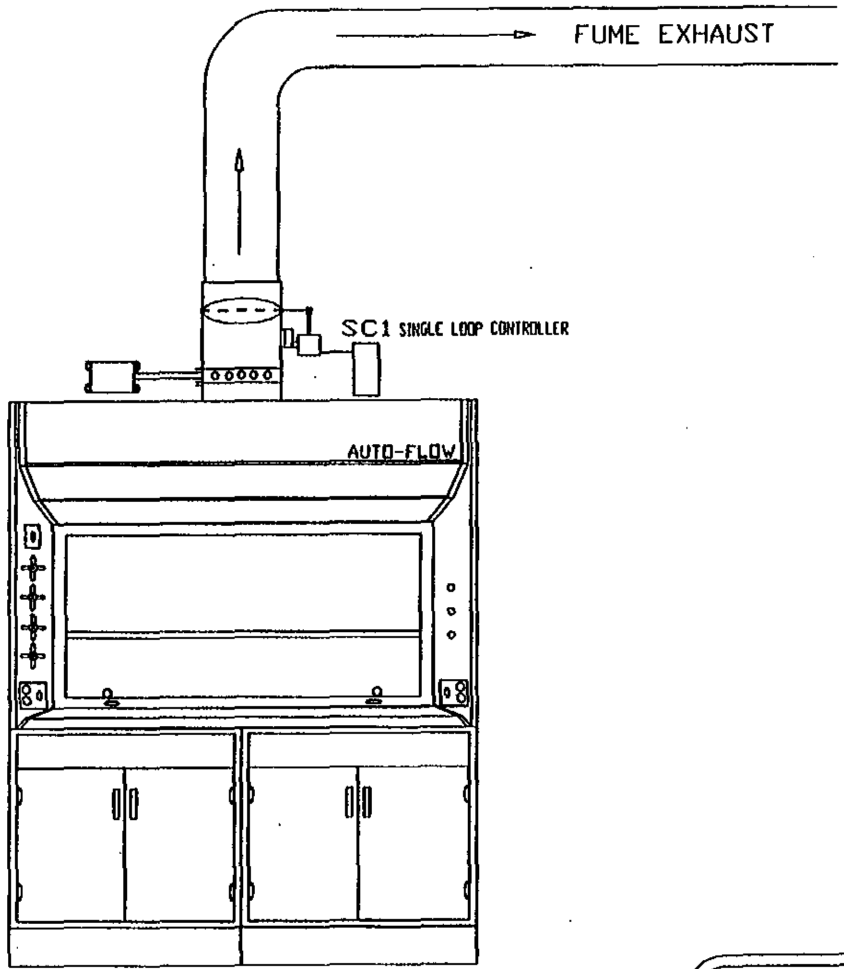
The controller measures the flow through the device with a parallel plate pitot array in the duct servicing the device. These measurements are scaled into cubic feet per minute. The controller executes its process loops using proportional, integral, and derivative control action. The controller and sensor combination act as a completely pressure independent control unit. Air flow is the measured variable for the controller's PID loop. The setpoint for air flow is fixed and user adjustable. The setpoint has the capability to change to a different fixed (user-adjustable) value based on input to the controller from an external switch or based on a time of day schedule. The controller's PID output is used to control output to the device's air regulating damper. The air regulating damper is positioned as required by the controller with an electronic damper actuator. The damper actuators incorporate internal feedback for positive positioning. The controller executes its control loop of five times per second. If air flow falls below the desired setpoint the controller modulates the air regulating damper toward the open position. If the air flow rises above the desired setpoint the controller modulates the air regulating damper toward the closed position.

Alarming

The controller provides the capability to alarm based on an actuator failure related to either loss of power or actuator position feedback that does not meet the commanded position. The controller also allows for alarms on the air flow measurements based on user-adjustable limits. These alarms annunciate locally or remotely or a combination of both.

CONSTANT VOLUME CONTROL

PROJECT: SAMPLE Standard Application #29				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP29	Controller	Constant Vol. Control	SC1	SC1-APP29-1	n/a	n/a	n/a	n/a		
APP29	Damper & Actuator	Hood Exhaust	CPP-P-8-NO-HM	CPPX-APP29-1	875	110	n/a	4-20 mA		
APP29	DP Transmitter	Hood Exhaust CFM	FTR-0.5	FTRX-APP29-1	988	0	n/a	0.0 to 0.5"wc		
APP29	Power Supply	Controller Power	UPS-1	UPS-APP29-1	n/a	n/a	n/a	24 VDC 500 mA		
APP29	Power Supply	Actuator Power	AXT-1	AXT-APP29-1	n/a	n/a	n/a	24 VAC CT 40VA		



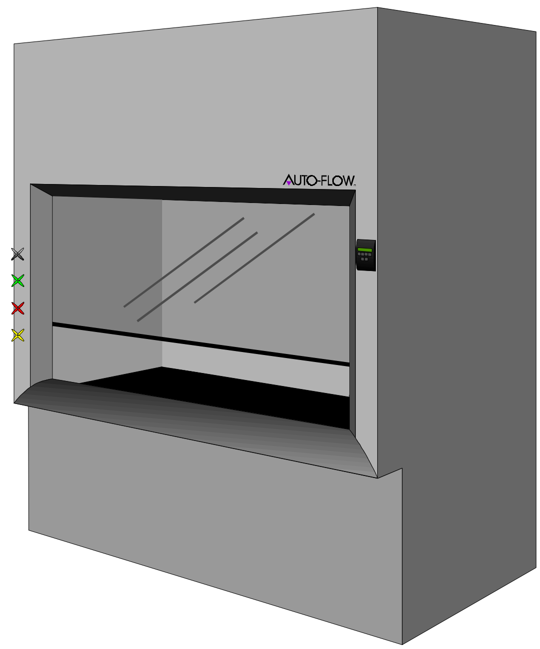
BENCH TYPE FUME HOOD
W/EXHAUST FLOW MEASUREMENT

TYPICAL FUME HOOD LAB APPLICATION # 29	DRAWN: LHP ENGR: RVT CHKD: RVF DATE: 9-13-95 SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 SINGLE HOOD CONSTANT VOLUME OR SWITCHED SETPOINT CONTROL DRAWING NO. A9400429

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #30

Glove Box Pressure Control

In this Sequence:

- *General*
- *Pressure Control*
- *Alarming*

Bill of Material
Drawing

AUTO-FLOW®

Sequence of Operation

Application #30: Glove Box Pressure Control

General

The glove box is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller is capable of interfacing with local network interface devices such as hand-held or wall-mounted local displays. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on control.

