EARLY RESULTS FROM A GOVERNMENT BUILDING ENERGY EFFICIENCY PROJECT

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ABSTRACT

This presentation is intended to show the process used to select energy efficiency measures for three new state office building and what results have been obtained to date. Two of the buildings have been occupied over one year while the third has been in use only six months. There are always problems to be solved with new projects. Some are interesting and some are expensive. Actual results will be presented without commentary. Questions from the audience will be answered as fully as possible. In several cases, answers have not been found to the surprising results of this demonstration project.

INTERACTION BETWEEN DESIGN ALTERNATIVES AND RUN ORDER

A key objective of analysis is to demonstrate BOTH the separate performance of individual design alternatives and the collective performance of the group of recommended measures. Thus the strategy used in this analysis is to evaluate one design alternative at a time, retain only those that provide good economic and sustainable performance, and thereby identify a "package" of recommended design alternatives. The alternative cases that are discussed below are described in the order in which they were run. Unless otherwise noted, each of the following alternative cases are added to the previous case, i.e., each new alternative is run "on top" of the preceding case. Thus, a package of design alternatives is identified or "grown", one measure at a time.

The benefit of this approach (e.g., as opposed to evaluating each new measure independently on top of the base case) is that it accounts for interaction between measures. Interaction between measures results when the amount of impact (benefit or penalty) of any measure is affected by the presence or absence of another measure. For example, the benefit of daylighting control will be greatest when evaluated assuming standard efficiency lighting and HVAC systems. However, the same daylighting measure evaluated assuming high efficiency lighting and HVAC systems will show significantly (e.g. up to 50%) less benefit since there would be less direct lighting load to mitigate and since the reduced heat gain would be removed from the building more efficiently.

Interaction between measures, therefore, creates a dilemma - on the one hand we wish to evaluate each design alternative separately, but the performance of almost any measure will depend on how early in the sequence of measures it is evaluated ("run"). Thus, if an analysis starts by assuming a less efficient base case, and then incrementally seeks to improve the overall performance of the design, **the performance of any measure adopted early in the sequence will tend to be overstated**. For example, if building envelope measures are evaluated before HVAC measures, the benefit of its load reduction will be greater if the building is served by a less efficient HVAC system. When the more efficient HVAC system is then run "on top of" the improved building envelope, the HVAC system has less load to meet which will decrease the incremental benefit resulting from its improved efficiency. If the order is reversed and the HVAC measure is run first, i.e., before the building envelope measure, then the HVAC loads were larger due to a less effective building envelope and the incremental benefit of the HVAC measure is overstated. Similarly, if the building envelope measure is then run on top of the improved HVAC, its incremental benefit is reduced.

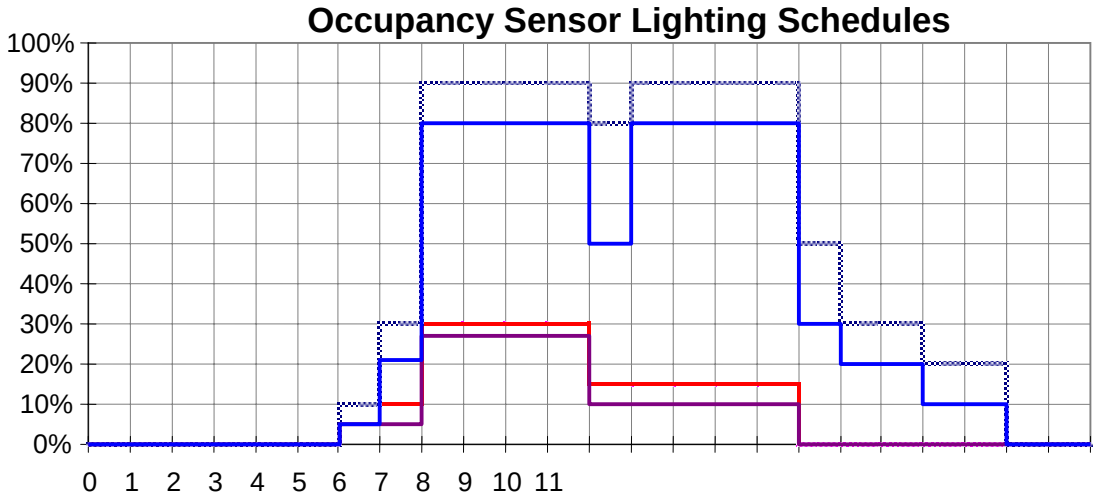
A compromise used in this analysis is to refine the building envelope first, in order to benefit HVAC sizing, and then report both incremental and cumulative performance (i.e., savings). Incremental performance identifies the benefit attributable to each measure individually. Cumulative performance is the performance of the entire package of measures. Since each measure is run "on top of" the previously adopted measures, cumulative performance is reported for the package of measures as each new measure is evaluated (i.e., up to that stage in the analysis).

