

# Energy Audit Report

## 140/160 Franklin (Embarcadero Annex)

### Oakland, California



By  
**15000 Inc.**  
613 4<sup>th</sup> Street, Suite 203a  
Santa Rosa, CA 95404

**Final Report**  
Feb 2009

# ENERGY AUDIT TABLE OF CONTENTS

---

<b>EXECUTIVE SUMMARY</b>	3
Overview of Results	3
<b>METHODOLOGY</b>	4
<b>PART 1 - BASELINE FACILITY DESCRIPTION</b>	7
General Information	7
Building Characteristics	8
Energy Performance Summary	10
Comparison of Similar Buildings	11
Metered Consumption Data	13
Systems Descriptions	14
<b>PART 2 – WALK THROUGH ANALYSIS</b>	16
Building Shell Characteristics	18
<b>PART 3 – BUILDING AND SYSTEMS REPORT</b>	20
Lighting System Characteristics	21
HVAC System Characteristics	22
Major Equipment Inventory	24
Energy Performance Target	25
<b>PART 4 – ENERGY ANALYSIS SUMMARY</b>	26
Component Energy Usage	27
Component Energy Usage, Figure 01	28
Recommended Energy Conservation Measures	29
Recommended Energy Conservation Measures, Figures 02, 03, 04	30
Electric Rate Options	31
<b>PART 5 – DETAILED RECOMMENDATIONS</b>	32
Detailed Findings & Recommendations	32-43
<b>APPENDICES</b>	
Appendix A, #373 Utility Rates.	
Appendix B, #732 Utility Rates	
Appendix C, Load Calculations – 384 Embarcadero (Baseline)	
Appendix D, Load Calculations – 140/160 Franklin (Baseline)	

## ***EXECUTIVE SUMMARY***

---

### **OVERVIEW OF RESULTS**

The owners of the properties at 140/160 Franklin, and the adjacent corner property at 384 Embarcadero commissioned 15000 Inc. to evaluate the buildings for potential savings in energy usage based upon criteria as discussed in the Methodology section of this report. Owner is Hamilton Zanze of San Francisco

In short, the building presents multiple energy savings opportunities with varying degrees of payback, return on investment and capital outlay. In general, it is recommended to perform the high priority, low capital improvement projects first. Each practical measure proposed is weighted for priority based upon capital expenditure versus net energy effect and Energy Usage Index. (EUI); The two distinct types of practical measures include;

#### **Operation and Maintenance Measures.**

Many of the operation and maintenance measures can be performed without additional cost to the tenant and should be implemented immediately. Items such as filter schedule changes and lighting control scenarios lead the list of non-capital items that will improve building performance.

#### **Capital Improvement Measures.**

Of the capital improvement measures, the higher capital cost items are the largest impact items such as changing of the compressor, boiler and pumping system for the 140/160 Franklin property.

# **METHODOLOGY**

---

## **GENERAL**

The ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) Level II energy audit was selected as the means of determining the potential savings while balancing initial capital expenditures. *(Procedures followed are ASHRAE's Procedures for performing Energy Audits prepared under ASHRAR Research Project RP-669 and ASHRAE Special Project SP-56 in cooperation with TC 7.6 Systems Energy Utilization)*

- **Level I, basic** — also known as the "one-day" or "walk-through" audit, this approach involves a cursory analysis of energy bills and a brief survey of the building to produce a rough estimate of how efficiently energy is used in the building. This level of effort will detect at least some of the "low-hanging fruit" and may suggest other options worthy of more study, but should never be viewed as comprehensive. Although this option is easiest it also produces the crudest results, so don't be tempted into thinking you're done once you do this much — you've really only gotten started.
- **Level II, intermediate** — by investing more effort in the building survey and energy analysis and by adding in some system performance testing, this method provides a breakdown of how energy is used in the building as well as a broader range of savings options, including simple capital investments. It accounts for the "people factor" and its effect on uncertainty of savings, and also explores maintenance procedures and assesses any impacts savings measures may have on them. Many facilities will find this level of analysis to be sufficient.
- **Level III, advanced** — also known as the "investment-grade audit", this analysis digs into the details of any large capital projects you may be considering as a result of previous, simpler audits. Even more detailed data is gathered from field equipment, extensive test measurements are taken which may include spot-measurements and short-term energy monitoring, possible risks are assessed, and intensive engineering and economic analysis produces reliable estimates of project energy and financial performance with the high confidence needed for major capital projects.

These audit approaches tend to overlap in practice. All three assess the potential energy savings and initial cost of various energy savings strategies, so in that sense all are similar. The differences are in your confidence that you've truly found all your savings opportunities, the accuracy of the expected savings and initial cost, and how much information you have about the difficulty of project implementation and the likely persistence of the savings over time. The devil is definitely in the details.

All level 2 and level 3 audits involve collecting general building data (location, size, usage type, energy sources), historical energy use data, and energy systems data (type of equipment in the envelope, lighting, HVAC, service water,

etc.) to get a description of the facility. The more detailed the available data is, the more complete this description can be. For example, sub-metering within a building makes it easy to call out specific end uses or facility areas, and having daily or even hourly consumption data allows you to call out time patterns normally buried within the monthly billing cycle.

All this data then feeds an energy use analysis that lays out how much energy is consumed for each major end use in the building, such as space heating, space cooling, lighting, air distribution, etc. This defines a baseline scenario for future years if no energy projects are undertaken. A similar analysis can be done with respect to peak energy demand.

The primary goal of the energy audit report is to identify sources of potential energy and cost savings throughout the building through optimization, replacement and to provide recommendations on capital and maintenance improvements.

## **INVESTIGATION & DATA COLLECTION**

The investigation for the report began in earnest at our first meeting on site and specifically with a visit to the building roof and occupied areas to evaluate the HVAC (Heating, Ventilating, and Air Conditioning) equipment.

Two separate follow up visits to the site were performed, each more in depth than the preceding beginning in December of 2008.

## **DOCUMENTATION REVIEW**

There are very little archive documents that provide an as-built condition for any of the building systems beyond that of general floor plan and exiting.

Documentation typically would be required for a higher threshold energy evaluation, but for the condition of the building and the system type, those documents likely would not be up to date considering the various piece-meal work that has been done throughout the building over the course of several years.

In addition, there has been a previous energy audit performed that does not coincide with the PG&E utility rates and bills provided by the Owner. Data is incomplete and DOES NOT INCLUDE the recommended three years of documentation of energy usage. The published data from the EPA Energy Star website was used in conjunction with the PG&E utility bills provided. It is believed the utility bills provided to our office are not an accurate reflection of energy use as they are abnormally low for an occupied building of this nature.

