ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline *Date:* 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

This energy savings projection form is a tool for calculating the energy cost comparisons of Constant Volume Hoods, Variable Volume Hoods and Variable Volume Hoods with an Automatic Sash Closure System to determine potential cost savings. Note: For calculation purposes it is inferred airflow control for the laboratory emulates fume hood airflow control (Variable Volume vs. Constant Volume)

Five Step Savings Projection:

Step #1: Determining the expected average operator usage of the fume hoods in the laboratory facility.
Step #2: Determine the Energy Costs associated with a Constant Volume Hood System.
Step #3: Determine the Energy Costs associated with a Variable Volume Hood System.
Step #4: Determine the Energy Costs associated with a Variable Volume Hood System with an Automatic Sash Closure System.
Step #5: Compare the calculated energy costs of each system.

Step #1 Determining the expected average operator usage of the fume hoods in the laboratory facility.

"Enter Value"

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours Usage
Full Open	100%	1	0	1
Partial Open	66%	4	30	34
Closed	20%	0	133	133
	Total Hours >>>>>>>>	**5**	**163**	**168**

Sash Position	Percentage of Time
Full Open	1%
Partial Open	20%
Closed	79%

AUTO-FLOW.

Laboratory and Fume Hood Controls Engineering Guid

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #2 Determine The Energy Costs associated with a Constant Volume Hood System

Section #1 *Collect the data listed below for the specific area, facility and system, and insert where indicated*

Facility Electrical Cost per Kilowatt-hour	$ 0.10	Required Hood Exhaust Volume	1250
Facility Average Heating Cost per MBTU	$ 7.50	Heating Degree Days (from ASHRAE)	5588
Facility Average Cooling Cost per MBTU	$ 7.30	Hood Exhaust Fan Motor Efficiency	0.85
Required Cooling MBTU's for selected Hood Volume	40.68	Horsepower of Hood Exhaust Fan or portion of total if manifolded system	1

Section #2 *This Section Calculates Heating Costs associated with selected Hood Volume*

$ 7.50	X	5588	X	1250	X	168	X 0.154 / 1,000,000 =	$ 1,355
Heating Cost (from Section #1)		Degree Days (from Section #1)		Hood Volume (from Section #1)		Total Hours Weekly Use (from Part #1)	Constant	Annual Heating Cost

Section #3 *This Section Calculates Cooling Costs associated with selected Hood Volume*

3.36	X	1250	X	40.68	X	$ 7.30	/ 1000 =	$ 1,247
Converted weekly operating time		Hood Volume (from Section #1)		Required cooling MBTU (from Section #1)		Cooling Cost (from Section #1)		Annual Cooling Cost

Section #4 *This Section Calculates Fan Energy Costs (assume identical horsepower for make-up air fan requirements)*

8760	X	$ 0.10	X	1	X	0.746	/	0.85	=	$ 769
Annual Run Hours		Electrical Cost (from Section #1)		Exhaust Fan Horsepower (from Section #1)		kw to hp constant		Motor Efficiency (from Section #1)		Annual Exhaust Fan Electrical Cost
8760	X	$ 0.10	X	1	X	0.746	/	0.85	=	$ 769
Annual Run Hours		Electrical Cost (from Section #1)		Make-up Fan Horsepower		kw to hp constant		Motor Efficiency (from Section #1)		Annual Make-up Fan Electrical Cost

Section #5 *This Section Calculates the Total Annual Operating Costs associated with the Hood Model*

$ 1,355	+	$ 1,247	+	$ 769	+	$ 769	= $ 4,140
Annual Heating Cost		Annual Cooling Cost		Annual Exhaust Fan Electrical Cost		Annual Make-up Fan Electrical Cost	Total Annual Operating Cost

Section #6 *This Section Calculates the Annual Cost per CFM*

$ 4,140	/	1250	=	$ 3.31
Total Annual Operating Cost (from Section #5)		Hood Volume from Section #1		Annual Cost per CFM

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #3 Determine the Energy Costs associated with a Variable Volume Hood System.

Section #1 *Determine Total Hood Volume for each of the previously defined Sash Operating Positions*

Operating Position	Percent of Total Volume Flow		Maximum Volume Flow		VAV Flow
Full Open	100% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**1250 CFM**
Partial Open	66% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**825 CFM**
Closed	20% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**250 CFM**

Section #2 *Determine the Average Flow Rate spread on a weekly basis*

Operating Position	Percent of Time		VAV Flow		Average Flow
Full Open	1% (from part #1)	X	1250 CFM (from Section #1 above)	=	**7 CFM**
Partial Open	20% (from part #1)	X	825 CFM (from Section #1 above)	=	**167 CFM**
Closed	79% (from part #1)	X	250 CFM (from Section #1 above)	=	**198 CFM**
			Total Average Volume Flow Rate for this Hood		**372 CFM**

Section #3 *Determine the percentage of the Average VAV Flow to CAV Flow*

372 CFM Average VAV Volume (from Section #2 above)	/	1250 CFM CAV Volume (from part #2 Section #1)	=	**30% CFM Percent of VAV to CAV**

Section #4 *Determine Annual VAV Hood Energy Costs*

$ 1,355 Annual CAV Heating Cost (from part #2 Section #2)	X	30% Percent of VAV to CAV (from Section #3 above)	=	**$ 404 Annual VAV Heating Cost**
$ 1,247 Annual CAV Cooling Cost (from part #2 Section #3)	X	30% Percent of VAV to CAV (from Section #3 above)	=	**$ 372 Annual VAV Cooling Cost**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 *continued* **Determine Fan Electrical Energy Costs**

Operating Position	Percent of Total Volume Flow		Percent of Time		Average Fan Volume factor
Full Open	100% (from part #1)	X	1% (from part #1)	=	**0.0060** **Full Volume**
Partial Open	66% (from part #1)	X	20% (from part #1)	=	**0.1336** **Partial Volume**
Closed	20% (from part #1)	X	79% (from part #1)	=	**0.1583** **Minimum Volume**
			Total VAV Fan Volume Factor		**0.2979**

($ 769 Annual CAV Exhaust Fan Cost (from Part #2 Section #4) + $ 769 Annual CAV Supply Fan Cost (from Part #2 Section #4)) X 0.29786 VAV Fan Factor (from above) = **$ 458.00 Annual VAV Hood Fan Cost**

Calculate to Total VAV Hood Annual Operating Cost

$ 404 Annual VAV Heating Cost (from this section previous page) + $ 372 Annual VAV Cooling Cost (from this section) previous page) + $ 458 Annual VAV Hood Fan Cost (from this section) = **$ 1,233.20 Annual VAV Hood Operating Cost**

Section #5 *Determine the Cost Differential of VAV Hood System vs. CAV Hood System*

$ 4,140 Total Annual CAV Operating Cost (from part #2 Section #5) - $ 1,233 Total Annual VAV Operating Cost (from above) = **$ 2,907.05 Annual Savings VAV vs. CAV Hood System**

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 Determining the Energy Costs associated with a VAV Hood with Automatic Sash Closure

Section #1 Determine Hood Use

Hours of Hood Use each Flow State per Week				
Sash Position	Percentage of Flow	Operator Present at Hood	Operator Absent from Hood	Total Hours use per flow state
Full Open	1	1	0	1
Partial Open	0.66	4	30	34
Closed	0.2	0	133	133
	Total Hours >>>>>>	**5**	**163**	**168**

Sash Position	Percentage of Time
Full Open	1%
Partial Open	2%
Closed	97%

Adjusted Hours with Sash Automatically Closing when Operator is Absent from Hood	1
	4
	163

Section #2 *Determine Total Hood Volume for each of the previously defined Sash Operating Positions*

Operating Position	Percent of Total Volume Flow		Maximum Volume Flow		VAV Flow
Full Open	100% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**1250 CFM**
Partial Open	66% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**825 CFM**
Closed	20% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**250 CFM**

Section #3 *Determine the Average Flow Rate spread on a weekly basis*

Operating Position	Percent of Time		VAV Flow		Average Flow
Full Open	1% (from Section #1)	X	1250 CFM (from Section #2 above)	=	**7 CFM**
Partial Open	2% (from Section #1)	X	825 CFM (from Section #2 above)	=	**20 CFM**
Closed	97% (from Section #1)	X	250 CFM (from Section #2 above)	=	**243 CFM**