TABLE 1 - Order of consideration of the elements for each of the buildings

		LaSalle		**Claiborne**		**Galvez**
	Alt	Run # + Added Feature	Alt	Run # + Added Feature	Alt	Run # + Added Feature
1	0	Min 90.1- 89 Compliance	0	Min 90.1- 89 Compliance	0	Min 90.1- 89 Compliance
2	1a	0+**Reoriented Bldg**	1a	0+**Envelope Reconfig**.	1a	0+**Reoriented Building**
3	1b	1+**Window Setbacks**	3a	1+**Atria** & Std Glass	1b	1+**Window Setback**
4	3a	2+Std Practice Glass	1d	2+ **Light Envelope Color**	1c	2+**Precast Skin**
5	1c	3+**Precast Skin**	1c	3+**Precast Skin**	1d	3+ **Light Envelope Color**
6	1d	4+**Light Envelope Color**	2a	4+**R19 Wall Ins**	1e	4+**East Patio Shading**
7	2a	5+**R-19 Wall Insulation**	2b	5+**R22 Roof Ins**	2a	5+**R-19 Wall Insulation**
8	2b	6+**R-30 Roof Insulation**	1b	6+**Window Setback**	2b	6+**R-30 Roof Insulation**
9	1e	7+**West Patio Shading**	4a	7+**Reduced Lighting PD***	3a	7+Std Practice Glass
10	4a	8+**Reduced Lighting PD***	4b	8+**Daylighting Ctrl**	3c	7+Dbl Low-e Bronze Glass
11	4b	9+**Daylighting**	4d	9+Light Shelf	4a	10+ **Reduced Lighting PD***
12	4d	9+Light Shelf	4e	10+**Mini Blinds**	4b	11+**Daylighting Controls**
13	3b	10+**LoE Bronze Glass**	3b	11+Dbl LoE Clr Glass	4c	12+**Occ Sensor Controls**
14	3c	10+LoE Green Glass	3c	11+LoE Bronze Glass	5c	13+**Heat Recovery Vent'r -2**
15	4c	11+**Occ Sens Lighting**	4c	12+**Occ Sens Lighting**	5a	14+ **Var. Sp. Dr. Pumps**
16	5b	13+**Var. Sp. Dr. Pumps**	5a	15+Reduced Fan Static	5b	15+**CO2 Controlled Vent.**
17	5c	15+ **Heat Recovery Vent'r -1**	5b	16+ **Var. Sp. Dr. Pumps**	8	16+ **Actual Chiller Plant**
18	5d	16+ **CO2 Controlled Vent.**	5e	17+**Gas Preheat**		
19	8	17+**Actual Chiller Plant**	5c	18+**Enthalpy Ht Recov - 4**		
20			5d	19+**CO2 Controlled Vent.**		
21			6	20+**CHW Pipe Insulation**		
22			7	21+Optimum Start/Start		
23			8	22+ **Actual Chiller Plant**		

Note: Claiborne was first building simulated and has a number of items that were rejected or combined and not tried separately in other 2 buildings. Items in **BOLD** were used in building.

Galvez Office Building, Louisiana State Capitol Complex
Lighting Use Profiles with and without Occupancy Sensor Control



(Totals to the equivalent of 2900 hours of full load operation per year)

Figure 1

OVERVIEW OF MEASURES CONSIDERED

The LaSalle and Galvez buildings are very similar – Claiborne is larger and "square"

Alternative 0: ASHRAE 90.1 Base Case

This simulates the building as if designed to minimally comply with the ASHRAE 90.1-1989 energy standard. The base case buildings have the same conditioned area as the proposed buildings but assume an aspect ratio of 2.5-to-1, with the long facades facing east and west. Envelope requirements are met via the system performance option. The computer program, ENVSTD was used to certify envelope compliance. A representative glass type, similar to Viracon uncoated monolithic gray is used. For the 90.1 base cases, the HVAC system is prescribed to be a built-up VAV system with perimeter re-heat, with 4.0 inches of supply fan static pressure and 1.0 inches of return fan static pressure. All fans are assumed to be controlled used VSD's. The service hot water load is prescribed to be 175 Btuh/person. Design conditions and loads are held constant for all cases (runs).