## **INITIAL SITE ASSESSMENT**

Following a review of the documentation, an initial site assessment was required. While trying not to disturb the tenants, we interviewed staff throughout all three buildings to determine if people “ran cool” or “ran warm”. The assessment

determined that there were not as many temperature control problems as would be expected, but most tenants in the 160 Franklin property “ran cool”.

### **MONITORING AND DATA LOGGING**

There was no monitoring and data logging for this assessment.

Manual testing of the Variable Air Volume (VAV) boxes at the 160/140 Franklin property was performed on a random selection of units. One unit was found to have a stuck damper actuator. In addition, one unit was found to have a non-functioning thermostat (2nd floor, vacant office space).

## ***PART 1 - BASELINE FACILITY DESCRIPTION***

---

### **GENERAL INFORMATION**

Although there are three separate property addresses, for means of continuity, we will be referring to all three buildings as the “Franklin Properties” while breaking down the components into “Franklin”, which represents 30,000 Square feet of occupied space and “Embarcadero” which occupies the balance of the space. (Approximately 15,000 square feet)

The use of the buildings are rather consistent from space to space. In general, the building is used as office space, with some clinical on the corner of Franklin and Embarcadero.

Glazing is general single pane store-front on ground levels and a mixed style of windows throughout the building above the ground level.

Basic construction is wood frame with steel throughout. The roof is a single ply vinyl roofing system with j-walk boards throughout to ease the impact of walking around.

General occupancy is 8:00 A.M. through 5:00 P.M. and throughout the building, there are roughly 160 occupants throughout by our best estimate. The density, considering the building is approximately 45,000 square feet is approximately 280 square foot per occupancy, low, by most office space standards.

### **FUNCTIONAL ANALYSIS**

Manual testing of the Variable Air Volume (VAV) boxes at the 160/140 Franklin property was performed on a random selection of units. One unit was found to have a stuck damper actuator. In addition, one unit was found to have a non-functioning thermostat (2nd floor, vacant office space).

**BUILDING CHARACTERISTICS**

Building ID: 140/160 Franklin (Embarcadero Annex)  
Date of Audit: December 15, 2008 with two follow up site visits.  
City/State/Zip: Oakland, CA 94607  
Lat: 37n48  
Long: 22w16  
Gross Floor Area: 45,781 Square Feet.  
Total Conditioned Area: 41,203 Square Feet.  
Conditioned Area,1 heated only: 0ft2  
Conditioned Area,1 cooled only: 0ft2  
Conditioned Area,1 heated & cooled: 41,203ft2  
Conditioned floors above grade: 3  
Conditioned floors below grade: 0  
Year of Construction2: 1910

Brief Building Description: 140/160 Franklin with the Embarcadero Annex is a property with three specific Assessor’s Parcel Numbers. 140 and 160 Franklin are conjoined with pass-through corridors and separate HVAC system for the building. The 384 Embarcadero Annex is a completely separate building with its own unique HVAC system, lighting, controls, utilities, etc.

---

**PRIMARY BUILDING TYPE**

- Office
  - 11  Owner Occupied
  - 12  Leased (1-5 Tenants)
  - 13  Leased (5+ Tenants)**
  - 19  Other—Define
- Hotel/Motel
  - 21  Motel (No Food)
  - 22  Hotel
  - 23  Hotel/Convention
  - 29  Other—Define
- Apartment
  - 31  General Occupancy
  - 32  Seniors Only
  - 39  Other—Define
- Education
  - 41  Primary
  - 42  Secondary
  - 43  University
  - 49  Other—Define
- Food Services
  - 51  Restaurant - Full Service
  - 52  Fast Food
  - 53  Take Out
  - 54  Lounge
  - 59  Other—Define
- Health Care
  - 61  Nursing Home
  - 62  Psychiatric
  - 63  Clinic
  - 64  Active Treatment Hospital
  - 69  Other—Define
- Retail
  - 71  Drycleaning
  - 72  Supermarket
  - 73  General Merchandise
  - 74  Shopping Mall Without Tenant Loads
  - 75  Shopping Mall Without Tenant Lighting Loads

140/160 Franklin – Oakland, CA

- |                         |                                     |
|-------------------------|-------------------------------------|
| 76 [ ] Shopping Mall    | 89 [ ] Other—Define                 |
| 77 [ ] Specialty Shop   | Other                               |
| 78 [ ] Bakery           | 91 [ ] Laboratory                   |
| 79 [ ] Other—Define     | 92 [ ] Warehouse                    |
| Assembly                | 93 [ ] Warehouse—Refrigerated       |
| 81 [ ] Theatre          | 94 [ ] Recreation/Athletic Facility |
| 82 [ ] Museum/Gallery   | 95 [ ] Jail                         |
| 83 [ ] Church/Synagogue | 96 [ ] Transport Terminal           |
| 84 [ ] Arena/Gym        | 97 [ ] Multi-Use. Complex           |
| 85 [ ] Arena/Rink       | 99 [ ] Other—Define                 |

1. GROSS FLOOR AREA is all floor area contained within the outside finished surface of permanent outer building walls including basements, mechanical equipment floors, and penthouses (*ANSI Standard Z65.1-1980, Construction Area*). No exclusions are made for shafts, stairs, or atria. CONDITIONED AREA is that area provided with heating or cooling to maintain temperature between 50°F and 86°F (*ANSI/ASHRAE Standard 105-1984*).
2. THE MEDIAN YEAR for construction of at least 51% of the conditioned space.
3. BUILDING TYPE as characterized by at least 51% of the conditioned space.

**ENERGY PERFORMANCE SUMMARY (2008)**

This is a summary of energy account worksheets on succeeding pages.

ENERGY TYPE	TOTAL ANNUAL USE	UNITS	CONVERSION MULTIPLIER To Thousands Btu See Page 17	THOUSANDS BTU (kBtu)	TOTAL ANNUAL COST (\$)
ELECTRICITY	464,224	Kwh	3.41	1,583,004	\$69,633
NATURAL GAS	302,602	Kwh	3.41	1,031,874	\$45,390
PURCHASED STEAM	0	0	0	0	0
PURCHASED HOT WATER	0	0	0	0	0
PURCHASED CHILLED WATER	0	0	0	0	0
OIL # _____	0	0	0	0	0
PROPANE	0	0	0	0	0
COAL	0	0	0	0	0
OTHER	0	0	0	0	0
	766,826	Kwh		<b>A 2,614,878</b>	<b>B \$115,023</b>