Pressure Control

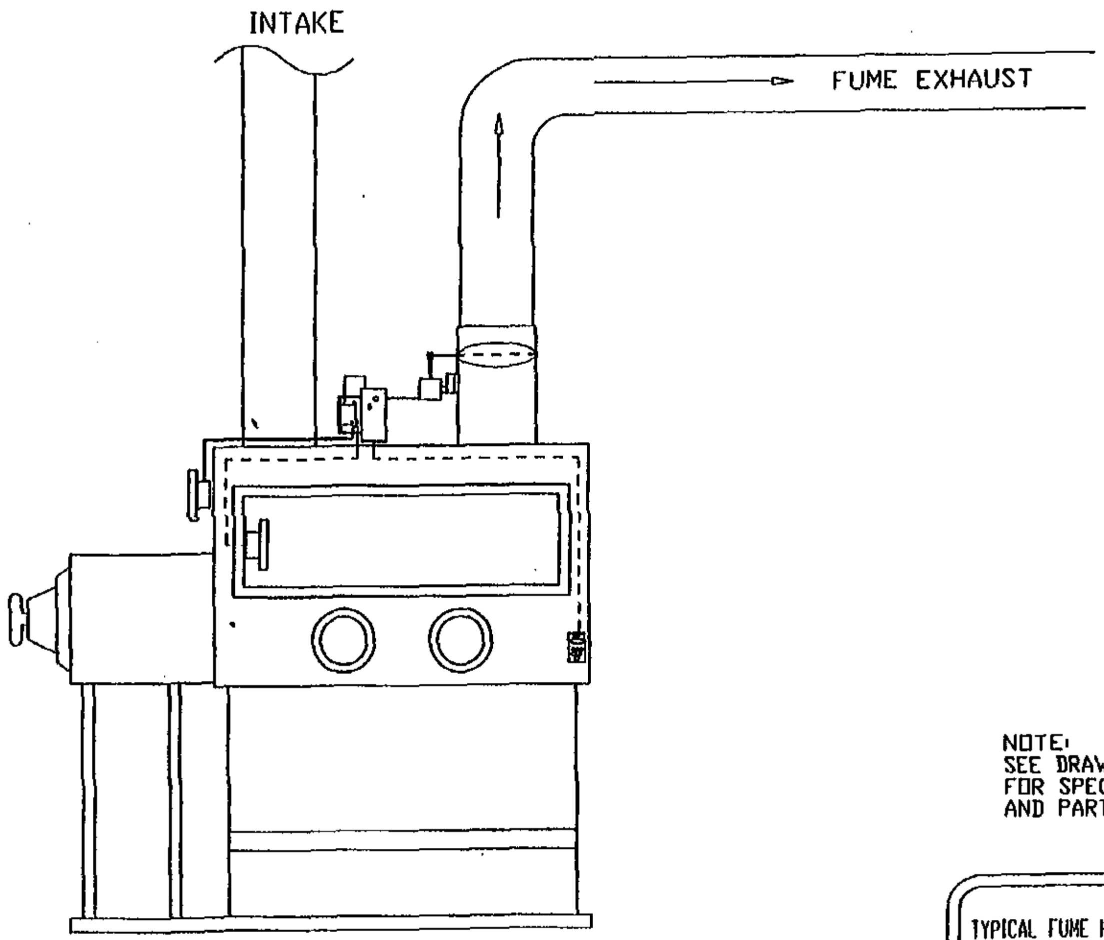
The total pressure differential is measured between the glove box interior and the surrounding space. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is -0.01"wc with respect to the surrounding space, a setpoint that is adjustable either locally or remotely. The controller's PID output is used to control output to the glove box exhaust air damper. The exhaust air damper is positioned by the controller with an electronic damper actuator. The damper actuators incorporate internal feedback for positive positioning. The controller executes its control loop five times per second. If the pressure differential falls below the desired setpoint the controller modulates the exhaust air damper toward the open position. If the pressure differential goes above the desired setpoint the controller modulates the exhaust air damper toward the closed position.

Alarming

The controller provides the capability to alarm based on an actuator failures related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarms of the differential pressure measurements based on user-adjustable limits. These alarms annunciate both locally and remotely.

GLOVE BOX PRESSURE CONTROL

PROJECT: SAMPLE Standard Application #30				PROJECT NO. :						DATE
										05/06/2000
ROOM NUMBER	DESCRIPTION	FUNCTION	PART NUMBER	TAG #	MAX CFM	MIN CFM	FAIL POSITION	RANGE		COMMENTS
APP30	Controller	Pressure Control	SC1	SC1-APP30-1	n/a	n/a	n/a	n/a		
APP30	Damper & Actuator	Box Exhaust	PDA-6-NO-HM	PDAX-APP30-1	540	65	n/a	4-20 mA		
APP30	Transmitter	Box Pressure	SPR-1A	SPR-APP30	n/a	n/a	n/a	0.0 to 0.01"wc		
APP30	Press. Sensor Pair	Box Pressure	SPS-2T	SPS-APP30-1A	n/a	n/a	n/a			
				SPS-APP30-1B	n/a	n/a	n/a			
APP30	Power Supply	Controller Power	UPS-1	UPS-APP30-1	n/a	n/a	n/a	24 VDC 500 mA		
APP30	Power Supply	Actuator Power	AXT-1	AXT-APP30-1	n/a	n/a	n/a	24 VAC CT 40VA		



NOTE:
SEE DRAWING A950057 ,
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

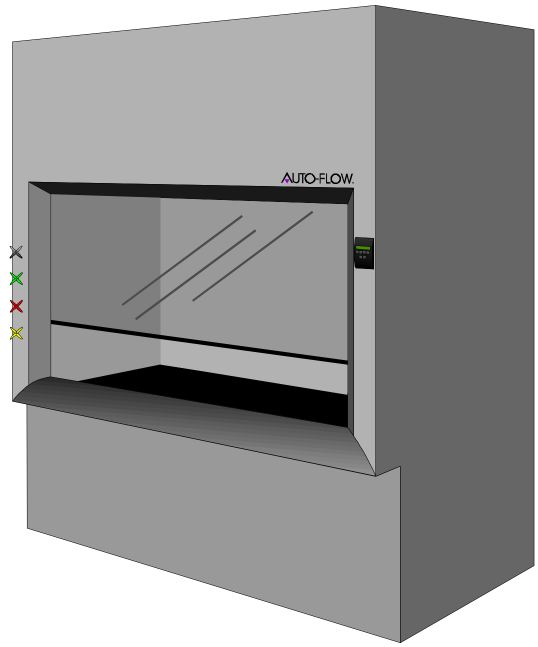
TYPICAL FUME HOOD LAB APPLICATION #30	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVF	GLOVE BOX PRESSURE CONTROL
	CHKD: RVF	
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400430

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide

Application #31

Biological Safety Cabinet



In this Sequence:

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Sequence of Operation

Application #31: Single Bench Biological Safety Cabinet

General

The biological safety cabinet is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LEDs capable of displaying current cabinet operating status in up to three different conditions
- audible alarm
- audible alarm silence
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on biological safety cabinet control.

Control

The controller measures the exhaust air flow volume leaving the biological safety cabinet with a parallel plate array in the cabinet exhaust duct. This measurement is scaled into cubic feet per minute (CFM) for use by the biological safety cabinet controller. The controller executes a process loop using proportional, integral, and derivative control action. The exhaust air flow reading is the measured variable for the controller's PID loop. The setpoint for exhaust air flow is a flow rate that translates to an average face velocity of 75 (Class I, Type A) or 100 (Class I, Type B1, 2, &3) feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the biological safety cabinet exhaust damper. The biological safety cabinet exhaust flow damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When exhaust flow falls below the desired setpoint the controller modulates the normally open biological safety cabinet exhaust damper toward the open position. If exhaust flow continues to fall below setpoint, the controller generates a local alarm (as described in the alarming section) after an adjustable time delay. When exhaust flow rises above the desired setpoint the controller modulates the normally open biological safety cabinet exhaust damper toward the closed position. If exhaust flow continues to rise above setpoint, the controller generates a local alarm after an adjustable time delay.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the cabinet. Initiation of either device positions the biological safety cabinet exhaust damper to an user-defined fixed position. In this mode the controller display indicates that the hood is in emergency mode while the audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally or a reset of the remote device.