Total Average Volume Flow Rate for this Hood **270 CFM**

continued nex page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 *continued*

Section #4 *Determine the percentage of the Average VAV Flow to CAV Flow*

270 CFM	/	1250 CFM	=	22% CFM
Average VAV Volume (from Section #3 above)		CAV Volume (from part #2 Section #1)		**Percent of VAV to CAV**

Section #5 *Determine Annual VAV Hood Energy Costs*

$ 1,355	X	22%	=	$ 292
Annual CAV Heating Cost (from part #2 Section #2)		Percent of VAV to CAV (from Section #4 above)		**Annual VAV Heating Cost**

$ 1,247	X	22%	=	$ 269
Annual CAV Cooling Cost (from part #2 Section #3)		Percent of VAV to CAV (from Section #4 above)		**Annual VAV Cooling Cost**

Determine Fan Electrical Energy Costs

Operating Position	Percent of Total Volume Flow		Percent of Time		Average Fan Volume factor
Full Open	100% (from Section #1)	X	1% (from Section #1)	=	0.0060 **Full Volume**
Partial Open	66% (from Section #1)	X	2% (from Section #1)	=	0.0157 **Partial Volume**
Closed	20% (from Section #1)	X	97% (from Section #1)	=	0.1940 **Minimum Volume**

Total VAV Fan Volume Factor 0.2157

($ 769	+	$ 769)	X	0.2157	=	$ 332
Annual CAV Exhaust Fan Cost (from Part #2 Section #4)		Annual CAV Supply Fan Cost (from Part #2 Section #4)		VAV Fan Factor (from above)		**Annual VAV Hood Fan Cost**

Calculate to Total VAV Hood with Sash Closure Annual Operating Cost

$ 292	+	$ 269	+	$ 332	=	$ 893.11
Annual VAV Heating Cost (from this section)		Annual VAV Cooling Cost (from this section)		Annual VAV Hood Fan Cost (from this section)		**Annual VAV Hood with Sash Closure Operating Cost**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline *Date:* 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Section #5 *Determine the Cost Differential of VAV Hood System vs. CAV Hood System*

$ 4,140	-	$ 893	=	$ 3,247
Total Annual CAV Operating Cost (from part #2 Section #5)		Total Annual VAV Operating Cost (from Section #4 previous page)		**Annual Savings VAV vs. CAV Hood System**

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #5 Summary of Operating Parameters & Energy Costs

SYSTEM DATA			
Facility Electrical Cost per Kilowatt-hour	$ 0.10	Required Hood Exhaust Volume	1250
Facility Average Heating Cost per MBTU	$ 7.50	Heating Degree Days (from ASHRAE)	5588
Facility Average Cooling Cost per MBTU	$ 7.30	Hood Exhaust Fan Motor Efficiency	0.85
Required Cooling MBTU's for selected Hood Volume	40.68	Horsepower of Hood Exhaust Fan or portion of total if manifolded system	1

CAV & VAV SASH OPERATION PARAMETERS

		Hours of Hood Use each Flow State per Week		
Sash Position	Percentage of Flow	Person at Hood	Person not at Hood	Total Hours usage
Full Open	100%	1	0	1
Partial Open	66%	4	30	34
Closed	20%	0	133	133
	Total Hours >>>>>>	**5**	**163**	**168**

VAV WITH AUTOMATIC SASH CLOSURE SASH OPERATION PARAMETERS

		Hours of Hood Use each Flow State per Week		
Sash Position	Percentage of Flow	Person at Hood	Person not at Hood	Total Hours usage
Full Open	100%	1	0	1
Partial Open	66%	4	30	34
Closed	20%	0	133	133
	Total Hours >>>>>>	**5**	**163**	**168**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Good Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #5 continued

Sash Position	Percentage of Time
Full Open	1%
Partial Open	2%
Closed	97%

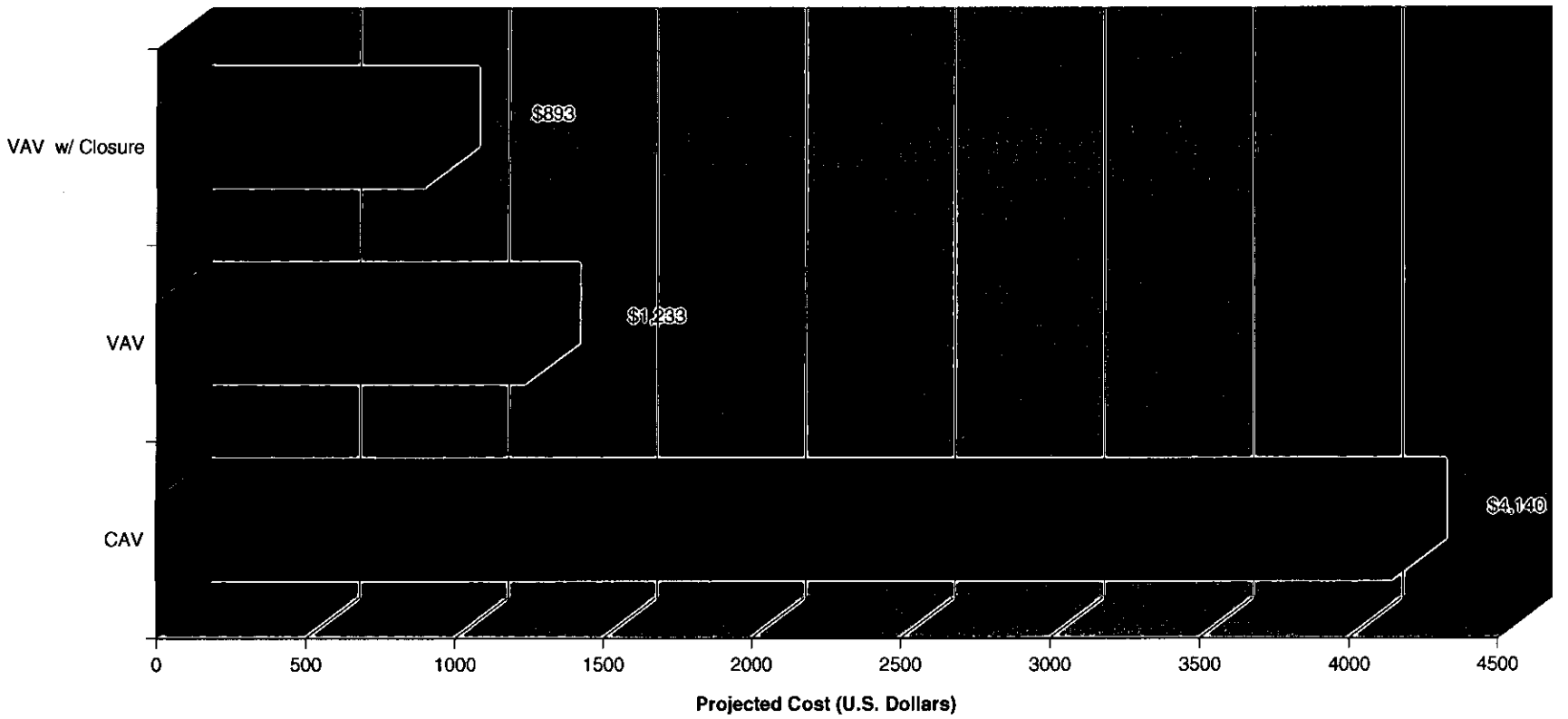
Hood Type	Annual Cost of Operation
CAV	$ 4,140
VAV	$ 1,233
VAV w/ Closure	$ 893

Adjusted Hours with Sash Automatically Closing when Operator is Absent from Hood	1
	4
	163