**ENERGY AND COST INDICES**

Energy Utilization Index (A ÷ Gross Floor Area) 57.11 kBtu/ft2/yr

Cost Index (B ÷ Gross Floor Area) 2.51 \$/ft2/yr

**ANALYSIS OF METERED ELECTRICAL DEMAND**

Maximum Demand 54,400 kW per month

Maximum Demand 54,000 kW × 1000 ÷ Gross Floor Area = 1,188.3 W/ft2

Minimum Demand 36,400 kW per month

Minimum Demand 30,400 kW × 1000 ÷ Gross Floor Area = 664.0 W/ft2

## COMPARISON WITH SIMILAR BUILDING(S)

	EUI kBtu/ft <sup>2</sup> /yr	Annual Cost \$/ft <sup>2</sup> /yr	Max. Dem W/ft <sup>2</sup>	Min. Demand W/ft <sup>2</sup>
THIS BUILDING (ID# 140/160 F):	52	\$24.93	1,188.3	795.1
COMPARISON BUILDING/DATABASE <sup>1</sup> :	82	\$64.14	1,865.2	1,248.3

Comparative data is derived from CEC 2003, Raw Data files of Commercial Building Energy Consumption Survey, U.S. Department of Energy Information Administration, and local utility data. The national average for EUI energy utilization index is 84. (Source is Environmental Protection Agency, latest published data)

Further analysis recommended? **Yes.**

There are anomalies in data that has been provided between previously published reports and local utility bills. Also, there is an extrapolated gap in the utility data and the recommended three years of annualized energy usage has not been provided by the building owner.

**PRELIMINARY BUILDING USE**

Average Hours/Week 65    Average Weeks/Year 52

Average Number of Occupants During Normal Occupied Period, 95

After Hours Cleaning, Y

**OVERALL BUILDING SCHEDULE**

Schedule during months of January through December

Days	M	T	W	Th	F	Sat	Sun	Hol.
Hours Open	12	12	12	12	12	5	0	0
Hours Closed	12	12	12	12	12	19	24	24
Peak no. of occupants	95	95	95	95	75	25	0	0
Avg. no. of occupants when open	65	65	65	65	65	25	0	0

1. Usage for at least 51% of the conditioned space.

**PRELIMINARY ENERGY ALLOCATION TO END USES**

Energy Type (from energy performance summary)

End Use	Primary	Secondary (more than 5%)
Heating	Natural Gas	Electricity
Cooling	Electricity	None
Domestic Water	Electricity	None

**METERED CONSUMPTION MONTHLY DATA: (2008)**

Utility Company, PG&E Account #7603103035 & 9941434866 Rate Number, A1

Energy Type, Electric Consumption Units, 1,000s of Kw.

Electric Measured Demand Units<sup>2</sup> NA

METERING PERIOD DAY/MONTH / YEAR			CONSUMPTION	"E" IF ESTIMATE	ELECTRICITY ONLY		C O S T <sup>3</sup>		
From	To	# of days			Measured Demand	Billed Demand	Consumption \$	Demand \$	Total \$
1		31		E	30400	68	\$4,864	NA	
2		28		E	31528	68	\$5,044	NA	
3		28		E	31528	72	\$5,044	NA	
4		31		E	36400	72	\$5,824	NA	
5		31		E	37690	80	\$6,030	NA	
6		35		E	51070	80	\$8,171	NA	
7		28		E	54200	80	\$8,672	NA	
8		32		E	54400	80	\$8,704	NA	
9		29		E	38680	80	\$5,824	NA	
10		29		E	36400	72	\$5,824	NA	
11		33		E	31528	68	\$5,044	NA	
12		30		E	30400	68	\$4,864	NA	
Total									

1. CCF, therms, kWh, gal, etc.

2. kW, kVA, etc.

3. Costs should include taxes, fees, contract charges, etc.

## **HVAC SYSTEMS**

There are two distinct HVAC system for the project. The 160/140 Franklin portion of the building (approximately 30,000 square feet) is served by a built-up central air handling system with 100% economizer function, return fan, supply fan, filter bank, closed circuit cooler, compressor and boiler.

### **Cooling**

Franklin: The cooling system is a built-up refrigerant system with compressor, closed circuit cooler, full hot-gas bypass and main Direct Expansion (DX) coil at the rooftop air handling system.

Embarcadero: The cooling system is a part of the low tonnage rooftop heat pump Air Conditioning Units (ACU) that serve that building.

### **Heating**

Franklin: Heating is VAV reheat with a pre-heating coil located in the main rooftop air handling system with a central boiler and primary pumping system. (Natural gas fired)

Embarcadero: The heating system is a part of the low tonnage rooftop heat pump Air Conditioning Units (ACU) that serve that building.

### **Fans**

Franklin: The central air handling system is a built-up style with supply and return fan of original vintage.

Embarcadero: The fan system is a part of the low tonnage rooftop package Air Conditioning Units (ACU) that serve that building.

### **HVAC Controls**

Franklin: There is an existing Direct Digital Control System (DDCS) for the entire building (LonMark based) with independent controls for 32 VAV zones.

Embarcadero: All units are controlled by programmable thermostat.

## **ELECTRICAL SYSTEMS**

### **Interior Lighting**

Interior lighting is switch driven with limited occupancy sensors for some common/public areas such as shared unisex restrooms.

### **Exterior Lighting**

Exterior lighting is installed at a minimum level, and there is no apparent “spillage” of wasted lighting upon personal observation.

### **Lighting Controls**

Lighting is not interlocked into the DDC system. Each zone/circuit is independently controlled by its own switch. There is no current dual-switching or day-lighting controls.

### **Miscellaneous Electrical Systems**

The domestic water heating system throughout the buildings are driven by electric, near-point-of-use water heaters.

## **FOSSIL FUEL SYSTEMS**

### **Domestic Hot Water**

Upon field investigation it appears that fossil fuels only drive the heating portions of the building as the Franklin property is served by natural gas at the boiler located on the roof and the Embarcadero property has multiple gas-fired pieces of equipment (ACUs) located on its roof.

### **Miscellaneous Fossil Fuel Systems**

No addition fossil fuel systems were observed.

## **OPERATIONS & MAINTENANCE PROCEDURES**

There are no current documented operation and maintenance procedures. Visual inspection of the central plant equipment showed differing dates on filter replacement,

## **ENERGY UTILIZATION**

The properties, according to projects and Energy Pro calculations utilize in excess of 400,000 Kwh annually, translating to an electrical energy cost of nearly \$30,000. The gas usage is significantly lower than the existing electrical usage.