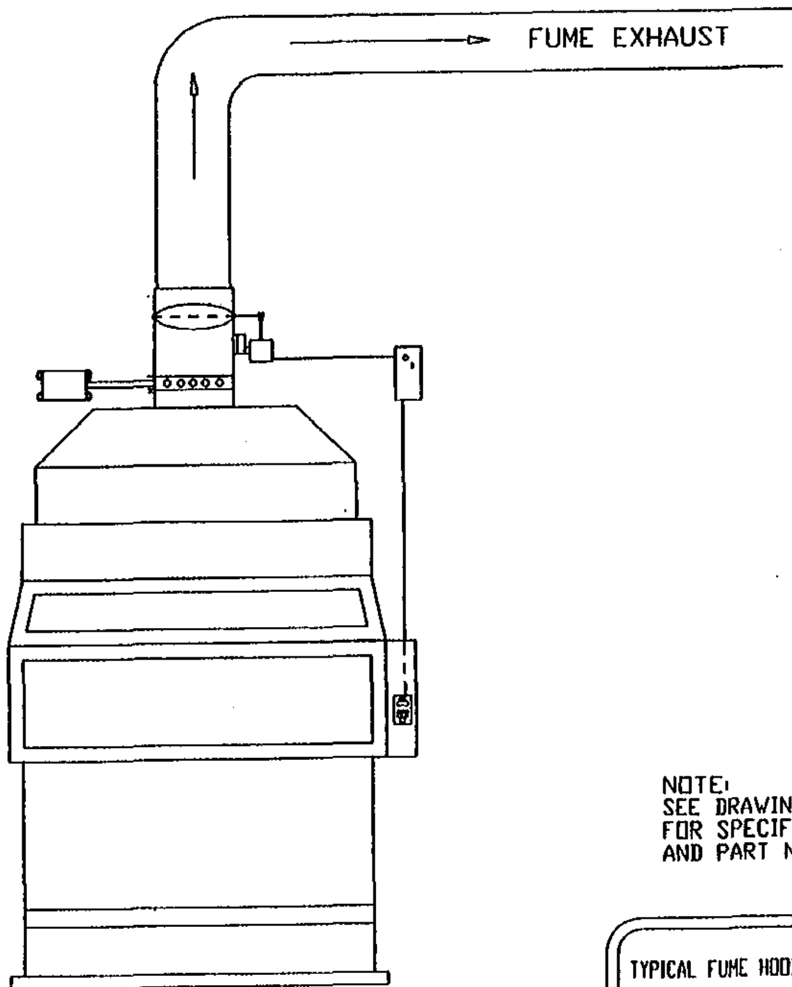
Alarming

The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

Velocity Unsafe	<20 FPM or >20 FPM	Red LED and continuous audible alarm
Velocity Low	<10 FPM	Yellow LED and pulsing audible alarm
Velocity High	>10 FPM	Yellow LED and pulsing audible alarm

Table 1

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms can be silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that mimics the operation of the built-in audible alarm.



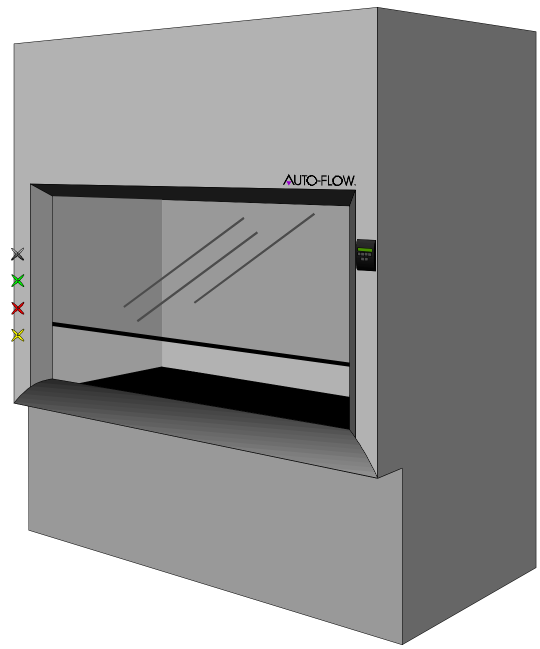
BID SAFETY HOOD

NOTE:
SEE DRAWING A950058
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 31	DRAWN: LHP ENGR: RVF CHKD: RVF DATE: 9-13-95 SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 BIO SAFETY HOOD FLOW DIAGRAM DRAWING NO. A9400431

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #32

Single Bench Fume Hood with Exhaust Bypass Control

In this Sequence:

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #32: Single Bench Fume Hood with Exhaust Bypass Control

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LEDs capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Fume Hood Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If velocity continues to fall below setpoint, the controller generates a local alarm (as described in the alarming section) after an adjustable time delay. When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If velocity continues to rise above setpoint, the controller generates a local alarm after an adjustable time delay.

Exhaust Bypass Damper Control

The controller measures static pressure in the common exhaust duct plenum using a duct static pressure sensor. The controller executes a process loop using proportional, integral, and derivative control action. The exhaust duct static pressure reading is the measured variable for the controller's PID loop. The setpoint for exhaust duct static pressure is determined in the field and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the exhaust bypass damper. The exhaust bypass damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. When exhaust duct static pressure falls below the desired setpoint the controller modulates the normally closed exhaust bypass exhaust damper toward the open position.. When exhaust duct static pressure rises above the desired setpoint the controller modulates the normally closed exhaust bypass damper toward the closed position.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood.. Initiation of either device positions the hood exhaust damper and exhaust bypass damper to a user-defined fixed position. In this mode the controller display indicates that the hood is in emergency mode while the audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally.

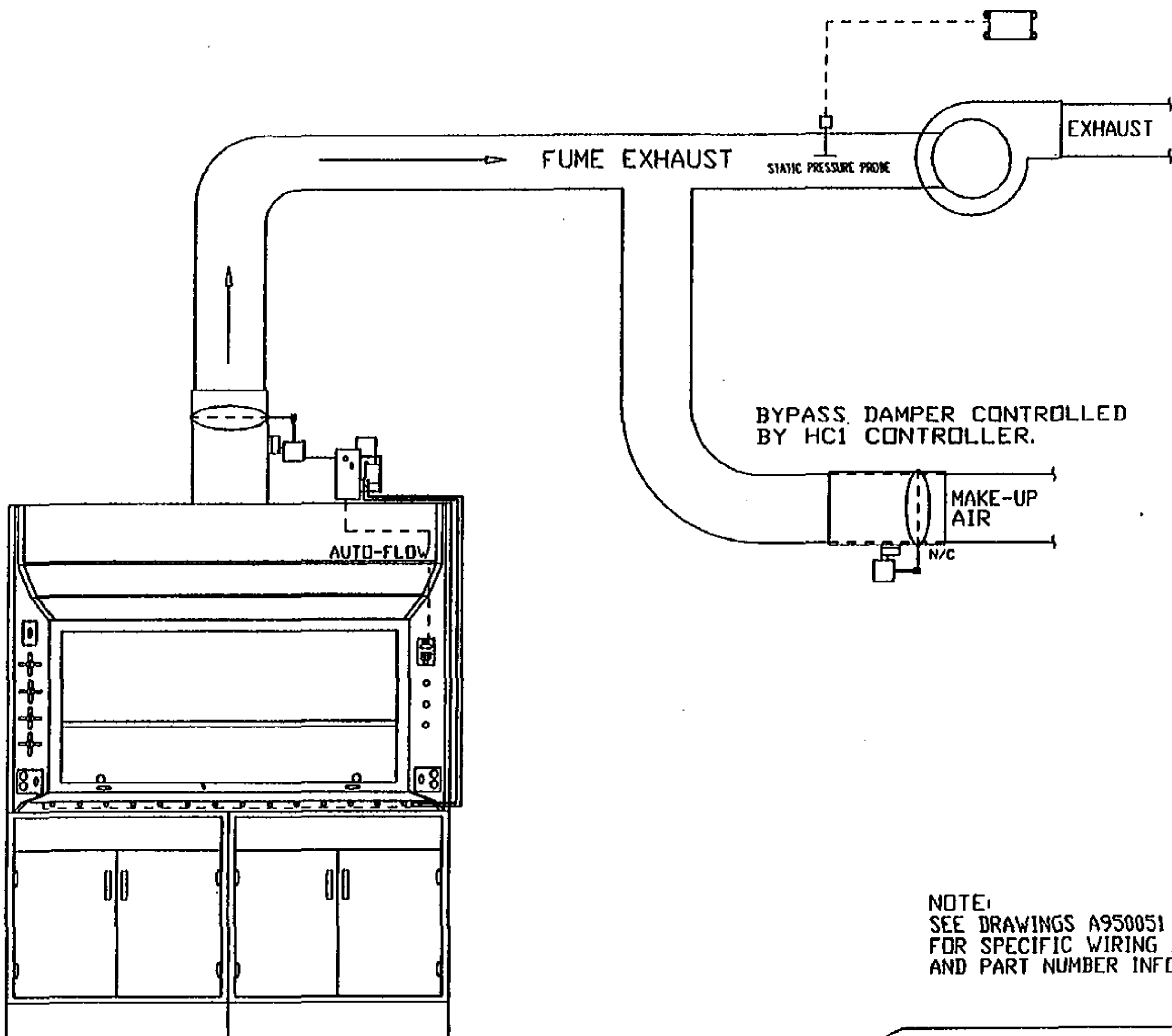
Alarming

The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

Table 1

Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms can be silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that mimics the operation of the built-in audible alarm.