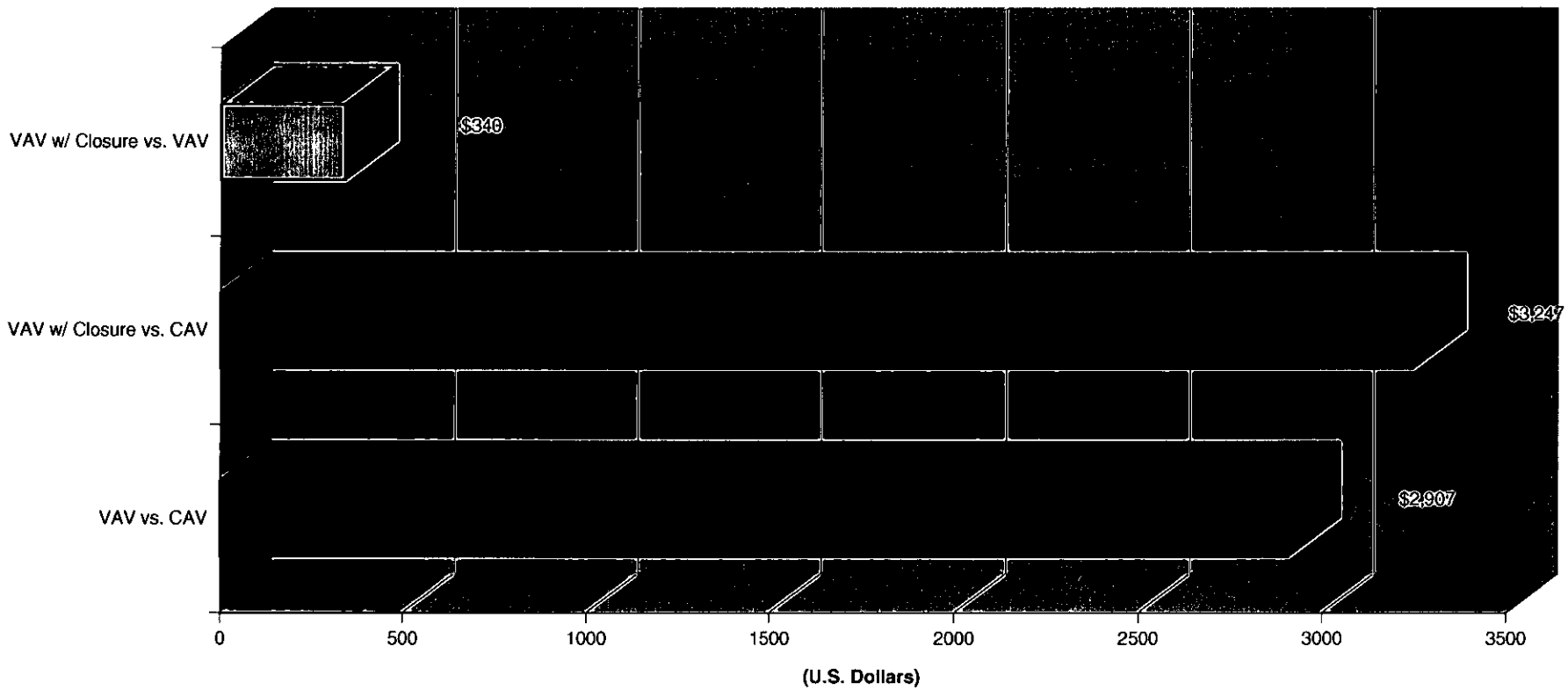
Savings

VAV vs. CAV	$ 2,907
VAV w/ Closure vs. CAV	$ 3,247
VAV w/ Closure vs. VAV	$ 340

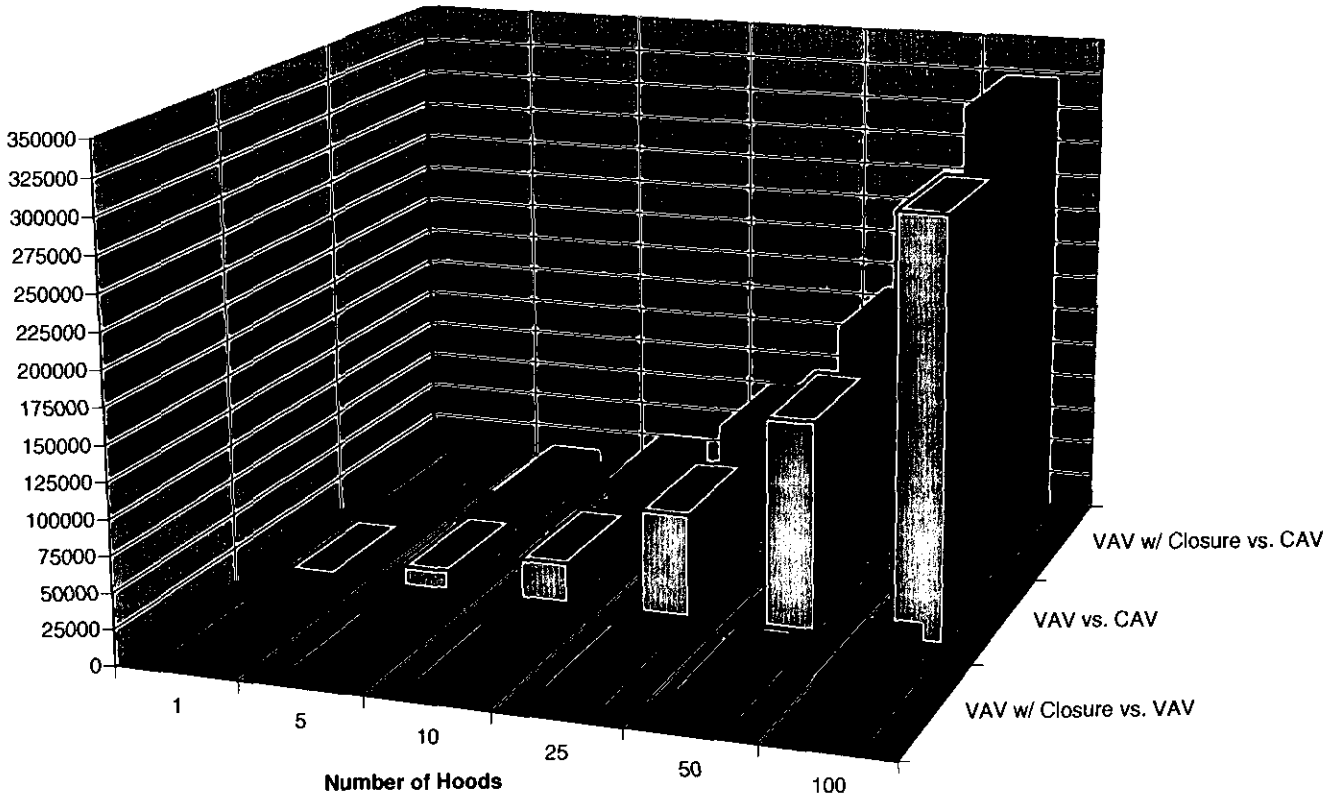
FUME HOOD ANNUAL OPERATING COST COMPARISON



PROJECTED ANNUAL HOOD SAVINGS COMPARISON



PROJECTED ANNUAL SAVINGS COMPARISON FOR MULTIPLE HOOD PROJECTS



ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

This energy savings projection form is a tool for calculating the energy cost comparisons of Constant Volume Hoods, Variable Volume Hoods and Variable Volume Hoods with an Automatic Sash Closure System to determine potential cost savings. Note: For calculation purposes it is inferred airflow control for the laboratory emulates fume hood airflow control (Variable Volume vs. Constant Volume)

Five Step Savings Projection:

Step #1: Determining the expected average operator usage of the fume hoods in the laboratory facility.
Step #2: Determine the Energy Costs associated with a Constant Volume Hood System.
Step #3: Determine the Energy Costs associated with a Variable Volume Hood System.
Step #4: Determine the Energy Costs associated with a Variable Volume Hood System with an Automatic Sash Closure System.
Step #5: Compare the calculated energy costs of each system.

Step #1 Determining the expected average operator usage of the fume hoods in the laboratory facility.

