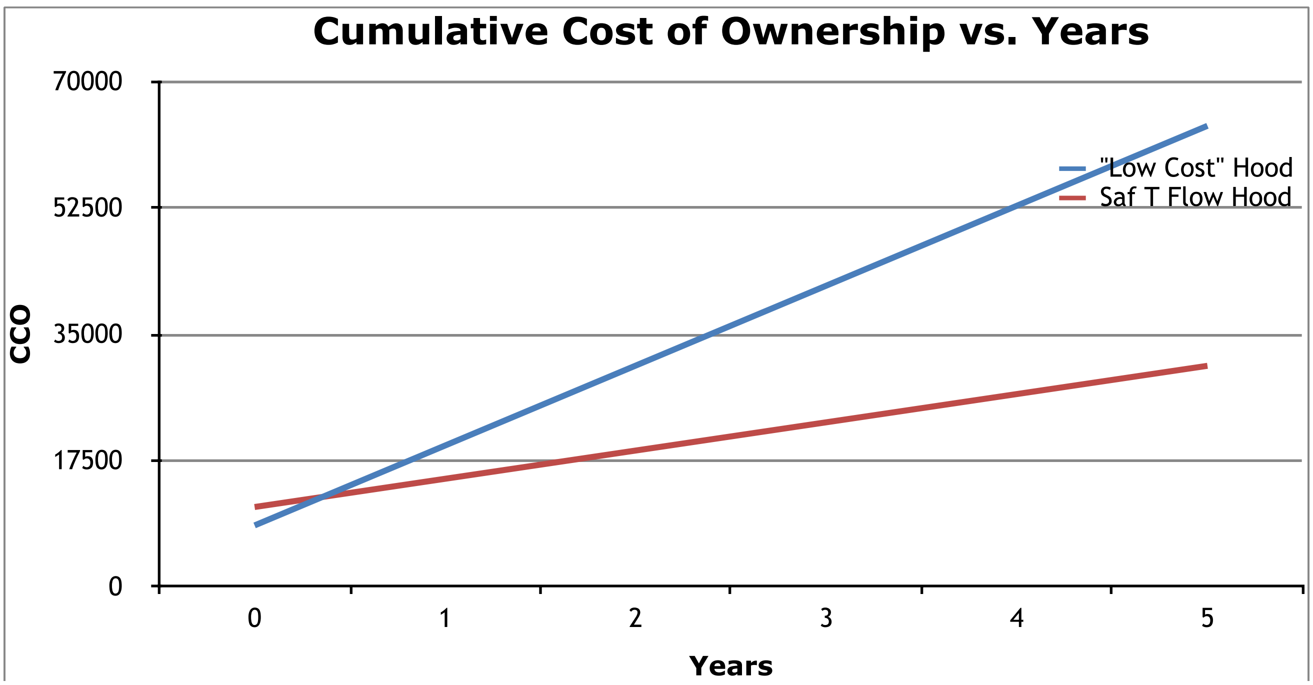
The Fume Hood Product Life Cycle

A Cost of Ownership Analysis



Comparison of an 8,300 USD and an 11,000 USD Fume Hood

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Background:
Flow Sciences is an American company that manufactures an impressive array of containment products, including fume hoods. www.flowsciences.com

Many lab-oriented businesses purchase fume hoods, including QC labs, hospitals, pharma production facilities, universities, and R&D centers.

In the present economy, project cost and scope are two of the most important parameters to manage. There is substantial pressure on building contractors to pursue the least expensive laboratory equipment solutions to maintain cost controls. This includes chemical fume hoods. Flow Sciences believes this to be an undesirable and cost inefficient strategy. Savings on inexpensive fume hoods at the outset of a lab's operational lifetime are rapidly and inevitably nullified due to persisting and, at times, overwhelming energy costs.

To avoid this situation, **fume hood cost of ownership** must be *defined and quantified* to optimize purchasing, construction, and on-going customer satisfaction based on product performance. To expedite distribution of this research, the savings and costs are all expressed in U S Dollars (USD or $).