BENCH TYPE FUME HOOD

NOTE:
SEE DRAWINGS A950051 & A9500515
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

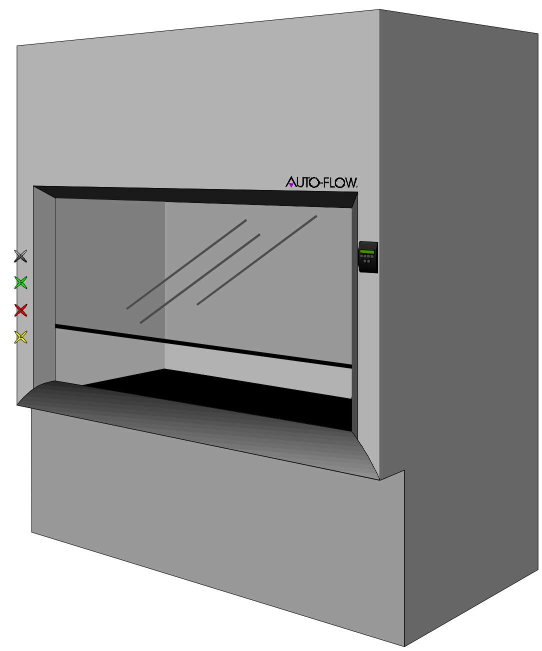
TYPICAL FUME HOOD LAB APPLICATION # 32	DRAWN: LHP ENGR: RVF CHKD: RVF DATE: 9-13-95 SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 SINGLE HOOD BYPASS FLOW DIAGRAM DRAWING NO. A9400432

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide

Application #33

Single Bench Fume Hood with General Exhaust Air Flow Tracking



In this Sequence:

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Application #33: Single Bench Fume Hood with General Exhaust Air Flow Tracking

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LEDs capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Fume Hood Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an adjusted percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller using an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If flow continues to fall below setpoint, after an adjustable time delay the controller generates a local alarm (as described in the alarming section). When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If velocity continues to rise above setpoint the controller generates a local alarm after an adjustable time delay.

Fume Hood Exhaust Air Flow Monitoring

The controller measures the exhaust air flow volume leaving the fume hood using a parallel plate pitot array in the fume hood exhaust duct. This measurement is scaled into cubic feet per minute for use by the controller in calculating total lab exhaust volume.

General Exhaust Air Flow Control

The controller measures the exhaust air flow volume leaving the general exhaust grille with a parallel plate pitot array and differential pressure transmitter in the general exhaust duct. This measurement is scaled into cubic feet per minute. The controller executes its process loop with proportional, integral, and derivative control action. The general exhaust air flow is the measured variable for the controller's PID loop.. The general exhaust air flow setpoint is based on the following equation:

General Exhaust Setpoint = (Total exhaust flow capacity- fume hood exhaust flow)

The setpoint is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory general exhaust air damper. The general exhaust air damper is positioned as required by the controller through an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. If general exhaust air flow falls below the desired setpoint the controller modulates the normally closed general exhaust air damper toward the open position. On a rise in general exhaust air flow above the desired setpoint the controller modulates the normally closed general exhaust air damper toward the closed position.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper to a user-defined fixed position. In emergency mode the controller display audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally, or a resetting of the remote device.

Alarming

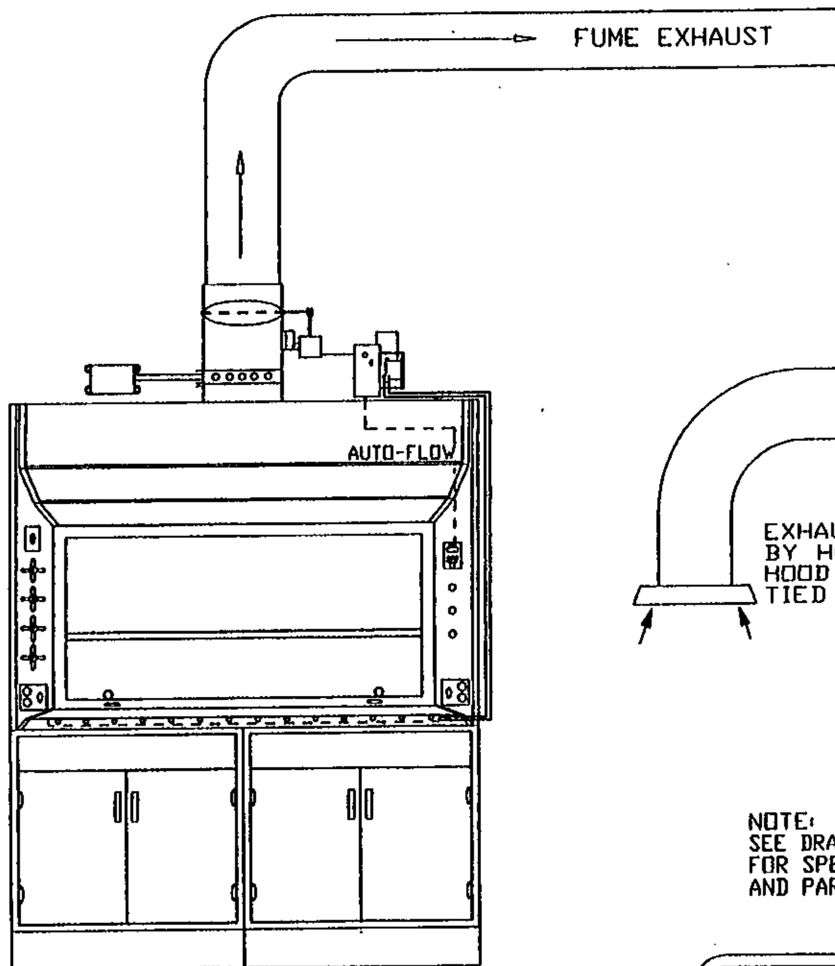
The controller has the ability to initiate alarms locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1):

Table 1

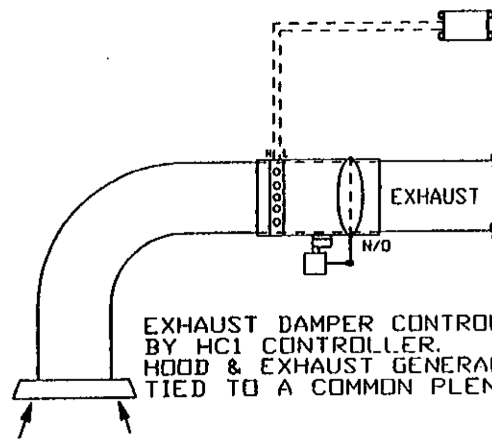
Velocity Unsafe	<80 FPM or >120 FPM	Red LED and continuous audible alarm
Velocity Low	<90 FPM	Yellow LED and pulsing audible alarm
Velocity High	>110 FPM	Yellow LED and pulsing audible alarm

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms are silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period.

After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that parallels the operation of the built-in audible alarm. The controller also provides an alarm for the exhaust flow value based on user adjustable limits. This alarm does not annunciate locally, it is transmitted over the communications network to the remote operator interface device.