"Enter Value"

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours Usage
Full Open	100%	1	2	3
Partial Open	80%	5	37	42
Closed	20%	0	123	123
	Total Hours >>>>>>>>	6	162	168

Sash Position	Percentage of Time
Full Open	2%
Partial Open	25%
Closed	73%

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #2 Determine The Energy Costs associated with a Constant Volume Hood System

Section #1 *Collect the data listed below for the specific area, facility and system, and insert where indicated*

Facility Electrical Cost per Kilowatt-hour	$ 0.10	Required Hood Exhaust Volume	1250
Facility Average Heating Cost per MBTU	$ 7.50	Heating Degree Days (from ASHRAE)	5588
Facility Average Cooling Cost per MBTU	$ 7.30	Hood Exhaust Fan Motor Efficiency	0.85
Required Cooling MBTU's for selected Hood Volume	40.68	Horsepower of Hood Exhaust Fan or portion of total if manifolded system	1

Section #2 *This Section Calculates Heating Costs associated with selected Hood Volume*

$ 7.50	X	5588	X	1250	X	168	X	0.154	/ 1,000,000= $ 1,355
Heating Cost (from Section #1)		Degree Days (from Section #1)		Hood Volume (from Section #1)		Total Hours Weekly Use (from Part #1)		Constant	Annual Heating Cost

Section #3 *This Section Calculates Cooling Costs associated with selected Hood Volume*

3.36	X	1250	X	40.68	X	$ 7.30	/	1000	= $ 1,247
Converted weekly operating time		Hood Volume (from Section #1)		Required cooling MBTU (from Section #1)		Cooling Cost (from Section #1)			Annual Cooling Cost

Section #4 *This Section Calculates Fan Energy Costs (assume identical horsepower for make-up air fan requirements)*

8760	X	$ 0.10	X	1	X	0.746	/	0.85	= $ 769
Annual Run Hours		Electrical Cost (from Section #1)		Exhaust Fan Horsepower (from Section #1)		kw to hp constant		Motor Efficiency (from Section #1)	Annual Exhaust Fan Electrical Cost
8760	X	$ 0.10	X	1	X	0.746	/	0.85	= $ 769
Annual Run Hours		Electrical Cost (from Section #1)		Make-up Fan Horsepower		kw to hp constant		Motor Efficiency (from Section #1)	Annual Make-up Fan Electrical Cost

Section #5 *This Section Calculates the Total Annual Operating Costs associated with the Hood Model*

$ 1,355	+	$ 1,247	+	$ 769	+	$ 769	=	$ 4,140
Annual Heating Cost		Annual Cooling Cost		Annual Exhaust Fan Electrical Cost		Annual Make-up Fan Electrical Cost		Total Annual Operating Cost

Section #6 *This Section Calculates the Annual Cost per CFM*

$ 4,140	/	1250	=	$ 3.31
Total Annual Operating Cost (from Section #5)		Hood Volume from Section #1		Annual Cost per CFM

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #3 Determine the Energy Costs associated with a Variable Volume Hood System.

Section #1 *Determine Total Hood Volume for each of the previously defined Sash Operating Positions*

Operating Position	Percent of Total Volume Flow		Maximum Volume Flow		VAV Flow
Full Open	100% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**1250 CFM**
Partial Open	80% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**1000 CFM**
Closed	20% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**250 CFM**

Section #2 *Determine the Average Flow Rate spread on a weekly basis*

Operating Position	Percent of Time		VAV Flow		Average Flow
Full Open	2% (from part #1)	X	1250 CFM (from Section #1 above)	=	**22 CFM**
Partial Open	25% (from part #1)	X	1000 CFM (from Section #1 above)	=	**250 CFM**
Closed	73% (from part #1)	X	250 CFM (from Section #1 above)	=	**183 CFM**
			Total Average Volume Flow Rate for this Hood		**455 CFM**

Section #3 *Determine the percentage of the Average VAV Flow to CAV Flow*

	455 CFM Average VAV Volume (from Section #2 above)	/	1250 CFM CAV Volume (from part #2 Section #1)	=	**36% CFM Percent of VAV to CAV**

Section #4 *Determine Annual VAV Hood Energy Costs*

	$ 1,355 Annual CAV Heating Cost (from part #2 Section #2)	X	36% Percent of VAV to CAV (from Section #3 above)	=	**$ 494 Annual VAV Heating Cost**
	$ 1,247 Annual CAV Cooling Cost (from part #2 Section #3)	X	36% Percent of VAV to CAV (from Section #3 above)	=	**$ 454 Annual VAV Cooling Cost**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 *continued* **Determine Fan Electrical Energy Costs**

Operating Position	Percent of Total Volume Flow		Percent of Time		Average Fan Volume factor
Full Open	100% (from part #1)	X	2% (from part #1)	=	0.0179 Full Volume
Partial Open	80% (from part #1)	X	25% (from part #1)	=	0.2000 Partial Volume
Closed	20% (from part #1)	X	73% (from part #1)	=	0.1464 Minimum Volume
			Total VAV Fan Volume Factor		0.3643

($ 769 Annual CAV Exhaust Fan Cost (from Part #2 Section #4) + $ 769 Annual CAV Supply Fan Cost (from Part #2 Section #4)) X 0.36429 VAV Fan Factor (from above) = $ 560.14 **Annual VAV Hood Fan Cost**

Calculate to Total VAV Hood Annual Operating Cost

$ 494 Annual VAV Heating Cost (from this section previous page) + $ 454 Annual VAV Cooling Cost (from this section) previous page) + $ 560 Annual VAV Hood Fan Cost (from this section) = $ 1,508.24 **Annual VAV Hood Operating Cost**

Section #5 *Determine the Cost Differential of VAV Hood System vs. CAV Hood System*

$ 4,140 Total Annual CAV Operating Cost (from part #2 Section #5) - $ 1,508 Total Annual VAV Operating Cost (from above) = $ 2,632.02 **Annual Savings VAV vs. CAV Hood System**

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 Determining the Energy Costs associated with a VAV Hood with Automatic Sash Closure

Section #1 Determine Hood Use

Hours of Hood Use each Flow State per Week

Sash Position	Percentage of Flow	Operator Present at Hood	Operator Absent from Hood	Total Hours use per flow state
Full Open	1	1	2	3
Partial Open	0.8	5	37	42
Closed	0.2	0	123	123
	Total Hours >>>>>>	**6**	**162**	**168**

Sash Position	Percentage of Time
Full Open	1%
Partial Open	3%
Closed	96%

Adjusted Hours with Sash Automatically Closing when Operator is Absent from Hood	**1**
	5
	162

Section #2 *Determine Total Hood Volume for each of the previously defined Sash Operating Positions*

Operating Position	Percent of Total Volume Flow		Maximum Volume Flow		VAV Flow
Full Open	100% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**1250 CFM**
Partial Open	80% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**1000 CFM**
Closed	20% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**250 CFM**

Section #3 *Determine the Average Flow Rate spread on a weekly basis*

Operating Position	Percent of Time		VAV Flow		Average Flow
Full Open	1% (from Section #1)	X	1250 CFM (from Section #2 above)	=	**7 CFM**
Partial Open	3% (from Section #1)	X	1000 CFM (from Section #2 above)	=	**30 CFM**
Closed	96% (from Section #1)	X	250 CFM (from Section #2 above)	=	**241 CFM**
			Total Average Volume Flow Rate for this Hood		**278 CFM**

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ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 *continued*

Section #4 *Determine the percentage of the Average VAV Flow to CAV Flow*

278 CFM	/	1250 CFM	=	**22% CFM**
Average VAV Volume (from Section #3 above)		CAV Volume (from part #2 Section #1)		**Percent of VAV to CAV**

Section #5 *Determine Annual VAV Hood Energy Costs*

$ 1,355	X	22%	=	**$ 302**
Annual CAV Heating Cost (from part #2 Section #2)		Percent of VAV to CAV (from Section #4 above)		**Annual VAV Heating Cost**

$ 1,247	X	22%	=	**$ 278**
Annual CAV Cooling Cost (from part #2 Section #3)		Percent of VAV to CAV (from Section #4 above)		**Annual VAV Cooling Cost**

Determine Fan Electrical Energy Costs

Operating Position	Percent of Total Volume Flow		Percent of Time		**Average Fan Volume factor**
Full Open	100% (from Section #1)	X	1% (from Section #1)	=	**0.0060 Full Volume**
Partial Open	80% (from Section #1)	X	3% (from Section #1)	=	**0.0238 Partial Volume**
Closed	20% (from Section #1)	X	96% (from Section #1)	=	**0.1929 Minimum Volume**

Total VAV Fan Volume Factor 0.2226

($ 769	+	$ 769)	X	0.2226	=	**$ 342**
Annual CAV Exhaust Fan Cost (from Part #2 Section #4)		Annual CAV Supply Fan Cost (from Part #2 Section #4)		VAV Fan Factor (from above)		**Annual VAV Hood Fan Cost**