This paper addresses one approach to such an assessment.

Procedure:

Tracking Methods for Lab Exhaust Expenses Over The Fume Hood Product Life Cycle

Flow Sciences worked with *Wave Consulting of Wilmington, North Carolina* to develop a numerical and economic model that tracked *lab exhaust expenses.* Data were collected. Eleven data sheets were used in all, each one comparing the Flow Sciences fume hood with the least energy efficient and least expensive fume hood we could find:

	FLOW SCIENCES		
	Cost of Ownership Model		
	COO Template		
	Answer the questions below to derive a cost difference between Flow Sciences and a competitor over a 15 year time period. After answering questions below, go to the 'Results' tab to see the difference in costs. For detailed breakdown of costs for each category, go to the corresponding tab to see how the results tab was calculated.		
	Order	*Flow Sciences*	*Competitor*
1	What is the average cost of one fume hood?	$11,000.00	$11,000.00
2	What is the number of units being considered for this order?	1	
	Energy Costs	*Flow Sciences*	*Competitor*
3	What is the published minimum CFM for this fume hood?	469	469
4	Cost per CFM per year	$10.00	
	Replacement Costs	*Flow Sciences*	*Competitor*
5	How often do you expect to retask, refit hoods on your site? (In years)	7.5	
6	What percentage of units will be replaced in each refitting?	0%	
7	What is the projected average cost to buy a hood at replacement time?	$12,500.00	$12,500.00
8	What is the average cost of equipment piece (like bypass) used to refit an existing fume hood?	$0.00	$3,000.00
9	Average labor time (hours) to replace equipment?	0	25
10	What is the average cost of labor?	$60.00	
	Maintenance Costs	*Flow Sciences*	*Competitor*
11	How many hours does it take to install one unit?	30	30
12	What is the average time each unit needs maintenance each year?	1	1
13	How long does it take to perform maintenance on fume hood? (hours)	2	2
14	What is the average labor cost per hour?	$60.00	
	Asset Valuation	*Flow Sciences*	*Competitor*
15	What is your cost of capital?	8.11%	
16	If known, what is incremental revenue per fume hood per year?	0	

Data Collection and Analysis: Seven Principles

1) **Capital Purchase Cost** – simply the *purchase and installation* cost of a new exhaust hood. *Many times, this is the only variable evaluated in a purchasing decision.*
2) **Energy cost defined –** the elephant in the room. Fume hoods have exhaust costs conservatively estimated at $10.00 per CFM per year! Fume hood exhaust CFM is an air stream which carries fumes out of the building. For a surprisingly large quantity of hoods, operation is continuous at 24/7. This air stream is blown into the outside environment and added to the entropy and toxicity of the universe without any benefit except as a fume transport

agent. This ENERGY COST is principally derived from fuel cost needed to expel the exhaust air and condition "new" air that replaces it. Most energy sources used today by utilities carry with them *huge adverse sustainability issues*.

3) **Maintenance cost defined -**

a) Repair – Counterweight cable repair, sash adjustments, cleaning, work top repair, moving the hood to another location. Some hoods with multiple sashes and complicated electronic systems have much higher maintenance costs than other hood systems.

b) Part Replacement – Such parts include VAV retrofitting, cable replacement, baffle replacement, baffle actuator replacement, and counter tops.

4) Selecting Brands of Fume Hoods for Comparison

Flow Sciences specifically analyzed eleven brands of six-foot-wide fume hoods whose exhaust performance data are published by their manufacturers. Each spread sheet compared one of the ten hoods with the least economical hood based on manufacturers published data.

5) **Finding Objective Cost Data for Various Brands**

We used GSA data and other information to estimate purchase/installation costs and the manufacturers' self-published exhaust data to estimate exhaust energy costs. Maintenance costs for each hood were calculated using the author's own experience with each brand and the complexity of each brand's design.

6) This Study is a Snapshot

It should be noted that most companies building fume containment equipment are always experimenting with new products and new applications. Any manufacturer may refine exhaust products and revise downward published exhaust values at any time. The researcher did not include unpublished data in the analysis presented here. As improved exhaust products reach the marketplace, we believe the *general costing model* used here can be extended to these upcoming products.