BENCH TYPE FUME HOOD
W/EXHAUST FLOW MEASUREMENT



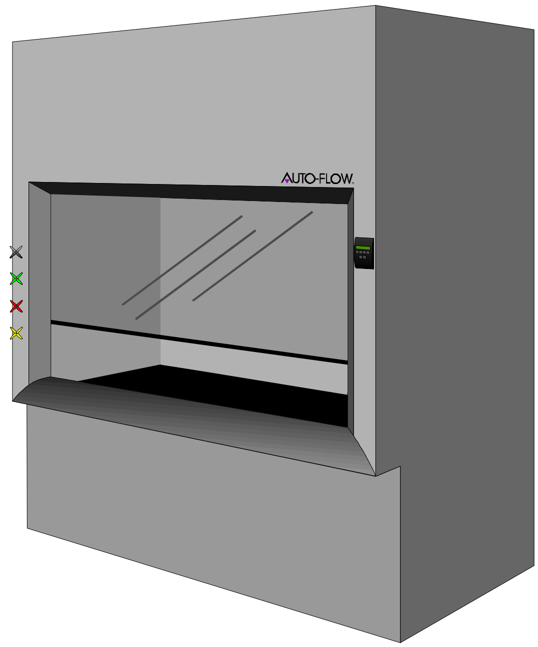
EXHAUST DAMPER CONTROLLED BY HC1 CONTROLLER.
HOOD & EXHAUST GENERALLY TIED TO A COMMON PLENUM.

NOTE:
SEE DRAWINGS A950053 & A9500516 FOR SPECIFIC WIRING DETAILS AND PART NUMBER INFORMATION.

TYPICAL FUME HOOD LAB APPLICATION # 33	DRAWN: LIP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVT	SINGLE BENCH, SINGLE EXHAUST AIR FLOW TRACKING FLOW DIAGRAM
	CHKD: RVT	
	DATE: 9-13-95	
	SHEET OF	DRAWING NO. A9400433

Sequence of Operation

Laboratory and Fume Hood
Controls Engineering Guide



Application #34

Isolation Room Control

In this Sequence:

- *General*
- *Configurationl*
- *Control*
- *Alarming*

Bill of Material
Drawings

Sequence of Operation

Application #34: Isolation Room Control

General
The isolation room is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities so that it can interface with hand-held or wall-mounted local display devices. The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all lab control aspects so that a failure of the communications network has no effect on fume hood control.

Configuration

The isolation room ventilation is configured as described in this section. The supply air to the space is controlled separately to its design requirements. The space is served by an exhaust air duct with a modulating control damper. A space pressure sensing device measures the total pressure differential across the barrier wall between the controlled space and the adjacent space. The controller panel includes a face-mounted alarm light, alarm horn, horn silence button, space pressure LCD display, isolation/normal selector switch, and a positive/negative selector switch.

Mode Control

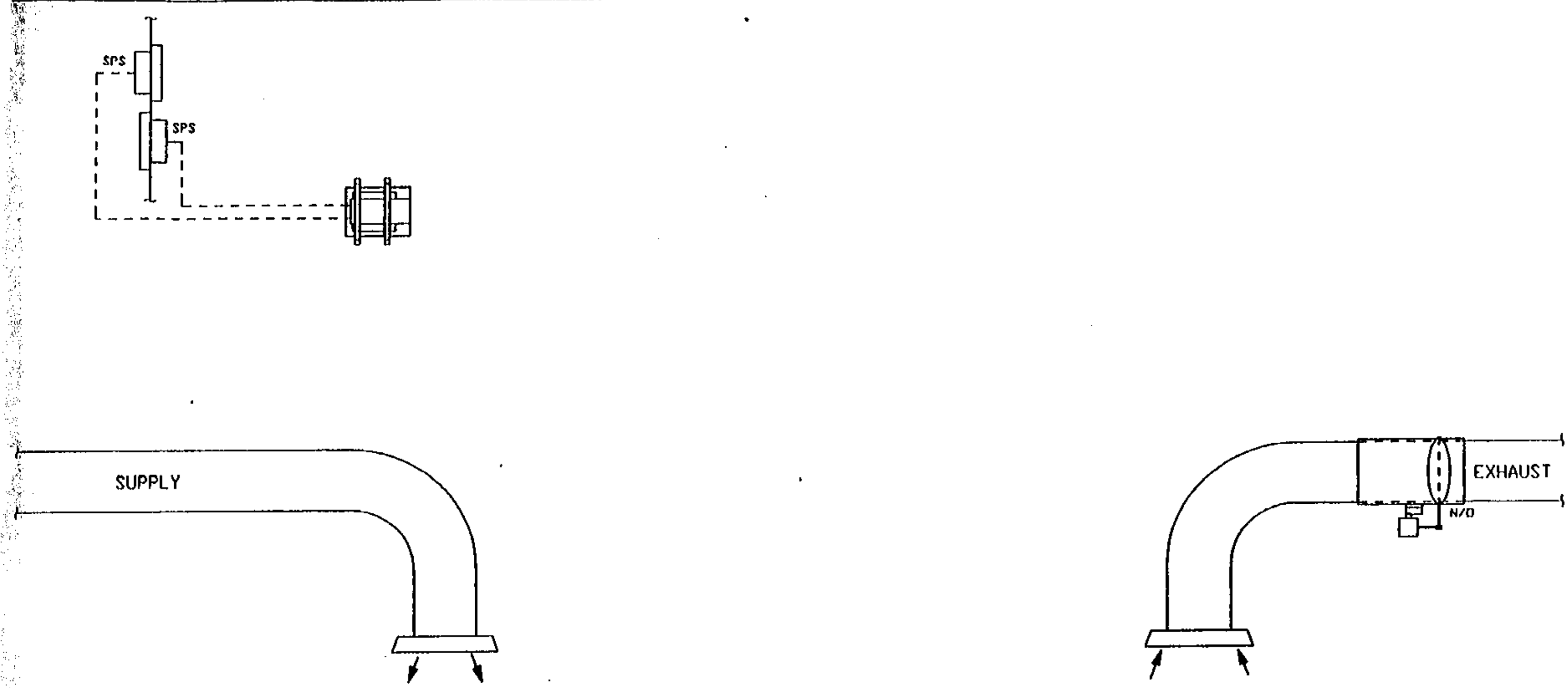
When the isolation/normal selector switch is in the normal position the exhaust control damper is modulated to maintain the space pressure at the neutral setpoint. When the isolation/normal selector switch is in the isolation position the exhaust control damper is modulated to maintain the space pressure at the setpoint determined by the position of the positive/negative selector switch. When the positive/negative selector switch is in the positive position the space pressure setpoint is a user-adjustable positive value and the space pressure sensor is set to measure a positive differential in the space with reference to the adjacent area. When the positive/negative selector switch is in the negative position the space pressure setpoint is a user-adjustable negative value and the space pressure sensor is set to measure a negative differential in the space with reference to the adjacent area.

Pressure Control

The total pressure differential is measured between the isolation room and the adjacent space. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The controller's PID output is used to control either the exhaust control damper or the return air control damper based on the current operating mode. The control damper is positioned as required by the controller with a fully electronic damper actuator. The controller executes its complete control loop a minimum of five times per second.