Calculate to Total VAV Hood with Sash Closure Annual Operating Cost

$ 302	+	$ 278	+	$ 342	=	**$ 921.70**
Annual VAV Heating Cost (from this section)		Annual VAV Cooling Cost (from this section)		Annual VAV Hood Fan Cost (from this section)		**Annual VAV Hood with Sash Closure Operating Cost**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Section #5 *Determine the Cost Differential of VAV Hood System vs. CAV Hood System*

$ 4,140	-	$ 922	=	$ 3,219
Total Annual CAV Operating Cost (from part #2 Section #5)		Total Annual VAV Operating Cost (from Section #4 previous page)		**Annual Savings VAV vs. CAV Hood System**

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #5 Summary of Operating Parameters & Energy Costs

SYSTEM DATA

Facility Electrical Cost per Kilowatt-hour	$ 0.10	Required Hood Exhaust Volume	1250
Facility Average Heating Cost per MBTU	$ 7.50	Heating Degree Days (from ASHRAE)	5588
Facility Average Cooling Cost per MBTU	$ 7.30	Hood Exhaust Fan Motor Efficiency	0.85
Required Cooling MBTU's for selected Hood Volume	40.68	Horsepower of Hood Exhaust Fan or portion of total if manifolded system	1

CAV & VAV SASH OPERATION PARAMETERS

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours usage
Full Open	100%	1	2	3
Partial Open	80%	5	37	42
Closed	20%	0	123	123
	Total Hours >>>>>>	**6**	**162**	**168**

VAV WITH AUTOMATIC SASH CLOSURE SASH OPERATION PARAMETERS

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours usage
Full Open	100%	1	2	3
Partial Open	80%	5	37	42
Closed	20%	0	123	123
	Total Hours >>>>>>	**6**	**162**	**168**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Average Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #5 *continued*

Sash Position	Percentage of Time
Full Open	1%
Partial Open	3%
Closed	96%

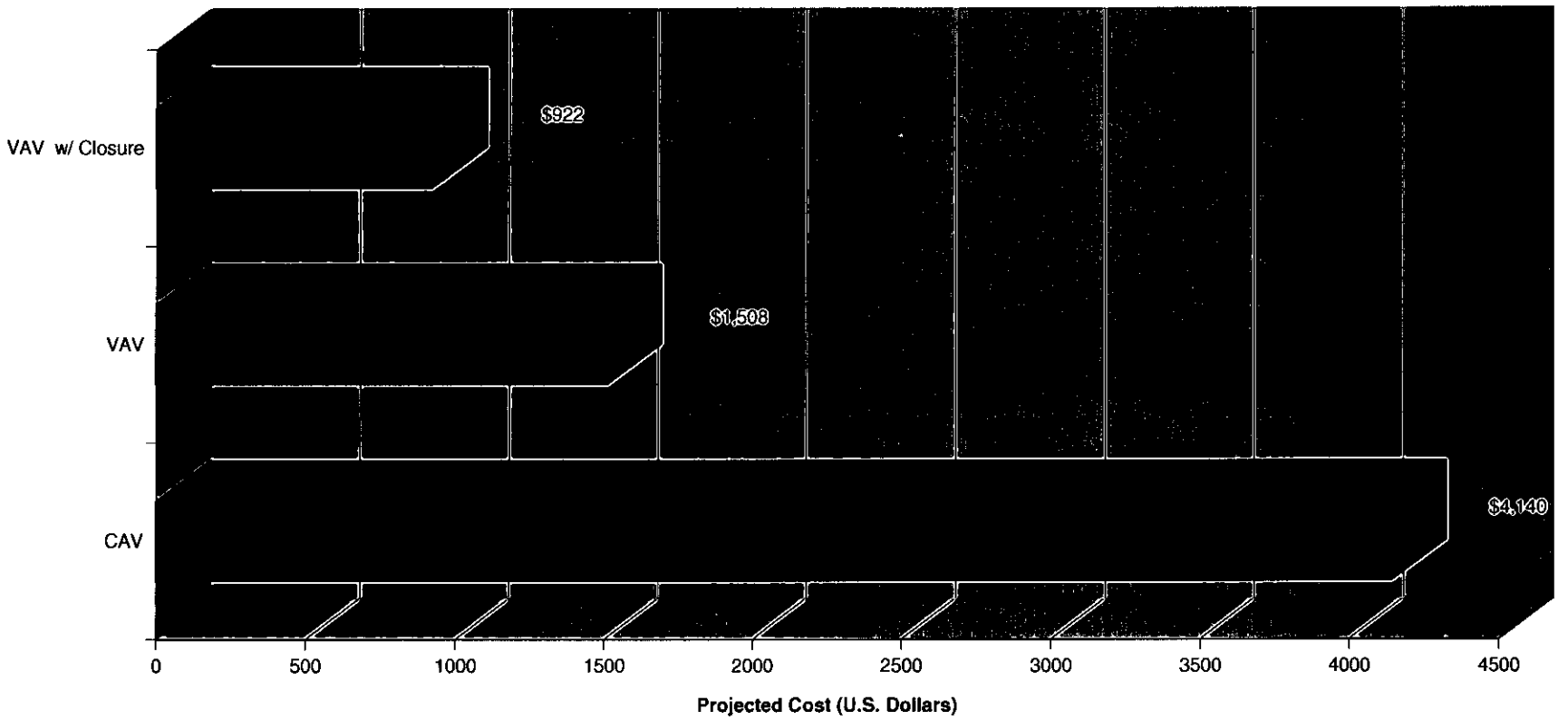
Hood Type	Annual Cost of Operation
CAV	$ 4,140
VAV	$ 1,508
VAV w/ Closure	$ 922

Adjusted Hours with Sash Automatically Closing when Operator is Absent from Hood	1
	5
	162