## ***PART 2 – WALK THROUGH ANALYSIS***

---

### **GENERAL**

#### **SPACE FUNCTION AND SYSTEM SUMMARY**

<b>SPACE NUMBER<sup>1</sup></b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>UNACCOUNTED</b>
FUNCTION TYPE <sup>2</sup>	2	4	13	21	22	26	
CONDITIONED AREA, ft <sup>2</sup>	2290	1500	1750	2100	1850	36291	
SPACE USAGE <sup>3</sup>							
h/wk	65	65	65	65	65	65	
wks/yr	52	52	52	52	52	52	
PRINCIPAL LIGHTING TYPE	1	1	1	1	1	1	
PRINCIPAL TERMINAL HVAC TYPE	33	33	33	33	33	33/37	(Two systems)

#### **REVISIONS TO ORIGINAL BUILDING FUNCTIONS**

The buildings, being constructed in the early parts of the 1900's, do not have their existing lighting, electrical, HVAC or utility locations. Through the course of the last 100 years, multiple upgrades have been performed.

Beyond the recent Direct Digital Control upgrade in the last ten years, the previous changes to the building appear to have been made more than twenty-five years ago.

## FUNCTION TYPES

Auditorium  
1 Auditorium

Corridor

**2 Corridor**

Classroom/Lecture Hall  
3 Classroom/Lecture

Hall

Electrical/Mechanical

Equipment Room

**4 General**

5 Control Room

Food Service

6 Fast Food/Cafeteria

7 Leisure Dining

8 Bar/Lounge

9 Kitchen

Recreation/Lounge

10 Recreational/Lounge

Stair

11 Active Traffic

12 Emergency Exit

Toilet and Washroom

**13 Toilet and Washroom**

Garage

14 Auto and Pedestrian

Circulation

15 Parking Area

Laboratory

16 Laboratory

Library

17 Audio Visual

18 Stack Area

19 Card Filing &

Cataloging

20 Reading Area

Lobby (General)

**21 Reception and**

**Waiting**

**22 Elevator Lobbies**

**Atrium (Multi-Story)**

23 First Three Floors

24 Each Additional Floor

Locker Room and Shower

25 Locker Room and Shower

Offices (Partitions > 4.5 ft below ceiling) open plan offices without partitions or with partitions more than 4.5 ft below the ceiling. Offices < 900 ft<sup>2</sup>.

**26 Reading, Typing and Filing**

27 Drafting

28 Accounting

Offices (Partitions 3.5 - 4.5 ft below ceiling) Open plan offices > 900 ft<sup>2</sup> with partitions 3.5 to 4.5 ft below the ceiling.

29 Reading, Typing and Filing

30 Drafting

31 Accounting

- 
1. Separate zones with at least 10% of conditioned space.
  2. Major space function types.
  3. See detailed usage schedule.
- 

## HVAC TYPES

30 Single Zone

31 Multi Zone

32 Dual Duct

33 Variable Air Volume

34 Reheat

35 Fan Coil Units

36 Unit Ventilators

37 Packaged Terminal Air Conditioner

38 Steam/Hot Water

Radiator/Convactor

39 Above system(s) w/Economizer

## LIGHTING TYPES

1 Fluorescent

2 Incandescent

3 Mercury Vapor

4 Sodium

5 Metal Halide

6 Other

## **BUILDING SHELL CHARACTERISTICS**

- Total exposed above-grade wall area (ft<sup>2</sup>) 16,955
- Insulated? Yes
- Glazing area (% of exposed wall area) 2,768
- Glazing type: Single
- Roof area (ft<sup>2</sup>) 13,379
- Insulated? Yes
- Floor surface area exposed to outdoor conditions: 0
- Insulated? Yes
- Above-grade wall area common with other conditioned building 1,578 (ft<sup>2</sup>)

## **OPERATION and MAINTENANCE**

Discuss/describe operation and maintenance procedures pertaining to building energy efficiency.

The building is currently bisected in an approximately 1/3 vs. 2/3 fashion between the Embarcadero and Franklin properties. The Embarcadero property is served by programmable thermostats while there is an existing (although recently refurbished) direct digital control system for the Franklin property.

According to meetings and discussion with the Owner and the Owner's representative, there is no on site control available for the DDC system.

**LIGHTING SYSTEMS DATA**

- Average installed load including ballast in more than 51%:  
1.3W/ft<sup>2</sup> of occupied space
- Switches Accessible to more than 51% of occupants.  
No.
- Special Automatic Controls?  
No.

Major Lighting Types 1 = Fluorescent 2 = Incandescent 3 = Mercury Vapor 4 = Sodium 5 = Metal Halide 6 = Other	% of Occupied Area
1	100%

**UNOCCUPIED SETBACK**

**Shutdown of:**

- AHUs by Time Schedule \_\_\_\_\_x\_\_\_\_\_
- Exhaust Fans by Time Schedule \_\_\_\_\_x\_\_\_\_\_
- Chillers:
- By Time Schedule \_\_\_\_\_x\_\_\_\_\_
- By Outside Air Temperature \_\_\_\_\_n\_\_\_\_\_
- Boilers
- By Time Schedule \_\_\_\_\_x\_\_\_\_\_
- By Outside Air Temperature \_\_\_\_\_n\_\_\_\_\_

## ***PART 3 – BUILDING & SYSTEMS REPORT***

### **ENVELOPE CHARACTERISTICS**

Building ID 140/160 Franklin (Embarcadero Annex)

Date of Audit Month Dec/Jan Year 2008/09

Construction Code	R-Value	Glass Shading Coefficient	Area (ft <sup>2</sup> )
W1	R-9	NA	16,955.0
D3	R-0	NA	126.0
D5	R-0	NA	104.0
R2	R-11	NA	13,379.0
G11	0.00	0.80	2,768.0
G12 / Skylight	0.00	0.80	80.0

### **CONSTRUCTION TYPE CODES**

#### **Walls**

W0 = Other \_\_\_\_\_  
 W1 = Wood  
 W2 = Masonry  
 W3 = Concrete, Above Grade  
 W4 = Concrete, Below Grade  
 W5 = Metal  
 W6 = Stone  
 W7 = Glass  
 W8 = Adjacent Building

#### **Doors**

D0 = Other \_\_\_\_\_  
 D1 = Solid Wood  
 D2 = Hollow Wood  
 D3 = Uninsulated Metal  
 D4 = Metal, Insulated Core  
 D5 = Glass (<85%)

#### **Roofs**

R0 = Other \_\_\_\_\_  
 R1 = Concrete Deck  
 R2 = Wood Deck  
 R3 = Metal Deck

#### **Windows**

Sash Type  
 G0 = Other \_\_\_\_\_  
 Fixed, Wood Sash:  
 G11 = Single Glaze  
 G21 = Double Glaze  
 Operable, Wood Sash:  
 G12 = Single Glaze  
 G22 = Double Glaze  
 Fixed, Metal Sash:  
 G13 = Single Glaze  
 G23 = Double Glaze  
 Operable, Metal Sash:  
 G14 = Single Glaze  
 G24 = Double Glaze

## LIGHTING SYSTEM CHARACTERISTICS

Describe in Detail, Utilize space function format.		
x	Typical W/ft <sup>2</sup>	1.3 • Operating schedules: None
•x	Design of controls	None • Operating and maintenance problems: None.
•x	Typical W/ft <sup>2</sup> installed, by type of light source: Fluorescent, 1.3 W/ft <sup>2</sup>	
•x	Light levels, footcandles, 3 feet above floor, without daylight: Not measured.	
•x	% of lamps not functioning: 0% Noted, unlikely.	