Unless otherwise noted, each of the following alternative cases are added to the previous case, i.e., each new alternative is run "on top" of the preceding case.

Alternative 1: Building Orientation and Fenestration

This package of measures represents architectural upgrades to selected basic design features of the minimally compliant 90.1 building described in the previous section.

Alternative 1a: Re-oriented Building

This alternative illustrates the impact of the improved aspect ratio and orientation of the proposed building. The aspect ratio is changed to actual design and the building is reoriented so that the long facades face north/south. Floor-to-floor heights are changed to actual design.

Alternative 1b: Window Setback

This alternative adds shading due to the integral columns/pilasters adjacent to most windows and window set-backs. This effect was modeled using shading "fins" approximately seven inches deep(Galvez) to 12 inches average set-back(Claiborne), at the immediate side of each window. Note, these only account for shading effect; no three-dimensional heat transfer effects associated with the revised geometry are accounted for.

Alternative 1c: Precast Skin

This alternative changes the exterior wall material from an assumed minimum cost spandrel glass-type construction to heavy weight precast concrete and insulated spandrel panels or precast concrete below windows. Insulation levels remain at the minimum level, i.e., insulation is not increased until Alternative 2a.

Alternative 1d: Light Surface Color

In this alternative case, the wall and roof color are change from medium/dark to light, i.e., solar absorbance changes from 0.7 to 0.35 for walls and roof.

Note: Highly reflective EPDM or "Hypalon" roofing was proposed as Baton Rouge is a known "Heat Island" city. The buyer did not want this kind of roof because of past experiences and a lack of highly qualified installers. Other considerations were that these are flat roofs that tend to collect dirt which would degrade the benefit somewhat and there are some partial roofs located outside office windows that the reflected light might have caused discomfort. Facilities Planning was comfortable with a built-up roofs and did not want anything else. A compromise was reached by making the top coarse "white" grit which has some reflective properties.

Alternative 1e: Patio Shading

This alternative adds porches on the facades, east on Galvez & west on LaSalle, which provide additional east/west shading.

Alternative 2: Envelope Insulation

These two measures represents upgrades to building envelope insulation levels, beyond the levels required for the minimum compliance with ASHRAE 90.1.

Alternative 2a: Increased Wall Insulation

This increases the wall insulation from a nominal R-11 to a nominal R-19; however, this assumes no thermal isolation of the steel framing members from the precast concrete panels. Thermal bridging through steel framing members degrades the nominal R-value of the insulation in both cases. (In the base case, R-11 becomes R-5.5 effective and in this case, R-19 becomes R-7.1 effective (see Table 8-Y, page 8-65, in the *90.1 User's Manual*).

Alternative 2b: Increased Roof Insulation

This alternative increases the roof insulation from a nominal R-13.7 to a nominal R-22(Claiborne, large roof) or R-30 (LaSalle and Galvez). This case assumes insulation board is applied to the exterior surface of framing members (i.e., very limited thermal bridging).

Alternative 3: Atria & Standard Glass

Claiborne - In this alternative case, atria are added on three sides of the building and the assumed minimum 90.1 glazing (i.e., single pane tinted, SC=0.67, U-value =1.23) is replaced with a "low tech" tinted insulating glazing. This assumed "standard practice"

glass is a double pane light bronze tinted (no low-e coatings), (see TABLE 3 below). The glass separating the atria from the adjacent zones is single pane clear ¼", full height. No daylighting or heat recovery is assumed in this alternative. Interior and exterior atria shading is included, i.e., shading due to the interior structure and the exterior 20 foot deep, 52 foot wide "notches" cut into each facade. The atria are assumed to be indirectly conditioned by exhausting relief air through them.

Galvez - This represents upgrades to exterior glazing, beyond the characteristics required for the minimum compliance with ASHRAE 90.1. Initially, three glass alternatives were considered. Prior analyses for similar state buildings included all three glass options. Subsequent discussions with the design teams and state facilities personnel eliminated the green daylight glass option for aesthetic reasons. For completeness, each of these glass alternatives is described below.