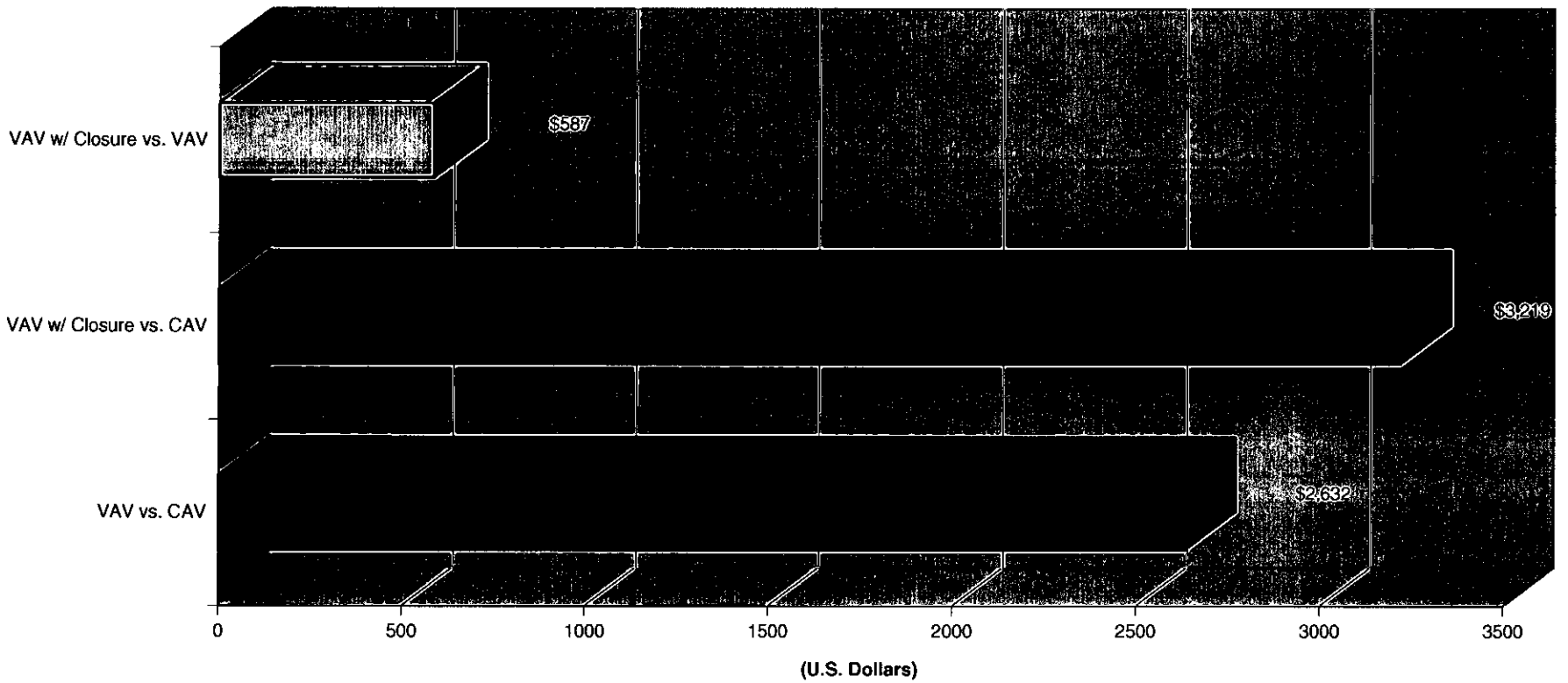
Savings

VAV vs. CAV	$ 2,632
VAV w/ Closure vs. CAV	$ 3,219
VAV w/ Closure vs. VAV	$ 587

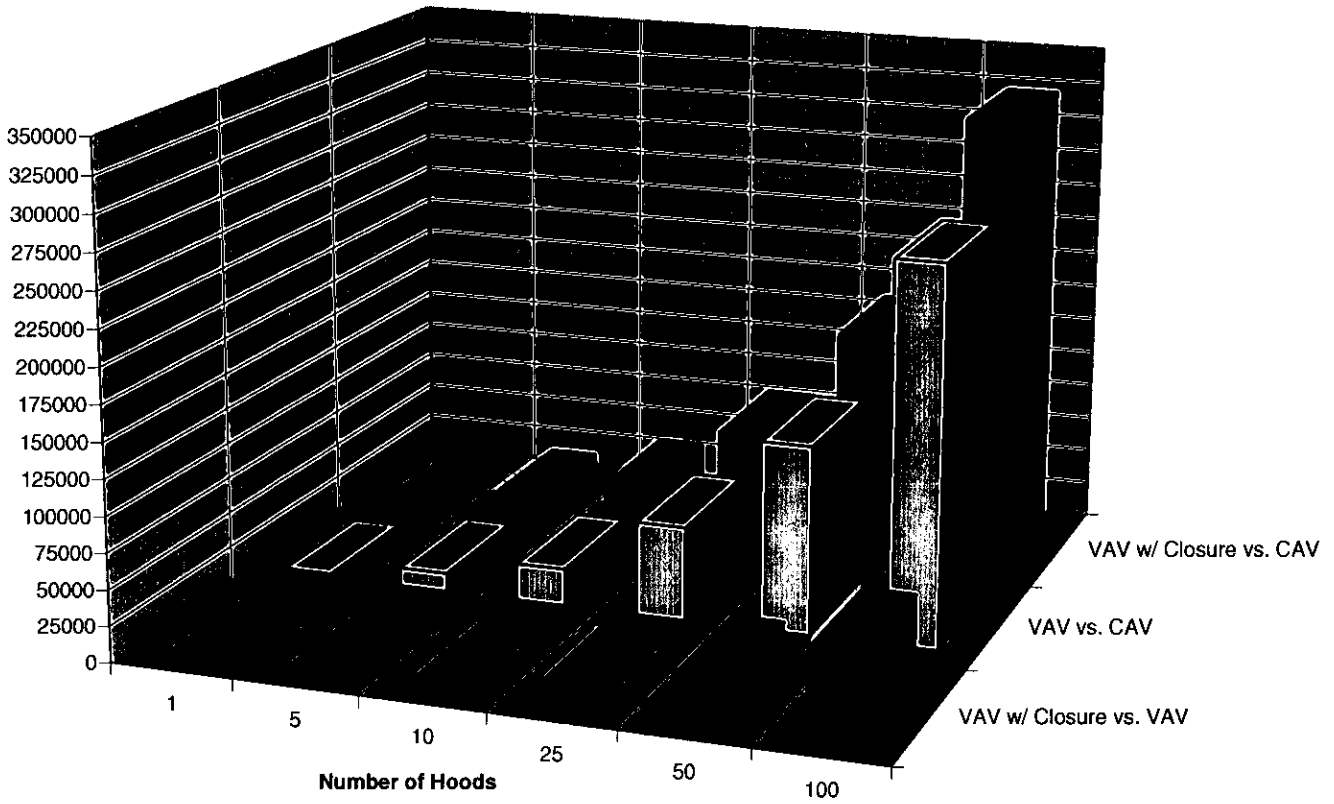
FUME HOOD ANNUAL OPERATING COST COMPARISON



PROJECTED ANNUAL HOOD SAVINGS COMPARISON



PROJECTED ANNUAL SAVINGS COMPARISON FOR MULTIPLE HOOD PROJECTS



ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

This energy savings projection form is a tool for calculating the energy cost comparisons of Constant Volume Hoods, Variable Volume Hoods and Variable Volume Hoods with an Automatic Sash Closure System to determine potential cost savings. Note: For calculation purposes it is inferred airflow control for the laboratory emulates fume hood airflow control (Variable Volume vs. Constant Volume)

Five Step Savings Projection:

Step #1: Determining the expected average operator usage of the fume hoods in the laboratory facility.
Step #2: Determine the Energy Costs associated with a Constant Volume Hood System.
Step #3: Determine the Energy Costs associated with a Variable Volume Hood System.
Step #4: Determine the Energy Costs associated with a Variable Volume Hood System with an Automatic Sash Closure System.
Step #5: Compare the calculated energy costs of each system.

Step #1 Determining the expected average operator usage of the fume hoods in the laboratory facility.

"Enter Value"

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours Usage
Full Open	100%	1	15	16
Partial Open	80%	5	60	65
Closed	20%	0	87	87
	Total Hours >>>>>>>>	6	162	168

Sash Position	Percentage of Time
Full Open	10%
Partial Open	39%
Closed	52%

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #2 Determine The Energy Costs associated with a Constant Volume Hood System

Section #1 *Collect the data listed below for the specific area, facility and system, and insert where indicated*

Facility Electrical Cost per Kilowatt-hour	$ 0.10	Required Hood Exhaust Volume	1250
Facility Average Heating Cost per MBTU	$ 7.50	Heating Degree Days (from ASHRAE)	5588
Facility Average Cooling Cost per MBTU	$ 7.30	Hood Exhaust Fan Motor Efficiency	0.85
Required Cooling MBTU's for selected Hood Volume	40.68	Horsepower of Hood Exhaust Fan or portion of total if manifolded system	1

Section #2 *This Section Calculates Heating Costs associated with selected Hood Volume*

$ 7.50	X	5588	X	1250	X	168	X	0.154	/ 1,000,000= $ 1,355
Heating Cost (from Section #1)		Degree Days (from Section #1)		Hood Volume (from Section #1)		Total Hours Weekly Use (from Part #1)		Constant	Annual Heating Cost

Section #3 *This Section Calculates Cooling Costs associated with selected Hood Volume*

3.36	X	1250	X	40.68	X	$ 7.30	/	1000	= $ 1,247
Converted weekly operating time		Hood Volume (from Section #1)		Required cooling MBTU (from Section #1)		Cooling Cost (from Section #1)			Annual Cooling Cost

Section #4 *This Section Calculates Fan Energy Costs (assume identical horsepower for make-up air fan requirements)*

8760	X	$ 0.10	X	1	X	0.746	/	0.85	= $ 769
Annual Run Hours		Electrical Cost (from Section #1)		Exhaust Fan Horsepower (from Section #1)		kw to hp constant		Motor Efficiency (from Section #1)	Annual Exhaust Fan Electrical Cost
8760	X	$ 0.10	X	1	X	0.746	/	0.85	= $ 769
Annual Run Hours		Electrical Cost (from Section #1)		Make-up Fan Horsepower		kw to hp constant		Motor Efficiency (from Section #1)	Annual Make-up Fan Electrical Cost

Section #5 *This Section Calculates the Total Annual Operating Costs associated with the Hood Model*

$ 1,355	+	$ 1,247	+	$ 769	+	$ 769	=		$ 4,140
Annual Heating Cost		Annual Cooling Cost		Annual Exhaust Fan Electrical Cost		Annual Make-up Fan Electrical Cost			Total Annual Operating Cost

Section #6 *This Section Calculates the Annual Cost per CFM*

$ 4,140	/	1250	=	$ 3.31
Total Annual Operating Cost (from Section #5)		Hood Volume from Section #1		Annual Cost per CFM

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #3 Determine the Energy Costs associated with a Variable Volume Hood System.