Typical lighting power density existing in all spaces is approximately 1.3 W/ft<sup>2</sup>. (Source: Energy Pro v4, typical assembly lighting levels for office buildings, ASHRAE Fundamentals, 2006)

California Energy Commission, Title 24 requirements for office space is 1.1 W/ft<sup>2</sup> lighting power density, not accounting for task lighting. Expectation of 20% below Title 24 lighting is common and should be used as a benchmark for future lighting levels. (0.88 W/ft<sup>2</sup> target)

There are limited occupancy sensors throughout the building, no de-lamping has occurred and there are no day-lighting controls. Through visual inspection all lighting appeared to be functioning.

**HVAC SYSTEM CHARACTERISTICS, Franklin (2/3)\***

Describe in detail.	
x Fuel Source	•x Control Description and Setting
• Fuel Conversion Equipment	•x Operating Periods
x Distribution Method	•x Space Temperature Setting and Setback
x Terminal Type	•x Operating and Maintenance Problems
x Equipment Capacity	

**Heating System (Gas fuel source)**

Heat system is provided through atmospheric, roof-mounted, boiler with single heating hot water coil to main air handler (AH-1) with VAV reheat. Capacity is 1.3 MBH input. All piping is installed on the roof.

**Cooling System (Electric source)**

Cooling system is provided through a built-up direct expansion system, BAC V1-120 closed circuit cooler and compressor (nameplate data unavailable, Kw rating and closed circuit cooler suggest 80 tons of cooling capacity, 960,000 BTUH).

**Air System(s)**

Built-up central air handler (AH-1) w/ variable speed drive on supply fan. There is a pre-set operation schedule through the DDC. There are no documented sequence of operation and control is not possible on site and must be done remotely.

There are no documented operating or maintenance problems.

\* Refer to appendix for breakdown of floor area.

## HVAC SYSTEM CHARACTERISTICS, Embarcadero (1/3)\*

Describe in detail.	
x Fuel Source	•x Control Description and Setting
• Fuel Conversion Equipment	•x Operating Periods
x Distribution Method	•x Space Temperature Setting and Setback
x Terminal Type	•x Operating and Maintenance Problems
x Equipment Capacity	

### Heating System (Electric source)

Heating is through heat pump operation through rooftop package units. 10 in total. – Refer to appendix for inventory of heat pumps and model numbers/capacity.

### Cooling System (Electric source)

Cooling is through heat pump operation through rooftop package units. 10 in total. – Refer to appendix for inventory of heat pumps and model numbers/capacity.

### Air System(s)

Air delivery is through heat pump operation through rooftop package units. 10 in total. – Refer to appendix for inventory of heat pumps and model numbers/capacity.

There are no documented operating or maintenance problems. Each unit is single zone, connected to a programmable thermostat.

\* Refer to appendix for breakdown of floor area.

**INVENTORY OF MAJOR HVAC EQUIPMENT**

Designation	Location	Model/ Type	Size	Capacity	Serves	Operating Hours/Year	Remarks
AH-1	Roof	Built Up	28,000 CFM	28,000 CFM	Franklin	3380	
VAV-1*	Various	NA	Various	Various	Franklin	3380	
B-1	Roof	Atmospheric	NA	1.3 MBH	Franklin	2870	
CM-1	Roof		NA	80 Ton	Franklin	2340	
CCC-1	Roof	BAC-V1	NA		Franklin	2340	
P-1	Roof	NA	NA	104 GPM	Franklin	2340	
HP-1/10	Roof	Various	NA	48 Tons	Emb.	3380	Combined.

\* Thirty two VAV units in total in Franklin property. Not individually noted.

**DOMESTIC HOT WATER SYSTEM CHARACTERISTICS**

Domestic hot water system is electric sourced, point of use storage type located at various locations through each building. Inventory on water heater system was not included. Only 1 per floor was noted for the Franklin property.

## ENERGY PERFORMANCE TARGET

This is a summary of energy account worksheets on succeeding pages.

ENERGY TYPE	TOTAL ANNUAL USE	UNITS	CONVERSION MULTIPLIER To Thousands Btu See Page 17	THOUSANDS BTU (kBtu)	TOTAL ANNUAL COST (\$)
ELECTRICITY	255,549	Kwh	3.41	871,425	\$40,887
NATURAL GAS	181,207	Kwh	3.41	617,917	\$28,993
PURCHASED STEAM	0	0	0	0	0
PURCHASED HOT WATER	0	0	0	0	0
PURCHASED CHILLED WATER	0	0	0	0	0
OIL # _____	0	0	0	0	0
PROPANE	0	0	0	0	0
COAL	0	0	0	0	0
OTHER	0	0	0	0	0
	436,756	Kwh		<b>A 1,489,342</b>	<b>B \$69,880</b>

## ENERGY AND COST INDICES

Energy Utilization Index (A ÷ Gross Floor Area) 32.53 kBtu/ft<sup>2</sup>/yr

Cost Index (B ÷ Gross Floor Area) 1.53 \$/ft<sup>2</sup>/yr

## ANALYSIS OF METERED ELECTRICAL DEMAND

Maximum Demand 33,728 kW per month

Maximum Demand 33,728 kW × 1000 ÷ Gross Floor Area = 736.7 W/ft<sup>2</sup>

Minimum Demand 22,568 kW per month

Minimum Demand 22,568 kW × 1000 ÷ Gross Floor Area = 492.9 W/ft<sup>2</sup>

1. Source: Energy Pro, DOE-2 energy simulation model for typical building load at current envelope conditions. Refer to appendix for included energy simulation model results.