7) **VAV Savings and Replacement Costs *were both excluded from this study*.**

The author realizes that energy savings can be increased by VAV (variable volume fume hoods).

VAV savings are very real; a great deal of work and product research has gone into reducing exhaust volume using such technology. No VAV comparisons are included here because the complexity of such comparisons is beyond the scope of this paper. If VAV fume hood technology is added to the simpler technologies evaluated here, even greater strides toward savings and sustainability will be made.

Also, over an extended number of years, replacement costs may be significant. Replacement costs for entire fume hoods were not considered here, since the study only investigated savings and costs over fifteen years, a time too short to justify consideration of replacements.

Observations When Comparing Costs of Ownership:

The data and model projections covering the ten products mentioned earlier are listed below:

Table 1: Evaluated 6' Fume Hoods Listed in Reverse Order of COO

#	Name, ranked by yearly COO	Type	Installed Cost	CFM (2)	15 Year COO (3)	Yearly COO	Payback Period Yrs (4)	Bonus after payback (5)
1	FSI (Flow Sciences Saf T Flow)	Const. Vol.	$11,000	469	$ 84,950	$ 5,663	0.81	157,622
2	A	Const. Vol.	$10,400	385	$ 86,370	$ 5,791	0.65	159,399
3	B	Const. Vol.	$9,000	460	$ 87,000	$ 5,820	0.51	160,954
4	C	Const. Vol.	$9,800	660	$117,980	$ 7,865	0.97	155,845
5	D	Const. Vol.	$10,500	690	$123,180	$ 8,212	1.25	152,735
6	E	Const. Vol.	$10,500	645	$123,630	$ 8,242	1.27	146,958
7	F	Const. Vol.	$10,000	735	$129,430	$ 8,629	1.27	146,958
8	G	Const. Vol.	$9,700	775	$129,550	$ 8,637	1.17	153,623
9	H	Const. Vol.	$8,300	1040	$169,820	$ 11,321	9.70	58,872
10	I	Const. Vol.	$6,000	1050	$172,620	$ 11,508	NA	NA

Explanatory Notes:

1) Row colors indicate: green "High Efficiency Hoods"; Yellow: less effective "HE Hoods"; Red "Standard Hoods"
2) Numbers come from model developed jointly by Flow Sciences and Wave Consulting of Wilmington, North Carolina. Cost factors considered are purchase price, energy cost, and maintenance cost. Hoods are assumed to be operated 24/7. Cost of exhaust air for comparison here is $10 / CFM / year. (Hoods operated 24h/day). Savings and payback with other exhaust scenarios can be calculated on a case-by-case basis.
3) Data for **lowest published CFM** comes from manufacturer catalogs. In all cases, it was assumed these lowest exhaust numbers produced safe containment under lab conditions. Data were taken for 6' hoods; other widths can be calculated as needed.
4) 15 Year cost of ownership *assumes no hoods were replaced*, maintenance calculated based on bypass manipulation, cable and counterweight adjustment, and glass / counter-weight repair and replacement.
5) Payback period means all cost savings based on annual cost of ownership for the given hood applied to purchase price will be recovered in this many years. Y= (Difference between installed cost of low energy hood and conventional hood (I) / Difference of cost of ownership of conventional hood and COO of low energy hood divided by 15)
6) *Bonus* is money available to owner which would have been spent on energy by owner of the least energy efficient hood over the 15-year evaluation period. (See #4). B= 166,620*(15-payback Period)/15
7) See **footnotes 1-6** for data sources used to generate performance characteristics for these 10 fume hoods
8) Data from an eleventh fume hood were used as a baseline to calculate savings for the other ten brands and styles evaluated in this white paper.

In Table 1, Flow Sciences has added several chart columns to illustrate savings projections:

1. ***Yearly cost of ownership*** takes the 15-year total cost of ownership and divides it by 15. This term is primarily energy expense, but also contains the initial hood cost plus maintenance expenses averaged out over 15 years. The three most cost-efficient hoods (Flow Sciences, A, and B) measured by COO are the ones at the top of the chart and cost an average of $5,700 per year to own and operate.