Section #1 *Determine Total Hood Volume for each of the previously defined Sash Operating Positions*

Operating Position	Percent of Total Volume Flow		Maximum Volume Flow		VAV Flow
Full Open	100% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**1250 CFM**
Partial Open	80% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**1000 CFM**
Closed	20% (from part #1)	X	1250 CFM (from part #2 Section #1)	=	**250 CFM**

Section #2 *Determine the Average Flow Rate spread on a weekly basis.*

Operating Position	Percent of Time		VAV Flow		Average Flow
Full Open	10% (from part #1)	X	1250 CFM (from Section #1 above)	=	**119 CFM**
Partial Open	39% (from part #1)	X	1000 CFM (from Section #1 above)	=	**387 CFM**
Closed	52% (from part #1)	X	250 CFM (from Section #1 above)	=	**129 CFM**
			Total Average Volume Flow Rate for this Hood		**635 CFM**

Section #3 *Determine the percentage of the Average VAV Flow to CAV Flow*

	635 CFM Average VAV Volume (from Section #2 above)	/	1250 CFM CAV Volume (from part #2 Section #1)	=	**51% CFM Percent of VAV to CAV**

Section #4 *Determine Annual VAV Hood Energy Costs*

	$ 1,355 Annual CAV Heating Cost (from part #2 Section #2)	X	51% Percent of VAV to CAV (from Section #3 above)	=	**$ 689 Annual VAV Heating Cost**
	$ 1,247 Annual CAV Cooling Cost (from part #2 Section #3)	X	51% Percent of VAV to CAV (from Section #3 above)	=	**$ 634 Annual VAV Cooling Cost**

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 *continued* **Determine Fan Electrical Energy Costs**

Operating Position	Percent of Total Volume Flow		Percent of Time		Average Fan Volume factor
Full Open	100% (from part #1)	X	10% (from part #1)	=	0.0952 Full Volume
Partial Open	80% (from part #1)	X	39% (from part #1)	=	0.3095 Partial Volume
Closed	20% (from part #1)	X	52% (from part #1)	=	0.1036 Minimum Volume
			Total VAV Fan Volume Factor		0.5083

($ 769 Annual CAV Exhaust Fan Cost (from Part #2 Section #4) + $ 769 Annual CAV Supply Fan Cost (from Part #2 Section #4)) X 0.50833 VAV Fan Factor (from above) = **$ 781.63 Annual VAV Hood Fan Cost**

Calculate to Total VAV Hood Annual Operating Cost

$ 689 Annual VAV Heating Cost (from this section previous page) + $ 634 Annual VAV Cooling Cost (from this section) previous page) + $ 782 Annual VAV Hood Fan Cost (from this section) = **$ 2,104.63 Annual VAV Hood Operating Cost**

Section #5 *Determine the Cost Differential of VAV Hood System vs. CAV Hood System*

$ 4,140 Total Annual CAV Operating Cost (from part #2 Section #5) - $ 2,105 Total Annual VAV Operating Cost (from above) = **$ 2,035.63 Annual Savings VAV vs. CAV Hood System**

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 Determining the Energy Costs associated with a VAV Hood with Automatic Sash Closure

Section #1 Determine Hood Use

Hours of Hood Use each Flow State per Week

Sash Position	Percentage of Flow	Operator Present at Hood	Operator Absent from Hood	Total Hours use per flow state
Full Open	1	1	15	16
Partial Open	0.8	5	60	65
Closed	0.2	0	87	87
	Total Hours >>>>>>	**6**	**162**	**168**

Sash Position	Percentage of Time
Full Open	1%
Partial Open	3%
Closed	96%

Adjusted Hours with Sash Automatically Closing when Operator is Absent from Hood	**1**
	5
	162

Section #2 *Determine Total Hood Volume for each of the previously defined Sash Operating Positions*

Operating Position	Percent of Total Volume Flow		Maximum Volume Flow		VAV Flow
Full Open	100% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**1250 CFM**
Partial Open	80% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**1000 CFM**
Closed	20% (from Section #1)	X	1250 CFM (from part #2 Section #1)	=	**250 CFM**

Section #3 *Determine the Average Flow Rate spread on a weekly basis*

Operating Position	Percent of Time		VAV Flow		Average Flow
Full Open	1% (from Section #1)	X	1250 CFM (from Section #2 above)	=	**7 CFM**
Partial Open	3% (from Section #1)	X	1000 CFM (from Section #2 above)	=	**30 CFM**
Closed	96% (from Section #1)	X	250 CFM (from Section #2 above)	=	**241 CFM**
			Total Average Volume Flow Rate for this Hood		**278 CFM**

continued nex page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #4 *continued*

Section #4 *Determine the percentage of the Average VAV Flow to CAV Flow*

278 CFM	/	1250 CFM	=	22% CFM
Average VAV Volume (from Section #3 above)		CAV Volume (from part #2 Section #1)		Percent of VAV to CAV

Section #5 *Determine Annual VAV Hood Energy Costs*

$ 1,355	X	22%	=	$ 302
Annual CAV Heating Cost (from part #2 Section #2)		Percent of VAV to CAV (from Section #4 above)		Annual VAV Heating Cost

$ 1,247	X	22%	=	$ 278
Annual CAV Cooling Cost (from part #2 Section #3)		Percent of VAV to CAV (from Section #4 above)		Annual VAV Cooling Cost

Determine Fan Electrical Energy Costs

Operating Position	Percent of Total Volume Flow		Percent of Time		Average Fan Volume factor
Full Open	100% (from Section #1)	X	1% (from Section #1)	=	0.0060 Full Volume
Partial Open	80% (from Section #1)	X	3% (from Section #1)	=	0.0238 Partial Volume
Closed	20% (from Section #1)	X	96% (from Section #1)	=	0.1929 Minimum Volume
			Total VAV Fan Volume Factor		0.2226

($ 769	+	$ 769)	X	0.2226	=	$ 342
Annual CAV Exhaust Fan Cost (from Part #2 Section #4)		Annual CAV Supply Fan Cost (from Part #2 Section #4)		VAV Fan Factor (from above)		Annual VAV Hood Fan Cost

Calculate to Total VAV Hood with Sash Closure Annual Operating Cost

$ 302	+	$ 278	+	$ 342	=	$ 921.70
Annual VAV Heating Cost (from this section)		Annual VAV Cooling Cost (from this section)		Annual VAV Hood Fan Cost (from this section)		Annual VAV Hood with Sash Closure Operating Cost

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Section #5 *Determine the Cost Differential of VAV Hood System vs. CAV Hood System*

$ 4,140	-	$ 922	=	$ 3,219
Total Annual CAV Operating Cost (from part #2 Section #5)		Total Annual VAV Operating Cost (from Section #4 previous page)		**Annual Savings VAV vs. CAV Hood System**

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline *Date:* 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #5 Summary of Operating Parameters & Energy Costs

SYSTEM DATA

Facility Electrical Cost per Kilowatt-hour	$ 0.10	Required Hood Exhaust Volume	1250
Facility Average Heating Cost per MBTU	$ 7.50	Heating Degree Days (from ASHRAE)	5588
Facility Average Cooling Cost per MBTU	$ 7.30	Hood Exhaust Fan Motor Efficiency	0.85
Required Cooling MBTU's for selected Hood Volume	40.68	Horsepower of Hood Exhaust Fan or portion of total if manifolded system	1

CAV & VAV SASH OPERATION PARAMETERS

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours usage
Full Open	100%	1	15	16
Partial Open	80%	5	60	65
Closed	20%	0	87	87
	Total Hours >>>>>>	6	162	168