## ***PART 4 – ENERGY ANALYSIS SUMMARY***

### **ENERGY ANALYSIS SUMMARY**

Building ID 140/160 Franklin (Embarcadero Annex)

Date of Audit Month Dec/Jan Year 2008/09

		kBtu ft <sup>2</sup> /yr	\$/ft <sup>2</sup> /yr	\$/yr
Actual Use	A	57.11	\$2.51	\$115,023
Target <sup>1</sup>	B	32.53	\$1.53	\$69,880
“Technical” Potential Savings	C (A-B)	24.58	\$0.98	\$45,143
Savings from Measures Recommended for Implementation (see following/attached)	D	12.29	\$0.49	\$22,572
Remaining Technical Potential Savings to be Defined	E (C-D)	12.29	\$0.49	\$22,571
Realistically Achievable Potential Savings still to be Defined	F	0	0	0
Total Achievable Savings	(D+F)	12.29	\$0.49	\$22,571

Cost of Next Stage in Analysis \$ 12,350 (G)

Cost of Measures Recommended (D) \$ See Attached (H)

Cost to Implement Potential Savings Still to be Defined (F) \$ 140,200 (I)

Total Implementation Cost (G+H+I) \$ 152,550

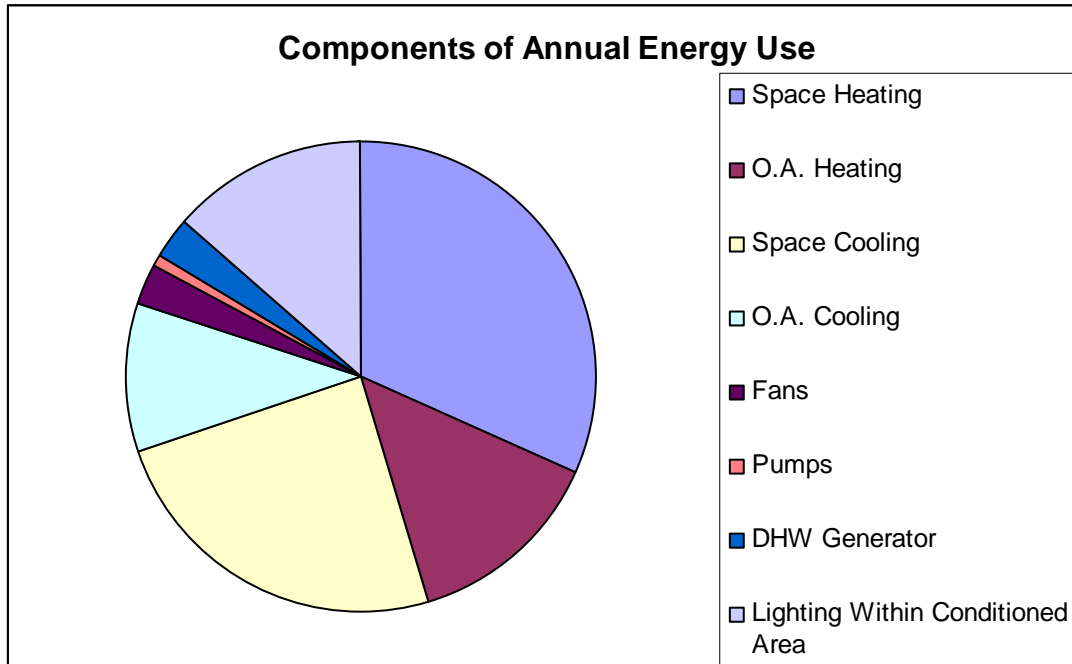
---

1. Source: Energy Pro, DOE-2 energy simulation model for typical building load at current envelope conditions. Refer to appendix for included energy simulation model results.

**COMPONENTS OF ANNUAL ENERGY USE**

	Electricity		Fuel	Other	Total	% of Total	Total	% of Total
	kWh	kBtu	kBtu	kBtu	kBtu	Use	Cost	Cost
Space Heating	32.0	109.2	721.7	0	830.9	31.8%	\$36,577	31.8%
O.A. Heating	13.7	46.8	309.3	0	356.1	13.6%	\$15,643	13.6%
Space Cooling	186.1	634.6	0	0	634.6	24.1%	\$27,722	24.1%
O.A. Cooling	79.8	272	0	0	272	10.4%	\$11,962	10.4%
Fans	20.2	68.8	0	0	68.8	2.6%	\$2,991	2.6%
Pumps	6.9	23.5	0	0	23.5	0.9%	\$1,035	0.9%
DHW Generator	22.1	75.5	0	0	75.5	3.1%	\$3,565	3.1%
Lighting Within Conditioned Area	103.4	352.6	0	0	352.6	13.5%	\$15,528	13.5%
Outside Conditioned Area								
Receptacles								
Kitchen								
Laundry								
Central Computer								
Conveyance								
Laboratory Equipment								
Other (describe)								
Unaccounted								
<b>TOTAL</b>	<b>464.2</b>	<b>1,583</b>	<b>1,031</b>		<b>2,614</b>	<b>100%</b>	<b>\$115,023</b>	<b>100%</b>