2. ***Payback Period*** ranges from "0.51 years" to "9.7 years" and is the time in years needed for legacy accumulated cost of ownership *to exceed accumulated cost of ownership of the fume hood being evaluated. (See relationship 3 below)*

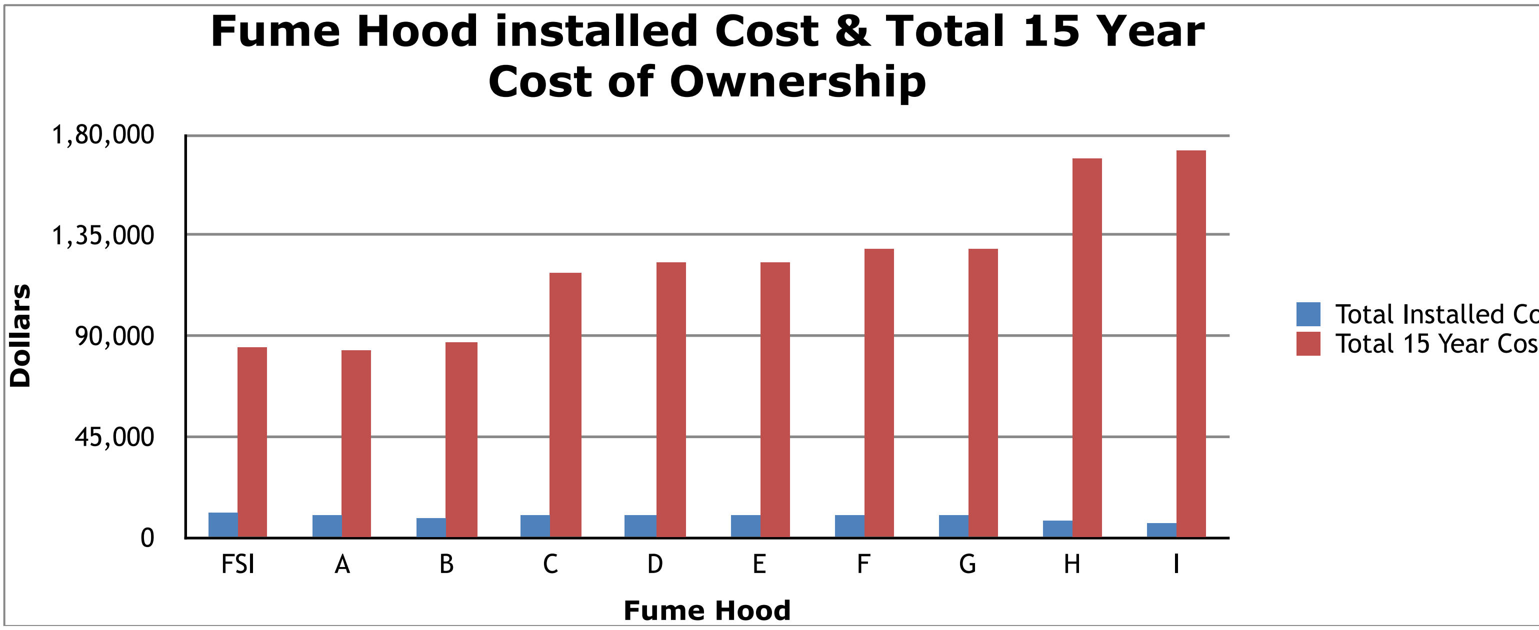
3. ***Bonus after Payback*** is the money saved after recovering the purchase price of the fume hood due to energy and maintenance savings.