VAV WITH AUTOMATIC SASH CLOSURE SASH OPERATION PARAMETERS

Sash Position	Percentage of Flow	Hours of Hood Use each Flow State per Week: Person at Hood	Person not at Hood	Total Hours usage
Full Open	100%	1	15	16
Partial Open	80%	5	60	65
Closed	20%	0	87	87
	Total Hours >>>>>>	6	162	168

continued next page

ENERGY SAVINGS PROJECTION FORM

Project Name: Sample 6-foot Fume Hood with Poor Sash Usage Discipline ***Date:*** 2-Oct-95

Rep Name: SAMPLE CALCULATIONS

Step #5 *continued*

Sash Position	Percentage of Time
Full Open	1%
Partial Open	3%
Closed	96%

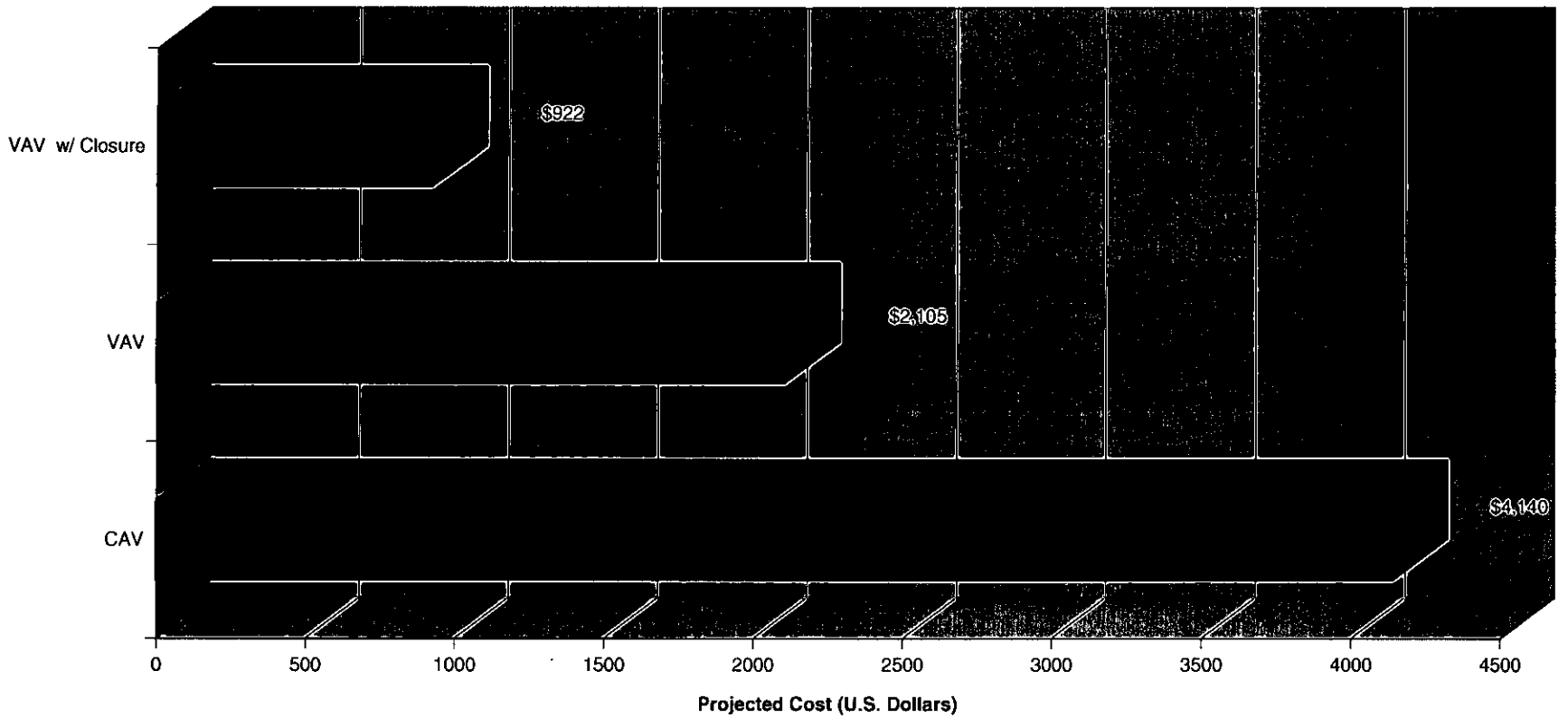
Hood Type	Annual Cost of Operation
CAV	$ 4,140
VAV	$ 2,105
VAV w/ Closure	$ 922

Adjusted Hours with Sash Automatically Closing when Operator is Absent from Hood	1
	5
	162

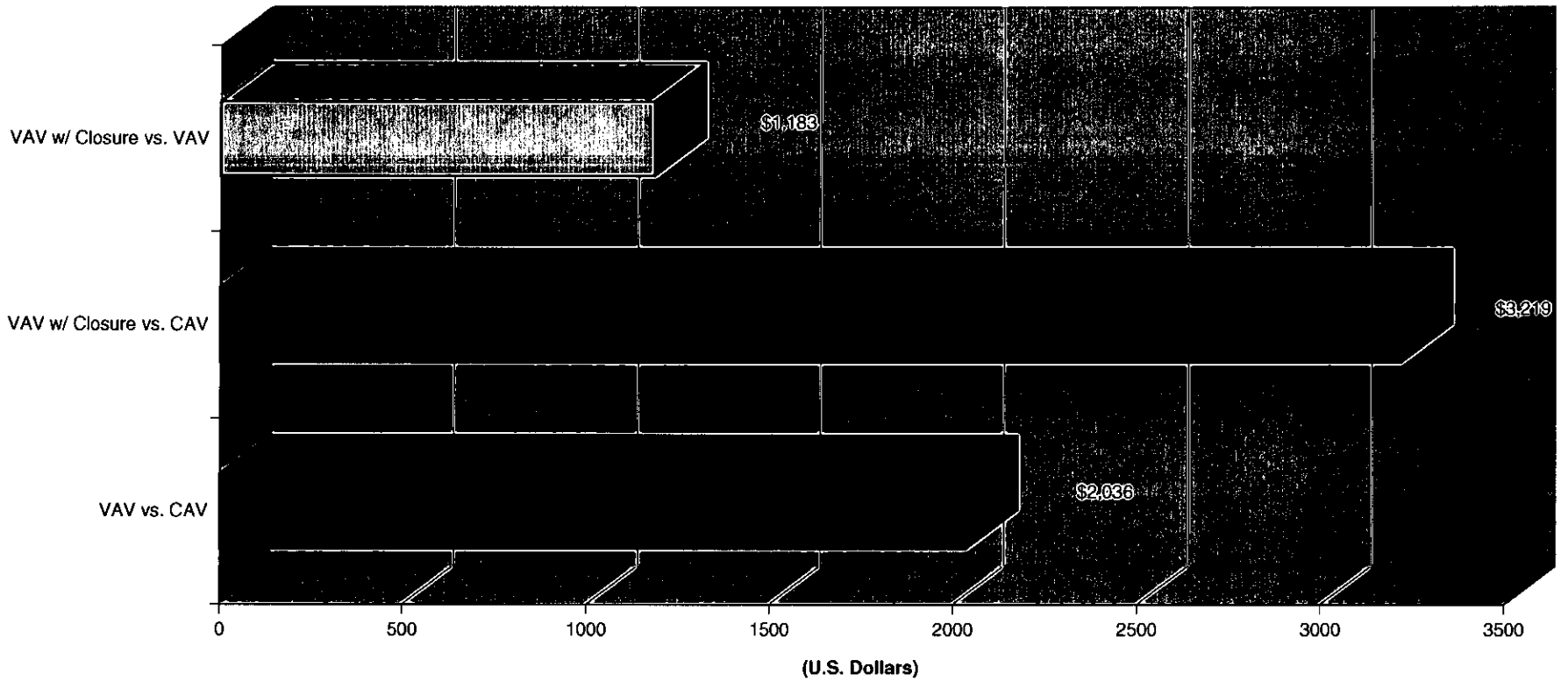
Savings

VAV vs. CAV	**$ 2,036**
VAV w/ Closure vs. CAV	**$ 3,219**
VAV w/ Closure vs. VAV	**$ 1,183**

FUME HOOD ANNUAL OPERATING COST COMPARISON



PROJECTED ANNUAL HOOD SAVINGS COMPARISON



PROJECTED ANNUAL SAVINGS COMPARISON FOR MULTIPLE HOOD PROJECTS