**FIGURE 01: COMPONENTS OF ANNUAL ENERGY USE**



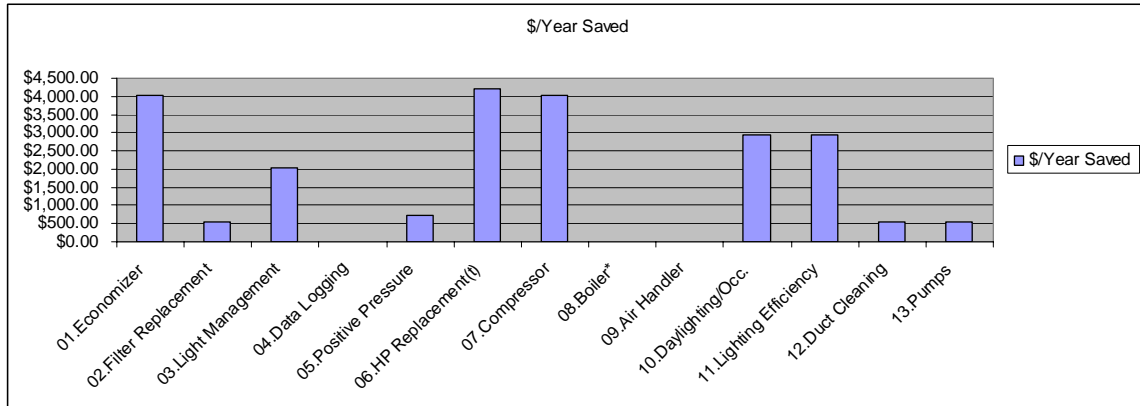
**RECOMMENDED ENERGY CONSERVATION MEASURES**

Measure Description	Energy Type(s)	Units Saved	\$/Year Saved	Implementation Cost	Extra Oper + Maint Cost	Simple Payback (Years)
01.Economizer	kBtu/ft2	2.20	\$4040.3	\$0.00	\$0.00	0.0
02.Filter Replacement	kBtu/ft2	0.30	\$551.0	\$0.00	\$500.00	0.9
03.Light Management	kBtu/ft2	1.10	\$2,020.2	\$0.00	\$500.00	0.25
04.Data Logging	kBtu/ft2	0.00	\$0.00	\$0.00	\$500.00	NA
05.Positive Pressure	kBtu/ft2	0.40	\$734.6	\$500.00	\$0.00	0.67
06.HP Replacement <sup>(t)</sup>	kBtu/ft2	2.29	\$4,205.8	\$60,000.00	\$0.00	14.26
07.Compressor	kBtu/ft2	2.20	\$4,040.3	\$15,000.00	\$0.00	3.71
08.Boiler*	kBtu/ft2	0.00	\$0.00	\$20,000.00	\$0.00	3.11
09.Air Handler	kBtu/ft2	0.00	\$0.00	\$6,000.00	\$0.00	NA
10.Daylighting/Occ.	kBtu/ft2	1.60	\$2,938.4	\$35,000.00	\$0.00	11.9
11.Lighting Efficiency	kBtu/ft2	1.60	\$2,938.4	\$0.00	\$2,500.00	0.85
12.Duct Cleaning	kBtu/ft2	0.30	\$551.0	\$1,200.00	\$0.00	2.18
13.Pump	kBtu/ft2	0.30	\$551.0	\$2,500.00	\$0.00	4.54
Total if all measures implemented		12.29	\$22,571	\$140,200.00	\$4,000.00	6.21

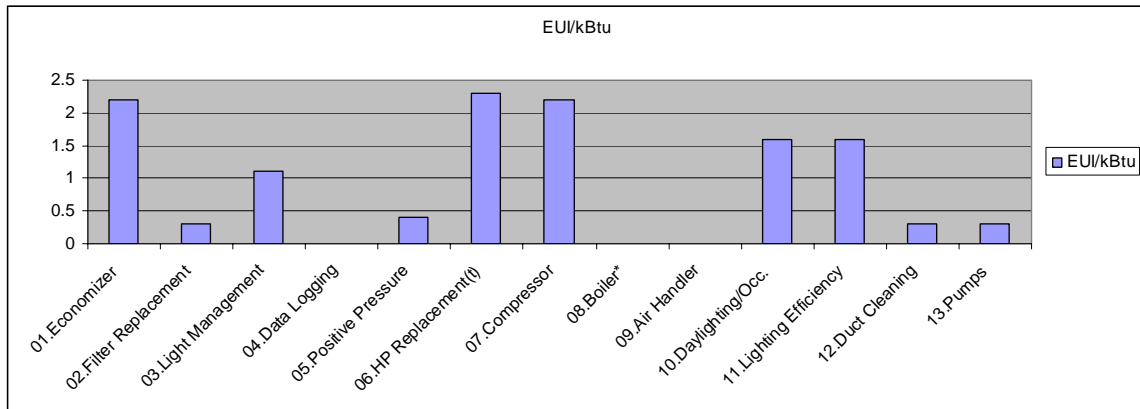
\* kBtu value is not included in the EUI figures shown here. Estimated kBtu savings is 3.5 and annual savings is \$6,427.3

(t) Replacement is for only eight of the 10 rooftop HP units.

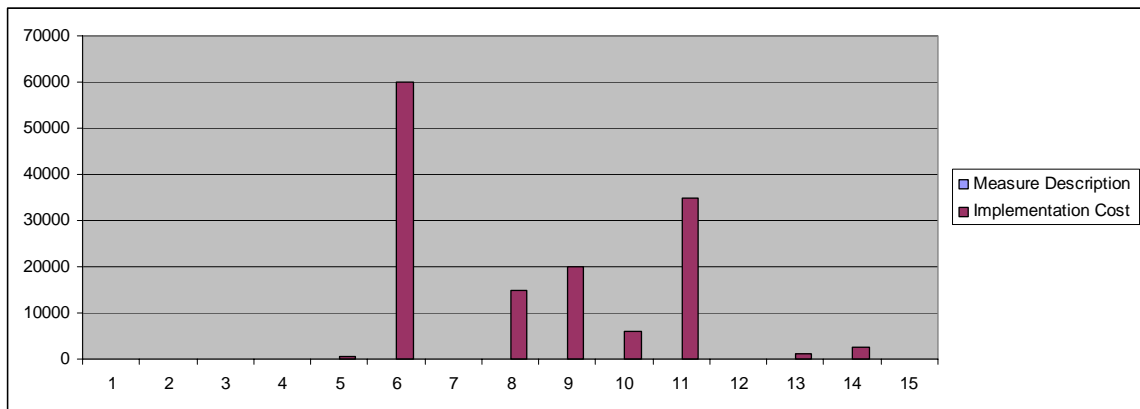
**FIGURE 02: COST SAVINGS BY PRACTICAL MEASURE**



**FIGURE 03: EUI SAVINGS BY PRACTICAL MEASURE**



**FIGURE 04: IMPLEMENTATION COST BY PRACTICAL MEASURE**



## **FURTHER ANALYSIS**

We have previously provided proposed energy usage for modifications to the heat pump units on 384 Embarcadero. However, detailed analysis of proposed energy usage for alternate systems is not included as a part of this report.

## **PRACTICAL MEASURES TO NOT PERFORM**

After review of the energy usage, it is not recommended to replace the air handling system on the Franklin property as the proposed EUI savings does not justify the capital outlay.

## **ELECTRIC RATE OPTIONS**

There are a number of utility rate options available for this property according to PG&E's recommendations. The current rate service for this property is A-1, Small General Service which includes a customer charge and an energy charge that varies by season.

Available options include;

A-10 Medium General Demand-Metered Service. This rate schedule is an option for customers with monthly demand usage under 500 kilowatts (kW). It includes a higher customer charge than A-1, a lower energy charge than A-1 (which also varies by season) and an additional charge for demand (measured in kW). Not available for this property.

A-10 TOU Medium General Service TOU Service. This rate schedule is an option for customers with monthly demand usage under 500 kilowatts (kW). It includes a higher customer charge than A-1, a lower energy charge than A-1 (which also varies by season and according to the time of day electricity is used) and an additional charge for demand (measured in kW). Customers must have an interval meter to participate.

E-19V Medium General Demand-Metered TOU Service, Voluntary Provisions. The voluntary E-19 rate also varies by season and according to the time of day electricity is used. It includes a higher customer charge than A-6, lower energy charges than A-6 and an additional charge for demand (kW).

## **UTILITY RATE RECOMMENDATIONS**

PG&E, the utility service provider will perform a courtesy rate analysis and provide proposed changes if recommended. They can be contacted at 1 (800) 468-4743.

## ***PART 5 – DETAILED RECOMMENDATIONS***

---

### **GENERAL**

#### **01. ECONOMIZER CONTROLS TO BE OPTIMIZED**

**Finding Description:** It was discovered during the site visit that the physical components of the economizer system and controls for the central plant located atop 140/160 Franklin do not function properly.