Conclusions:

These data from Table 1 reveal *at least five key relationships*:

Relationship 1: Over 15 years of operation, *Total Installed Cost* is dwarfed by *Cost of Ownership* expenses. See Graph 1:

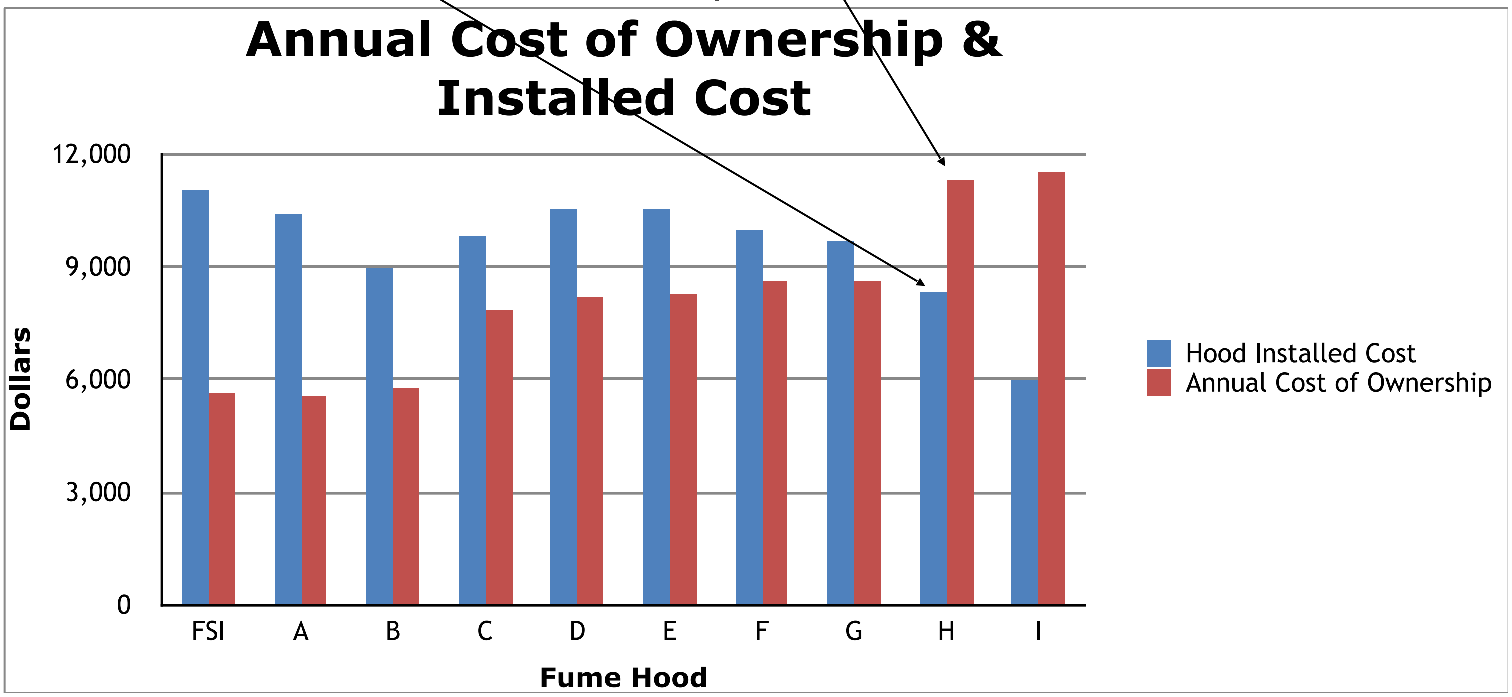
Graph 1:



When placed on the same graph with the same scale, differences in *installed costs* between all the hoods studied *appear minor compared to overall cost of ownership*. "Energy costs", roughly proportional to exhaust CFM, ***IS** the elephant in the room*.