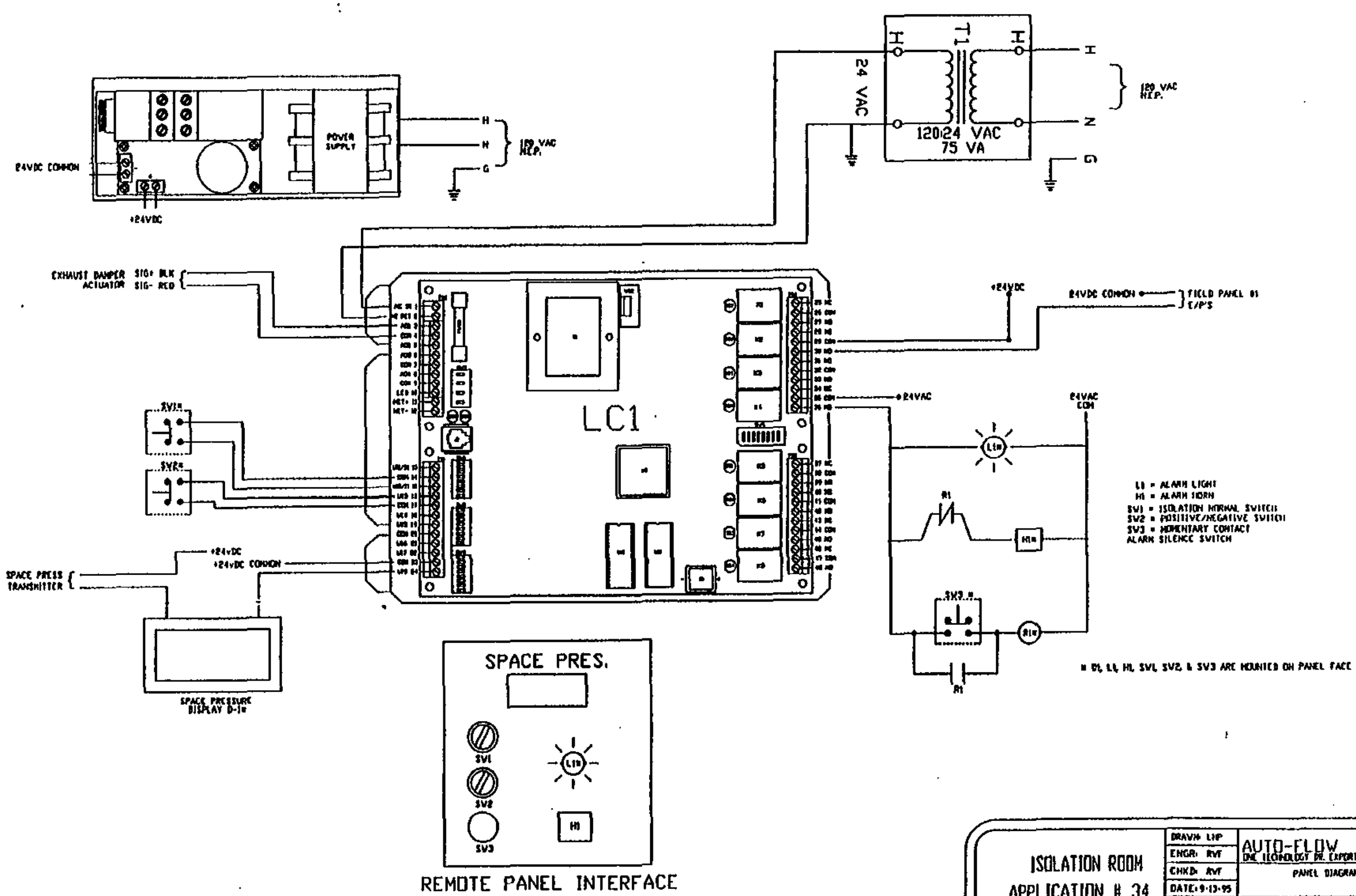
Alarming

The controller provides the capability to detect an alarm based on an actuator failure related to either loss of power or actuator position feedback that does not meet commanded position. The controller also allows for alarming of the differential pressure measurements based on user-adjustable limits. The alarm panel light and horn energize whenever the space pressure is outside the user-adjustable limits for the current setpoint. When a pressure alarm occurs the user has the option of silencing the audible alarm horn by pressing the alarm silence button on the panel face. The pressure display continuously shows the current space pressure value.



NOTE:
SEE DRAWINGS A9500515 & A9500521
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

ISOLATION ROOM APPLICATION # 34	DRAWN: LHP	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632
	ENGR: RVF	
	CHKD: RVF	SINGLE SUPPLY/EXHAUST PRESSURE FLOW DIAGRAM
	DATE: 9-12-95	
	SHEET OF	DRAWING NO. A9400434

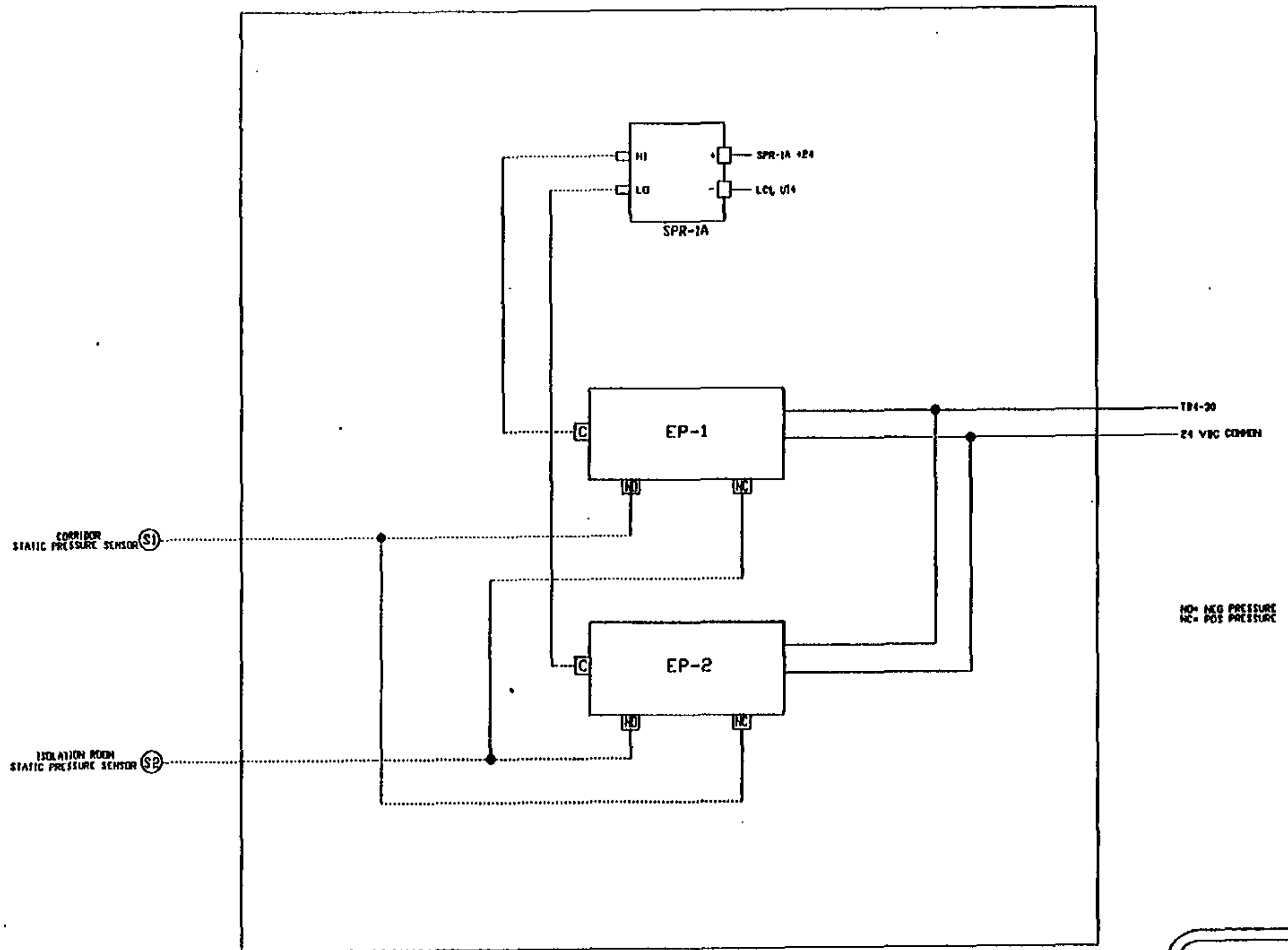


ISOLATION ROOM
APPLICATION # 34

DRAWN: LHP
ENGR: RVF
CHKD: RVF
DATE: 9-13-95
SHEET OF

AUTO-FLOW
ONE TECHNOLOGY DR. EXPORT, PA 15632
PANEL DIAGRAM
DRAWING NO. A9400434P1

* (MOUNT PANEL WITHIN 12' OF SPACE PRESSURE SENSORS)