Alternative 3a: Standard Practice Glass
This alternative replaces the base case ASHRAE 90.1 glass with a glass that is representative of recent standard practice for other Louisiana state buildings. This standard practice glass is assumed to be double pane light bronze tinted (no low-e coating) which improves (lowers) the shading coefficient from the maximum allowed SC=0.73 to SC=0.58 and improves (lowers) the center-of-glass U-value from 1.09 Btu/h·sf·F to 0.56 Btu/h·sf·F. This glass also decreases the visible transmittance which will reduce daylighting performance. A representative product for this glass specification is Viracon uncoated insulating bronze (see TABLE 3 below).

Alternative 3b: Low "E" Insulated Clear Glass
This alternative replaces the reference glass (uncoated double bronze) in all exterior perimeter zones (excludes atria) with a double pane **clear** product having a low emissivity ("low e") coating on the #2 surface. There are three benefits to this glass, compared to the "standard practice" tinted bronze glass: improved U-value, reduced from 0.56 to 0.30; reduced shading coefficient from 0.58 to 0.43; and increased visible transmittance from 48% to 70%. Relative to the standard practice glass, the double low-e clear glass provides less reduction in shading coefficient (from SC=0.58 to SC=0.43), but improves the visible transmittance (from 48% to 70%). A representative product for this glass specification is Viracon Solarscreen 2000 low-e insulating clear, VE1-2M (see TABLE 3 below).

Alternative 3c: Double Low "E" Insulated Bronze Glass
This alternative replaces the standard practice glass from 3a with a double low-e coated product, which tends to give the maximum solar control with minimum visible transmittance penalty. The principal benefit of the double low-e bronze glass is that it significantly improves (reduces) the shading coefficient from 0.58 to 0.30, however, it is gained at the cost of decreased visible transmittance (from 48% to 42%). A significant improvement is also obtained in the U-value. A representative product for this glass specification is Viracon Solarscreen 2000 low-e insulating bronze, VE4-2M (see TABLE 3 below).

TABLE 3

Glass Properties*

Louisiana State Capitol Complex Office Buildings

Viracon Glass Name (and Code)	**U-Value****	**SC**	**VT**	**Ke**
Uncoated Monolithic Bl-Green (base case glass - single pane)	1.09	0.73	54%	0.74
Uncoated Monolithic Gray (single pane)	1.09	0.66	44%	0.67
Uncoated Insulating Bronze (standard practice" double pane)	0.56	0.58	48%	0.83
Solarscreen Low-E Insulating Green, VE2-85	0.32	0.44	65%	1.48
Solarscreen 2000 Double Low-E Clear, VE1-2M	0.28	0.43	70%	1.63
Solarscreen 2000 Double Low-E Bronze, VE4-2M	0.30	0.30	42%	1.40
Used in LaSalle & Galvez – Viracon Solarscreen VE 4-85	0.32	0.42	45%	1.07
Used in Claiborne – AFG Ind. Comfort E2 Clear	0.35	0.71	73%	1.03

** all glass products are ¼ inch with .5 inch gap*

*** center-of-glass, summer U-values*

Alternative 4: Lighting System Optimization
This alternative illustrates the impact of several improvements that directly or indirectly improve the efficiency of the lighting system in the building:

Alternative 4a: Reduced Lighting Power Density
The ASHRAE 90.1 base case is assumed to have an average lighting density of 2.0 W/sq. ft. in open office areas and 1.8 W/sq. ft. in private office areas, based on the system performance method of determining allowable lighting power budget. Assuming a **direct** lighting system that utilizes T-8 fluorescent lamps with electronic ballasts, the average lighting power density is assumed to be reduced to an estimated 1.6 W/sq. ft. in open office areas and to 1.8 W/sq. ft. in private office areas. Note that "Daylighting" and "Lumen maintenance" controls are adopted in the next measure.

Alternative 4b: Daylighting/Lumen maintenance Controls
The lights within 12 to 15 feet of the glazed perimeter are assumed to be controlled using continuous dimming daylighting sensors. The glazing assumed to be used for this case is from Alternative 3b, i.e., double pane low-e light gray. Although this glass has a relative high daylighting performance index, K_e = 1.00, (i.e., visible transmittance=38% divided by shading coefficient=0.38) it has generally poor daylight performance due to its comparatively low visible transmittance. Assumed design light levels were 50 footcandles for all perimeter office areas. This measure assumes a 12-15 foot deep perimeter, two-thirds of which consists of 14 foot wide private offices with one controller per office plus 12 additional per floor. This measure also assumes approximately a 20% lighting power savings due to daylighting which was used and for lumen maintenance control which was not employed. All ballasts are set at 80% maximum by the Lighting Control System.