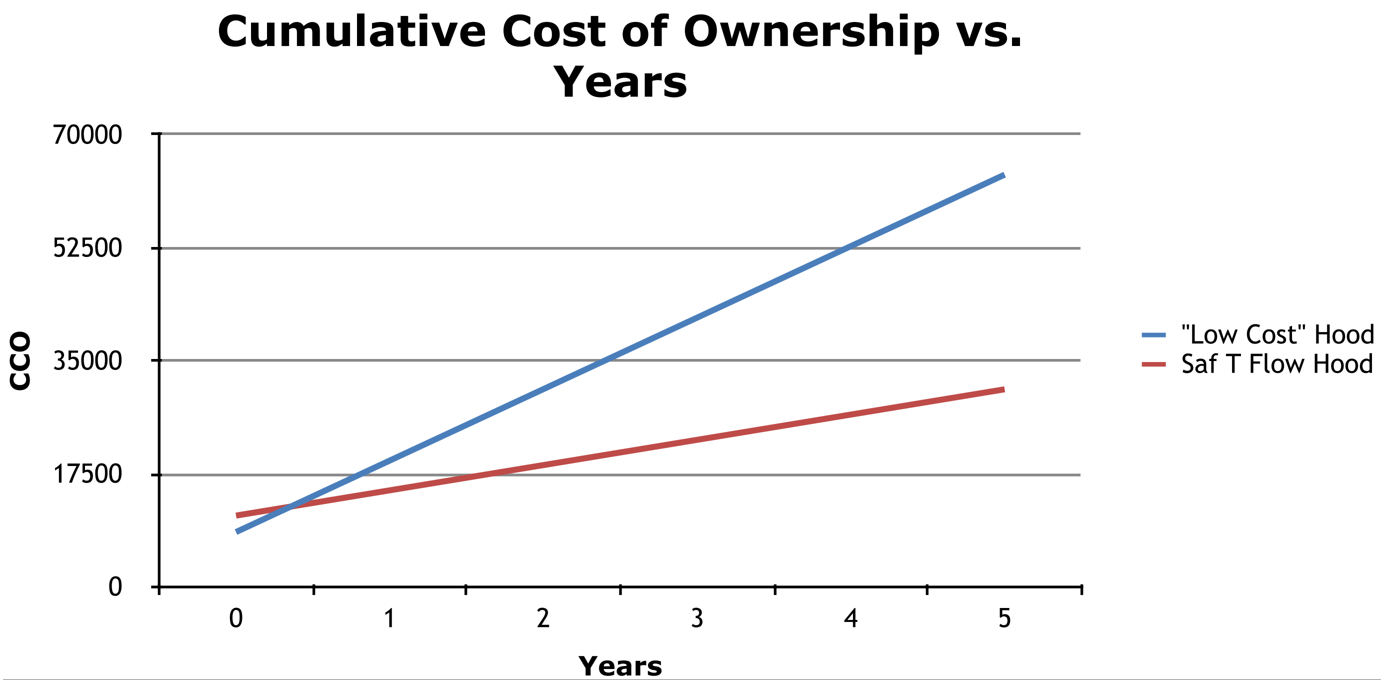
Relationship 2: Generally, *Total Installed Cost* is inversely proportional to *Annual Cost of Ownership.* The less you pay for a fume hood, the more it costs each year to run.

Graph 2:



Any hood that incorporates improved engineering and research to increase efficiency *will cost more on the front end.* This initial cost **is rapidly recovered over four to eight months**, largely with energy savings produced by *successfully engineered containment at lower exhaust volume*. These savings continue to accumulate for the next 14 years! **Spend this money on any future project you value; this will be a far better investment than throwing dollars up the exhaust stack!**

Relationship 3: *All High Efficiency Hoods studied herein have a remarkably short payback period*!



The graph above shows cumulative cost of ownership (CCO) of a typical High Efficiency Hood (Installed cost of $11050) vs. CCO for a legacy fume hood with an installed cost of $8,500 and higher exhaust CFM. In this extreme example, the HE hood starts showing efficiency paybacks after about FIVE MONTHS. *Other hood-to-hood comparisons in this study show a payback period never greater than 0.8 years for any HE hood compared to a legacy hood.*

Who would NOT opt for the HE philosophy **when it has such a short payback time!**

Relationship 4; Sustainability:

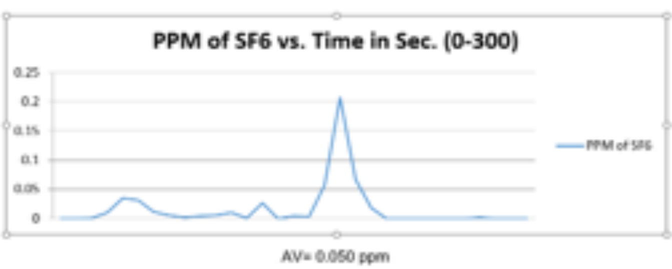
The above data show that a relatively small investment in extra energy-saving and maintenance features produce immediate overall fume hood savings and *very short payback*. Even though these results are defined within a 15 year "product lifetime", the most sustainably designed hoods pay off their energy-saving features **in less than one year**.

While all costs in this study are important contributors to cost of ownership, *energy consumption is of overriding importance* in assessing cost of ownership. *A more expensive sustainable fume hood* ***is always the better deal****, even during the first year of operation!*

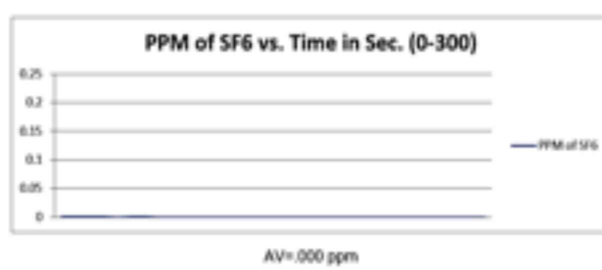
Using data in Table 1 and conversions readily available[7], *about $92,670 extra money* would be spent over 15 years to run a legacy fume hood rather than an energy efficient one. At $41.14 per ton, that's 2252 more tons of coal required over this time period to operate a 6' legacy fume hood. However, coal fired power plants are on the average 33% efficient, so that raises the actual coal tonnage to 6824. When burned, 6824 tons of coal will more or less make 19617 tons of carbon dioxide. Running through all the conversions, this means a legacy 1050 CFM fume hood will make 1.8 CFM **MORE** of carbon dioxide pollutant compared to a high efficiency hood. This means such a hood has a (100*1.8/1050) or a 0*.17% exhaust volume tax* of CO_2 as a result of the coal being burned to operate the hood. If this CO_2 stream were added to the hood's exhaust (instead of being given off at an electrical plant), it would **boost** the exhaust contaminant CO2 concentration by **1700 PPM at the fume hood exhaust stack**.

Relationship 5, Due Diligence:

All high efficiency fume hoods are NOT created equal! *This* white paper is based *only* on measured exhaust volume and resulting costs. Our own research shows careful testing must prove good containment occurs at the lower design exhaust volume used by high efficiency hoods. In the real world, superficially "minor" hood characteristics can cause major problems with containment. Check these two preliminary "Sash Movement Tests" (ASHRAE 110-2016, Section 8.3) on a developmental Saf T Flow high efficiency fume hood run at 60 FPM:



3" Sash Handle



1.75" Sash Handle

Just altering the sash handle depth 1 ¼ inches improved the containment from marginal to superior under dynamic challenge! These types of variance in prototype HE hoods performance means a candidate high efficiency fume hood *must* be validated using reproducible 3rd party ASHRAE 110 containment data under the proposed operating face velocity and make-up air conditions!

In summary, the author believes there are *four indisputable reasons* to select a high-efficiency hood over a legacy hood for whatever laboratory application presents itself:

1) High efficiency fume hoods like the Saf T Flow hood **save money** on energy, repairs, and down-time over a legacy hood, **even within the first year**. In this first year, the added purchase cost of a high efficiency unit is overwhelmed by the savings in *cost of ownership*. (Relationship #3)

2) Whether cheap or expensive, all hoods have a purchase/installation price *powers of ten lower* than the 15-year energy cost to support them.

3) Legacy fume hoods have adverse impacts of carbon dioxide production and wasted energy. High efficiency fume hoods have a very large potential to support sustainability related to these expenses.

4) All *high efficiency hoods* are *not* created equal. In all cases, a series of standardized containment tests should be performed *with good results* as a final necessary guarantor of the selected high efficiency fume hood.