FIELD PANEL # 1
FP-1

ISOLATION ROOM APPLICATION # 34	DRAWN: LHP	AUTO-FLOW
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY/EXHAUST PRESSURE FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET	DRAWING NO. A9400434A

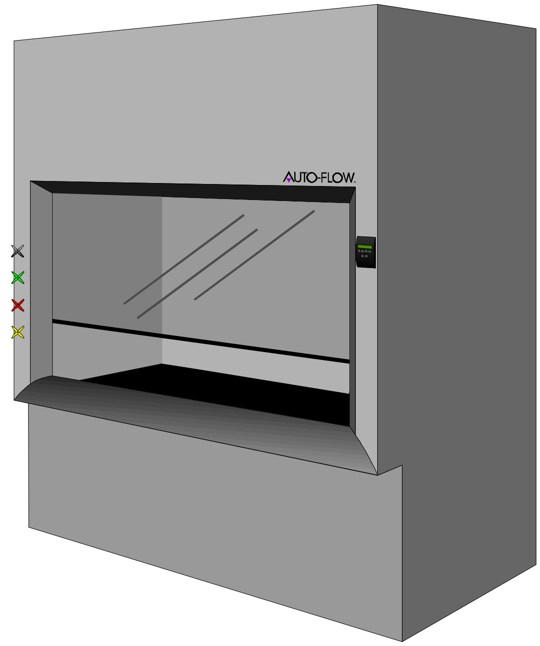
AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide

Application #35

Single Bench Fume Hood with Single Supply Pressure Control



In this Sequence:

- *General*
- *Control*
- *Emergency Override*
- *Alarming*

Bill of Material
Drawing

Sequence of Operation

Application #35: Single Bench Fume Hood with Single Supply Pressure Control

General

The fume hood is equipped with a stand-alone networkable microprocessor-based controller. The controller has password protection at both the local and remote interface levels. This protection supports multiple levels of access. The controller has local operator interface capabilities consisting of but not limited to the following:

- two line LCD or LED display capable of simultaneously displaying scaled point values and English language text point descriptors
- LEDs capable of displaying current hood operating status in up to three different conditions
- audible alarm
- audible alarm silence key
- key style interface to enter password and gain menu access

The networking capabilities allow for remote operator interface as well as data/alarm logging and storage. The controller functions as a stand-alone unit for all hood control aspects so that a failure of the communications network has no effect on fume hood control.

Fume Hood Control

The controller measures face velocity directly in the plane of the fume hood sash opening using the air foil pitot method. The controller executes a process loop using proportional, integral, and derivative control action. The face velocity reading is the measured variable for the controller's PID loop. The setpoint for face velocity is usually set as 100 feet per minute, and is adjustable either locally or remotely. The controller's PID output is calculated by the controller software providing an equal percentage control output to the fume hood exhaust damper. The fume hood exhaust damper is positioned as required by the controller with an electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its control loop twenty times per second. When face velocity falls below the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the open position. If velocity continues to fall below setpoint, the controller generates a local alarm (as described in the alarming section) after an adjustable time delay. When face velocity rises above the desired setpoint the controller modulates the normally open fume hood exhaust damper toward the closed position. If velocity continues to rise above setpoint, the controller generates a local alarm after an adjustable time delay, as described in the alarming section.

Lab Pressure Control

The total pressure differential is measured between the laboratory space and the adjacent corridor. The controller executes a process loop using proportional, integral, and derivative control action. The total pressure differential reading is the measured variable for the controller's PID loop. The setpoint for total pressure differential is - 0.005"wc with respect to the adjacent corridor, and is adjustable either locally or remotely. The controller's PID output is used to control output to the laboratory supply damper. The laboratory supply damper is positioned by the controller with a fully electronic damper actuator. The damper actuator incorporates internal feedback for positive positioning. The controller executes its complete control loop five times per second. If the total pressure differential falls below the desired setpoint the controller modulates the normally closed laboratory supply damper toward the open position. If total pressure differential goes above the desired setpoint the controller modulates the normally closed laboratory supply damper toward the closed position.

Emergency Override

The controller has an emergency override key on its local operator interface. In addition, the controller has an external emergency override input to cover initiating devices located away from the hood. Initiation of either device positions the hood exhaust damper and the lab supply damper to user-defined fixed positions. In this mode the controller display indicates that the hood is in emergency mode while the audible alarm sounds and the red LED pulses. Clearing this mode requires that the controller display's enter key be pushed if the condition is initiated locally or reset of the remote device.

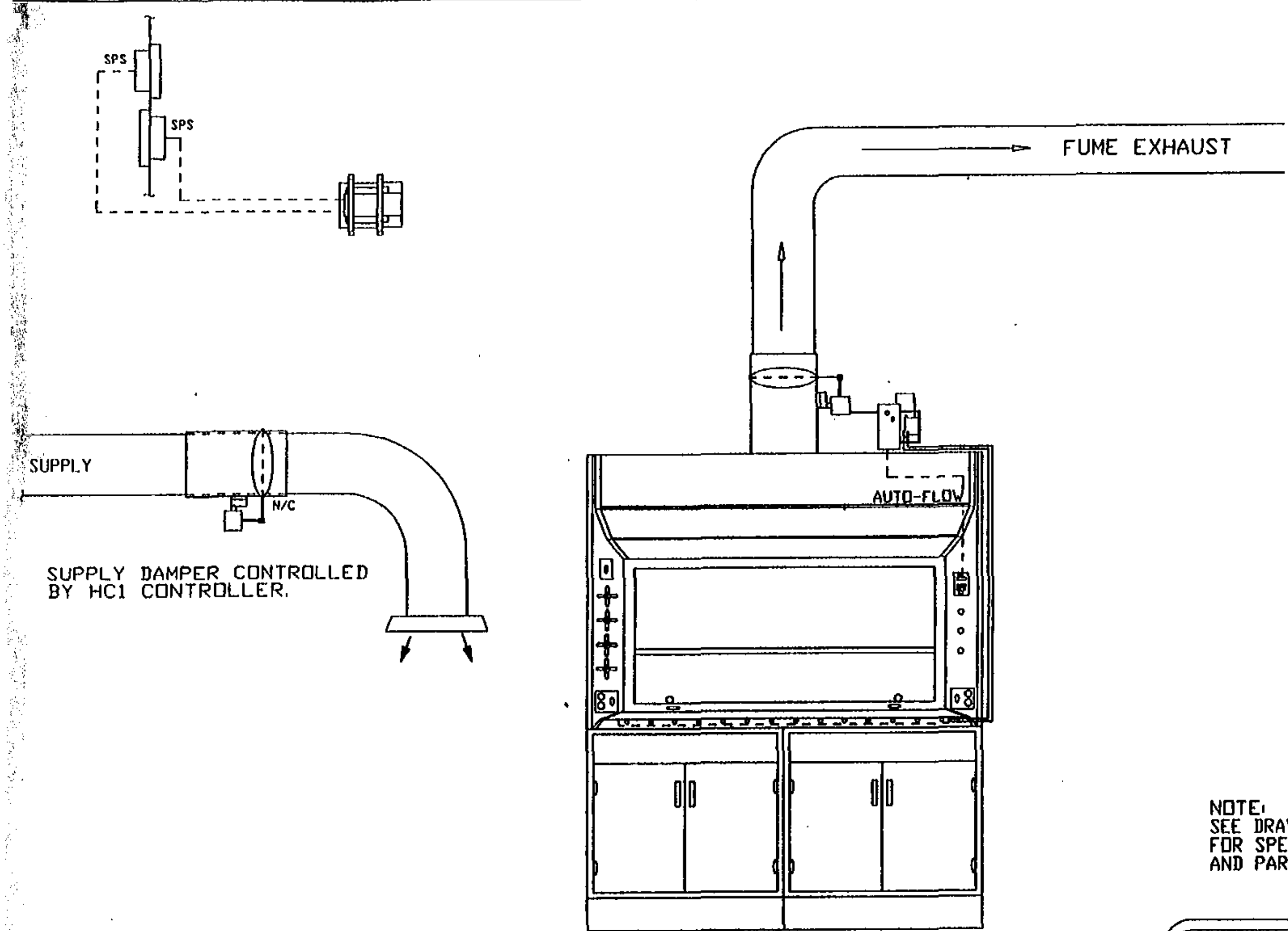
Fume Hood Alarming

The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values (See Table 1) :