Alternative 4c: Occupancy Sensor Controls for Ambient Lighting
This alternative assumes the use of occupancy sensor lighting controls in all corridors (30% assumed savings), private offices (20% assumed savings), conference rooms (30% assumed savings), core service areas (50% assumed savings), and storage areas (50% assumed savings). Note that this measure is adopted in combination with Alternative 4a (reduced lighting power density) and Alternative 4b (double low-e bronze glass with daylighting controls). This measure assumes two-thirds of the perimeter is 14 foot wide private offices with one controller per office. This item was deployed through out the buildings including open bay areas.

Alternative 4d: Light Shelves
This alternative adds two additional feet of glass height (increase from six feet to eight feet high) and places an interior light shelf (24" interior horizontal shade) at six feet above sill height. The perimeter lighting zone is increased from twelve feet (location of perimeter office partitions) to fifteen feet to account for borrowed light provided to circulation areas via a glass transom at the top of the perimeter partition. No interior blinds are assumed (mini blinds are added in the next case). Note that this measure applies only to the exterior perimeter zones, not to the atria perimeter zones or the atria themselves. This alternative was not used anywhere.

Alternative 4e: Mini Blinds
This alternative adds mini blinds to all exterior perimeter zones. The schedule of use assumes that the mini blinds will be deployed during the months of March through October, whenever incident solar radiation exceeds 50 Btu/hr/sq. ft.. Under all other conditions, the mini blinds are assumed to be open. The impacts of the mini blinds on solar and daylight transmission are estimated from the ASHRAE *Handbook of Fundamentals.*

Alternative 5: Mechanical Systems Upgrades
This package of measures represents upgrades to the building mechanical systems and controls, beyond that which is required for minimum compliance with ASHRAE 90.1.

Alternative 5a: Reduced Fan Static
ASHRAE 90.1 allows 5.0 inches of total static pressure. The base case assumed 4.0 inches of total supply static pressure and 1.0 inches of return static pressure. This alternative reduces the supply static pressure 1.5 inches and the return static to 0.5 inches.

Alternative 5b: Variable Speed Drive Pump Control
The minimum 90.1 design assumes two-speed pump control. This alternative replaces this with variable speed pump control (90 feet of head assumed).

Alternative 5c: Exhaust Air Enthalpy Heat Recovery
Minimum 90.1 design does not require an economizer in Baton Rouge. Additionally, minimum 90.1 design assumes no exhaust air heat recovery. This alternative provides enthalpy-controlled economizers that operate whenever the outdoor air has less enthalpy and a lower dry-bulb temperature than the return air. This alternative also provides heat recovery (sensible only - operates to exchange heat between the make-up and relief air whenever the delta-T between them exceeds seven degrees, i.e., operates to recover heat or "coolth"). Recovery efficiency is assumed to be 84.2%.

Note that no moisture exchange is modeled, therefore, this measure, does not fully capture the reduced latent cooing load benefits that would actually be realized.

Alternative 5d: CO2-Controlled Ventilation Air
Additionally, the minimum 90.1 design assumes approximately 25 CFM of outdoor ventilation air per person (constant for all hours of fan operation). This alternative also provides CO2 control to modulate the required amount of outside air quantities. In the simulation, this was modeled by forcing the amount of outdoor ventilation air to track the occupancy profile.

Alternative 5e: Natural Gas Preheat
The minimum 90.1 design assumes electric preheat which was used in the LaSalle and Galvez buildings. This alternative replaces this with natural gas preheat in the Claiborne building.

Alternative 6: Chilled Water Piping Insulation
This alternative simulates the benefit due to increased chilled water pipe insulation (assumes approximately ½ inch additional insulation beyond that which is required by 90.1).

Alternative 7: Optimum Start/Stop via EMS
This alternative simulates the benefit due to improved fan on/off operation due to an optimum start/stop EMS control. All buildings have an EMS by Johnson Controls but Lighting system is separate.

Alternative 8: Actual Chiller Plant
Minimum 90.1 design requires a chiller plant with a nominal full-load efficiency of 0.67 kW/ton. This alternative models the actual chiller plant efficiency (0.61 kW/ton).

Energy Savings Synopsis of Louisiana Capitol Complex Demonstration Project

Capitol Complex Office Building	Area used in Simulation	Acquisition & Maintenance	25 Yr Life-Cycle $	Annual Site Energy Used			Natural Gas Saved	Electricity Saved Annually	Peak Demand Saved	Electricity Use	Energy Saved Annually	Energy Use Summary	Total Energy
		Incremental	Undiscounted	Elect	Nat Gas	Total	Total	Total	Total	Total	Site	Site	savings
		Cost ($)	LCC ($)	MWh	Mbtu	Mbtu	Mbtu	MWh	MW	kWh/sq.ft.	MBtu	kBtu/sf/yr	%
LaSalle	330,000 sq.ft.	$1,497,728	$4,781,000	3927	0	13398	0	2410	1.07	11.90	8,226	41	44.0%
Claiborne	465,000 sq.ft.	$2,836,107	$6,139,125	4483	311	15610	-22	3390	0.96	9.64	11,547	34	42.5%
Galvez	334,140 sq.ft.	$1,448,830	$5,093,325	3929	0	13406	0	2621	1.11	11.76	8,945	40	36.0%
Totals	1,129,140 sf	$5,782,665	$16,013,450	12150		42415		8421	3.15	10.76	28,718	38	

TABLE 4

Final Summary Results - Louisiana State Capitol Complex - "West" Office Building

21 November 2000 (Only one Ht Recov Sys; No Thermal Breaks at Window Frames) (page 1 of 1)

			Annual Energy Use & Costs				Cumulative Savings (% savings)				
	Measure # and Description	Peak Elect kW	Elect kWh	Source Energy Mbtu	Annual Utility Cost $	25 Year Life-Cycle** System ($)	Source Energy Mbtu	Peak Elect kW	Annual Utility Cost $	Simple Pay-back	25 Year Life-Cycle Utility ($)
0	Minimum 90.1 Compliance	2488	5,460,309	55,908	$430,784	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
1	0+Bldg Orient & Fenestration	2192	5,100,059	52,219	$399,736	$3,794,156	3689 (7%)	296 (12%)	$31048 (7%)	12.2	$776200 (7%)
2	1+Envelope Insulation	2125	5,074,664	51,959	$396,289	$3,963,082	3949 (7%)	363 (15%)	$34495 (8%)	12.1	$862375 (8%)
3	2+LoE Bronze Glass, No ThrmBrk	2024	4,881,788	49,984	$379,126	$5,387,631	5923 (11%)	464 (19%)	$51658 (12%)	11.5	$1291450 (12%)
4	3+Lighting+DL/Occ System	1567	3,380,278	34,610	$266,362	$5,578,401	21297 (38%)	921 (37%)	$164422 (38%)	4.4	$4110550 (38%)
5	4+Mechanical System	1453	3,156,758	32,322	$250,447	$5,709,471	23586 (42%)	1035 (42%)	$180337 (42%)	4.7	$4508425 (42%)
6	5+1 Heat Wheel	1417	3,050,134	31,230	$239,544	$5,709,471	24678 (44%)	1071 (43%)	$191240 (44%)	4.4	$4781000 (44%)

Annual Energy Use = 3,050,134 / 330,000 = 9.24 kWh per sq. ft.

** *assumes 25 year for architectural features, 25 year for lighting equip, 25 year for HVAC equip (includes replacement $ as needed)*

Based on the DOE-2 SIMULATIONS:

LaSalle Annual Energy Use	= 3,050,134 / 330,000 =	9.24 kWh per sq. ft.
Claiborne Annual Energy Use	= 4,482,753 / 465,000 =	9.64 kWh per sq. ft.
Galvez Annual Energy Use	= 3,399,335 / 334,140 =	10.17 kWh per sq. ft.

TABLE 5

Final Summary Results - Louisiana State Capital Complex – Claiborne Office Building