Table 1

Velocity Unsafe	*<80 FPM or >120 FPM*	*Red LED and continuous audible alarm*
Velocity Low	*<90 FPM*	*Yellow LED and pulsing audible alarm*
Velocity High	*>110 FPM*	*Yellow LED and pulsing audible alarm*

In addition, the controller provides the capability to alarm based on an actuator failure related either to loss of power or because actuator position feedback did not meet commanded position. In this alarm condition the controller display's red LED and the audible alarm pulse. Audible alarms can be silenced by pressing the silence key on the controller's display module. This key does not cancel the alarm condition but does silence the alarm for a programmable time period. After the time delay the audible alarm returns if the condition has not been corrected. The controller provides a dedicated digital output for initiating a remote alarm klaxon or remote alarm light that mimics the operation of the built-in audible alarm.



NOTE:
SEE DRAWINGS A950051 & A9500520
FOR SPECIFIC WIRING DETAILS
AND PART NUMBER INFORMATION.

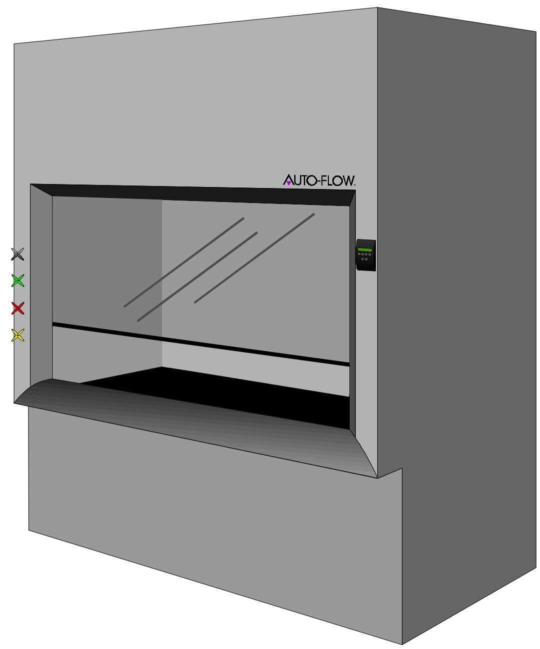
BENCH TYPE FUME HOOD

TYPICAL FUME HOOD LAB APPLICATION # 35	DRAWN: LHP	AUTO-FLOW
	ENGR: RVT	
	CHKD: RVT	SINGLE SUPPLY, SINGLE BENCH HOOD PRESSURE CONTROL FLOW DIAGRAM
	DATE: 9-13-95	
	SHEET OF	DRAWING NO A9400435

AUTO-FLOW®

Sequence of Operation

Laboratory and Fume Hood Controls Engineering Guide



Application #36

Single Bench Fume Hood-
Face Velocity Monitoring
Only

In this Sequence:

- *General*
- *Hood Monitoring*
- *Alarming*

Bill of Material
Drawing

AUTO-FLOW®

Sequence of Operation

Application #36: Single Bench Fume Hood- Face Velocity Monitoring Only

General

The fume hood is equipped with an electronic fume hood monitor. The monitor has built-in local operator interface capabilities that include the following:

- Normal flow indicator
- Alarm flow indicator
- Test/reset button
- Power on indicator
- Audible alarm
- Alarm setpoint adjustment potentiometer

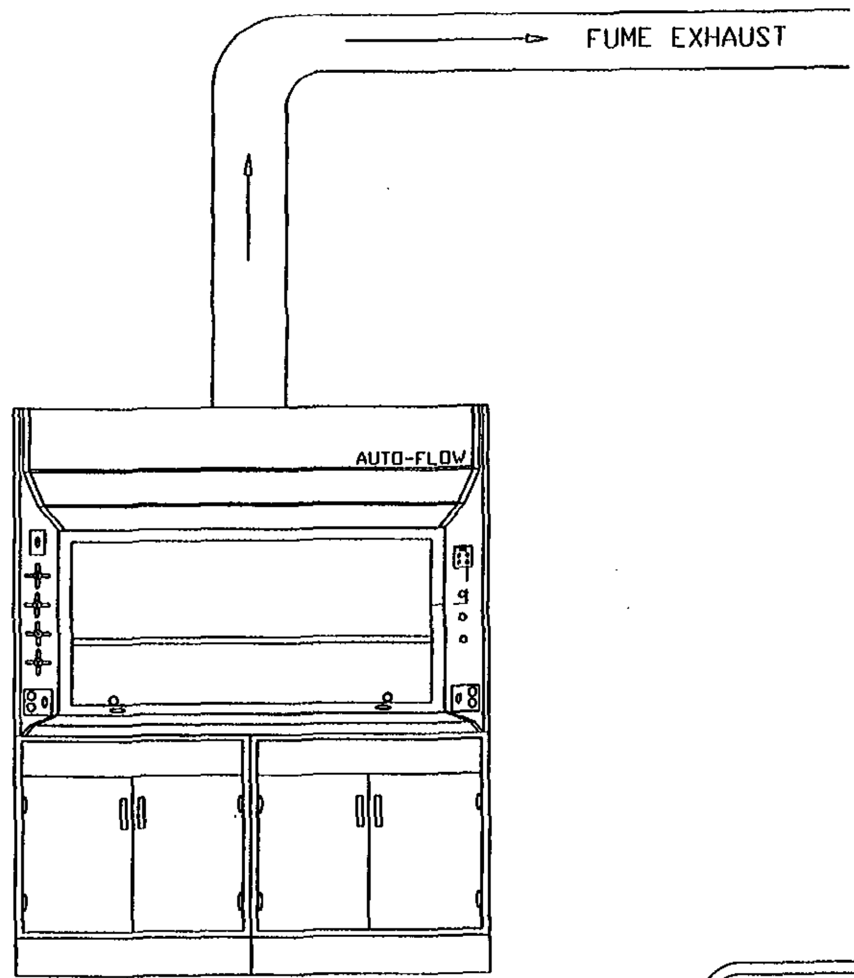
Hood Monitoring

The monitor measures face velocity by the flow of air passing through the air inlet located on the face of the HM1. The air flow passes over dual hot/cold thermistors and exits through the sidewall of the hood.

Alarming

The controller has the ability to initiate alarms both locally and remotely (if required) based on the following (adjustable) face velocity values:

Velocity Safe	>80 FPM (adjustable from 50 to 150 FPM)	Green LED on
Velocity Low	<80 FPM (adjustable from 50 to 150 FPM)	Red LED and continuous audible alarm *OPTIONAL* NC relay contact (24V 0.3A DC or AC



BENCH TYPE FUME HOOD MONITOR ONLY

TYPICAL FUME HOOD LAB APPLICATION #36	DRAWN: LJP ENGR: RVT CHKD: RVT DATE: 9-13-95 SHEET OF	AUTO-FLOW ONE TECHNOLOGY DR. EXPORT, PA 15632 SINGLE BENCH HOOD FLOW DIAGRAM DRAWING NO. A9400436