8/31/1998

Measure # and Description		Annual Energy Use & Costs: Peak Elect kW	Elect kWh	Source Energy Mbtu	Annual Utility Cost $	25 Year Life-Cycle** System ($)	Cumulative Savings (% savings): Source Energy Mbtu	Peak Elect kW	Annual Utility Cost $	Simple Pay-back	25 Year Life-Cycle Utility ($)
0	Minimum 90.1 Compliance	2,942	7,872,603	80,607	$598,454	n/a	n/a		n/a	n/a	n/a
1	0+Envelope Reconfiguration	2,836	7,715,979	79,003	$583,612	$7,060,584	1604 (2%)	106 (4%)	$14842 (2%)	24.9	$371050 (2%)
2	1+Additional Roof Insulation	2,824	7,714,059	78,984	$582,396	$7,433,422	1623 (2%)	118 (4%)	$16058 (3%)	24.8	$401450 (3%)
3	2+Lighting Optimization	2,358	6,399,525	65,524	$485,281	$10,086,240	15083 (19%)	584 (20%)	$113173 (19%)	16.3	$2829325 (19%)
4	3+Mini Blinds	2,334	6,342,288	64,938	$481,290	$10,184,647	15669 (19%)	608 (21%)	$117164 (20%)	16.6	$2929100 (20%)
5	4+LoE Clear Glass	2,258	6,263,324	64,130	$472,661	$12,437,994	16477 (20%)	684 (23%)	$125793 (21%)	17.2	$3144825 (21%)
6	5+Occ Sensor Lighting	2,187	5,921,922	60,634	$451,858	$12,747,994	19973 (25%)	755 (26%)	$146596 (24%)	16.8	$3664900 (24%)
7	6+Low Static Duct System	2,148	5,585,057	57,185	$426,679	$15,359,770	23422 (29%)	794 (27%)	$171775 (29%)	17.2	$4294375 (29%)
8	7+VSD Pumps at Bldg Level	2,144	5,564,553	56,975	$425,477	$15,759,911	23632 (29%)	799 (27%)	$172977 (29%)	17.2	$4324425 (29%)
9	8+Gas Preheat	2,029	5,366,011	54,943	$416,737	$16,211,118	24750 (31%)	913 (31%)	$181717 (30%)	17.1	$4542925 (30%)
10	9+Enthalpy Heat Recovery	1,940	4,640,905	47,518	$362,430	$18,363,503	33066 (41%)	1003 (34%)	$236024 (39%)	16.6	$5900600 (39%)
11	10+CHW Pipe Insulation	1,934	4,620,285	47,307	$361,175	$18,429,273	33277 (41%)	1009 (34%)	$237279 (40%)	16.6	$5931975 (40%)
12	11+Optimum Start/Stop	1,990	4,580,665	46,901	$360,770	$19,627,118	33684 (42%)	952 (32%)	$237684 (40%)	16.6	$5942100 (40%)
13	12+Central CHW Plant	1,980	4,482,753	45,899	$352,889	$20,365,023	34686 (43%)	963 (33%)	$245565 (41%)	16.3	$6139125 (41%)

Annual Energy Use = 4,482,753 / 465,000 = 9.64 kWh per sq. ft.

** assumes 25 year for architectural features, 25 year for lighitng equip, 25 year for HVAC equip (includes replacement $ as needed)

TABLE 6

FINAL Summary Results - Galvez Office Building, Louisiana State Capitol Complex

2 January 2001

334,140 sq.ft.

Measure # and Description	Annual Energy Use & Costs					Cumulative Savings (% savings)				
	Peak Elect kW	Elect kWh	Source Energy Mbtu	Annual Utility Cost $	25 Year Life-Cycle** System ($)	Source Energy Mbtu	Peak Elect kW	Annual Utility Cost $	Simple Pay-back	25 Year Life-Cycle Utility ($)
0 Min 90.1 Compliance	2836	6,020,133	61,640	$563,089	$8,530,270	n/a	n/a	n/a	n/a	n/a
1a 0+Reoriented Building	2779	5,907,056	60,482	$554,469	$8,399,685	1158 (2%)	57 (2%)	$8620 (2%)	immed	$215500
1b 1a+Window Setback	2744	5,825,462	59,646	$548,788	$8,313,623	1993 (3%)	92 (3%)	$14301 (3%)	immed	$357525
1c 1b+Precast Skin	2670	5,653,488	57,886	$532,177	$8,130,921	3754 (6%)	166 (6%)	$30912 (5%)	2.2	$772800
1d 1c+Light Surface Color	2648	5,618,141	57,524	$529,378	$8,088,519	4116 (7%)	188 (7%)	$33711 (6%)	2.0	$842775
1e 1d+East Patio Shading	2641	5,608,182	57,422	$528,663	$8,077,687	4218 (7%)	195 (7%)	$34426 (6%)	2.0	$860650
2a 1e+Increased Wall Insulation	2627	5,586,889	57,204	$526,236	$8,068,099	4436 (7%)	209 (7%)	$36853 (7%)	2.6	$921325
2b 2a+Increased Roof Insulation	2620	5,576,466	57,097	$525,266	$8,074,488	4543 (7%)	216 (8%)	$37823 (7%)	3.1	$945575
3a 2b+Standard Practice Glass*	2570	5,495,089	56,264	$517,264	$8,077,043	5376 (9%)	266 (9%)	$45825 (8%)	5.3	$1145625
3b 2b+Dbl Low-e Daylight Lt Green Glass*	2534	5,417,941	55,474	$511,120	$8,058,660	6166 (10%)	302 (11%)	$51969 (9%)	6.1	$1299225
3c 2b+Dbl Low-e dbl Bronze Glass	2503	5,348,056	54,758	$505,914	$7,979,794	6881 (11%)	333 (12%)	$57175 (10%)	5.5	$1429375
4a 3c+Reduced Lighting Power Density	2337	4,906,053	50,233	$471,737	$7,658,995	11407 (19%)	499 (18%)	$91352 (16%)	5.6	$2283800
4b 4a+Daylighting Controls	2023	4,136,546	42,354	$412,231	$6,916,655	19286 (31%)	813 (29%)	$150858 (27%)	4.5	$3771450
4c 4b+Occupancy Sensor Controls	1966	3,889,928	39,829	$396,539	$6,819,336	21811 (35%)	870 (31%)	$166550 (30%)	4.9	$4163750
5a 4c+Heat Recovery Ventilator	1788	3,558,425	36,434	$371,866	$6,652,871	25205 (41%)	1048 (37%)	$191223 (34%)	5.3	$4780575
5b 5a+Variable Speed Drive Pump Control	1756	3,485,344	35,686	$365,942	$6,590,008	25953 (42%)	1080 (38%)	$197147 (35%)	5.3	$4928675
5c 5b+CO2-Controlled Ventilation Air	1755	3,470,475	35,534	$365,309	$6,681,918	26106 (42%)	1081 (38%)	$197780 (35%)	5.8	$4944500
5d 5c+Central (Existing) Chiller Plant	1722	3,399,335	34,805	$359,356	$6,591,736	26834 (44%)	1114 (39%)	$203733 (36%)	5.6	$5093325

Annual Energy Use = 3,399,335 / 334,140 = 10.17 kWh per sq. ft.

** assumes 25 year for architectural features, 25 year for lighitng equip, 25 year for HVAC equip (includes replacement $ as needed)

TABLE 7 - Actual Meter Readings for 12 months in kWh

LASALLE BUILDING		364,700 sq. ft.			
Month		METER #3	METER #4	TOTAL	kWh/s.f.
	Sep-02	213835	231403	445238	1.221
	Oct-02	302110	296563	598673	1.642
	Nov-02	265742	314560	580302	1.591
	Dec-02	267600	309413	577013	1.582
	Jan-03	348159	382459	730618	2.003
	Feb-03	334573	351330	685903	1.881
	Mar-03	334800	351400	686200	1.882
	Apr-03	334896	351489	686385	1.882
	May-03	230935	271223	502158	1.377
	Jun-03	226088	256195	482283	1.322
	Jul-03	226826	260042	486868	1.335
	Aug-03	319775	319235	639010	1.752
12 Mon.		2,858,738	3,116,035	5,974,773	16.383
Mon. average for 12 months		285,874	311,604	597,477	1.638

Note: Meters 1 & 2 were used during construction and no longer exist

CLAIBORNE BUILDING		498,766 sq. ft.						
Month	METER#1	METER #2	METER #3	METER #4	METER #5	TOTAL	kWh/s.f.
Sep-02	89,431	70,430	95,970	113,632	92,724	462,187	0.927
Oct-02	97,568	79,601	111,109	136,923	111,729	536,930	1.077
Nov-02	88,700	69,070	90,655	128,331	104,718	481,474	0.965
Dec-02	107,017	79,270	87,576	135,714	110,743	520,320	1.043
Jan-03	119,648	79,916	93,034	146,628	119,648	558,874	1.121
Feb-03	112,163	74,699	88,646	138,263	112,823	526,594	1.056
Mar-03	112,200	74,722	88,700	138,300	112,853	526,775	1.056
Apr-03	112,299	74,800	88,900	138,396	112,931	527,326	1.057
May-03	87,727	67,011	88,446	118,117	96,383	457,684	0.918
Jun-03	75,056	57,371	102,318	114,064	93,076	441,885	0.886
Jul-03	95,622	76,348	90,031	123,952	99,063	485,016	0.972
Aug-03	93,512	74,091	90,377	121,659	101,198	480,837	0.964
	1,190,943	877,329	1,115,762	1,553,979	1,267,889	6,005,902	12.042
Mon. average for 12 months.	99,245	73,111	92,980	129,498	105,657	500,492	1.003

Red numbers are guestimates based on limited data and equal .816 x meter 4