**General Finding Impacts**

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	Yes
Demand Savings:	Yes
Comfort:	Yes
Maintenance and reliability:	Yes

**Recommendation:** It is recommended that the control dampers for the economizer be replaced (actuators appear to be fine) and the program verified through the DDC for proper economizer operation. While on site, the weather conditions suggested a perfect economizer operation situation and the controls/dampers were non-functional.

**Implementation Plan:** Contractor shall replace existing dampers and coordinate DDC program amendments with controls contractor.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	No
Significant capital expenditure to implement:	No
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate

## 02. PROPER FILTER MAINTENANCE

**Finding Description:** It was discovered during the site visit that the maintenance of the central filtration bank at the built-up AHU on 140/160 Franklin had been performed. Inspection of the filter banks at the individual ACUs was not confirmed. Assumption is filtration is off schedule

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	Yes
Demand Savings:	No
Comfort:	No
Maintenance and reliability:	Yes

**Recommendation:** It is recommended that the filters be replaced on a documented schedule in order to reduce fan static pressure loss and electrical use.

**Implementation Plan:** Owner shall replace filters on a documented schedule.

Further investigation required by 15000 Inc. under current scope:	NO
Further engineering needed outside current scope:	NO
Significant capital expenditure to implement:	NO
Further investigation/testing required of the owner:	NO
Savings calculation method:	Spreadsheet

### 03. LIGHTING MANAGEMENT

**Finding Description:** Many lights during normal business operation are being left on within none occupied and shared spaces.

**General Finding Impacts**

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	No
Demand Savings:	Yes
Comfort:	No
Maintenance and reliability:	Yes

**Recommendation:** It is recommended that the building occupants be provided a lighting control schedule with a reminder to eliminate lighting during occupied hours.

In addition the DDC system shall be programmed for lighting override. It appears that this may be occurring at the moment.

**Implementation Plan:** Owner shall create a documented lighting control schedule for tenants and confirm that the lighting schedule is confirmed with the DDCs.

Further investigation required by 15000 Inc. under current scope:	NO
Further engineering needed outside current scope:	NO
Significant capital expenditure to implement:	NO
Further investigation/testing required of the owner:	NO
Savings calculation method:	Estimate

## 04. DATA LOGGING

**Finding Description:** There is no current Measurement and Verification plan enacted for the site's energy usage as a whole.

### General Finding Impacts

Energy Savings:	No
Natural Gas Savings:	No
Indoor Air Quality:	No
Demand Savings:	No
Comfort:	No
Maintenance and reliability:	No

**Recommendation:** It is recommended that the control contractor begin logging energy usage per building, and preferably per system.

Limited sub-metering could be installed to determine the effectiveness of the heating/cooling systems in addition to lighting systems.

**Implementation Plan:** Owner shall coordinate with controls contractor to begin preliminary implementation of M&V plan.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	No
Significant capital expenditure to implement:	No
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate

## 05. BUILDING PRESSURIZATION

**Finding Description:** During the investigation it became evident that the building was excessively positively pressured resulting in a large loss of heating and cooling depending on the season.

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	Yes
Indoor Air Quality:	No
Demand Savings:	Yes
Comfort:	Yes
Maintenance and reliability:	Yes

**Recommendation:** It is recommended that the building fans for 140/160 Franklin be replaced as a general replacement with the accompanying air handling unit and be replaced with a unit compatible with variable speed frequency drives.

**Implementation Plan:** Owner should retain a mechanical engineering firm to redesign a new rooftop air handling system to replace the existing one completely.

All work will be performed by an HVAC contractor.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	Yes
Significant capital expenditure to implement:	Yes
Further investigation/testing required of the owner:	Yes
Savings calculation method:	Estimate

## 06. HEAT PUMP REPLACEMENT

**Finding Description:** Eight of the ten rooftop heat pump units on top of the 384 Embarcadero Annex are in need of replacement as they have been installed decades ago and have run through their effective lifespan. Each unit utilizes R-22 refrigerant which is slated for obsolescence in 2020.

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	Yes
Indoor Air Quality:	Yes
Demand Savings:	Yes
Comfort:	Yes
Maintenance and reliability:	Yes

**Recommendation:** While this is a high capital impact item, it is also one of the largest potential energy savings for the property.

**Implementation Plan:** Owner should employ an engineering firm to redesign new rooftop package units for the Embarcadero Annex.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	Yes
Significant capital expenditure to implement:	Yes
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate

## 07. COMPRESSOR REPLACEMENT

**Finding Description:** The original compressor for the 140/160 Franklin properties is still installed within the housing on the roof. All nameplate data has subsequently eroded away, and while the closed circuit cooler has been replaced, the original compressor remains. In addition, the maintenance appears to be negligent on this piece of equipment and the entire building's energy performance would improve significantly with a replacement.

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	No
Demand Savings:	No
Comfort:	Yes
Maintenance and reliability:	Yes

**Recommendation:** Leave the existing housing, and replace the existing compressor in addition to insulating the existing hot-gas bypass for the refrigeration system.

**Implementation Plan:** Owner shall coordinate with controls contractor to begin preliminary implementation of M&V plan.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	Yes
Significant capital expenditure to implement:	Yes
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate

## 08. BOILER REPLACEMENT

**Finding Description:** The existing rooftop boiler located on top of 140/160 Franklin is in dire need of replacement. Over time, the original 80% efficient boiler is likely (estimate only) to be operating at near 60% capacity while technology exists to operate upwards of 93% thermal efficiency.

### General Finding Impacts

Energy Savings:	No
Natural Gas Savings:	No
Indoor Air Quality:	No
Demand Savings:	No
Comfort:	No
Maintenance and reliability:	No

**Recommendation:** Replacement of entire boiler and pumping system. The pump itself has already failed and is spilling heated water onto the roof corroding the roof and potentially leading towards permanent building damage. Reliability of the heating system is very low.

**Implementation Plan:** Owner shall implement design documents to schedule the replacement of the boiler and pumping system.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	Yes
Significant capital expenditure to implement:	Yes
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate

## 09. AIR HANDLER REPLACEMENT

**Finding Description:** The existing air handling system for 140/160 Franklin is antiquated and dated to the original building specifications. Air leaks, old coils and general equipment inefficiencies make replacement of the air handling system a priority. The energy savings aren't as great alone as the energy savings have been documented in other measures such as boiler, compressor, etc.

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	Yes
Demand Savings:	No
Comfort:	Yes
Maintenance and reliability:	Yes

**Recommendation:** It is recommended that the owner replace the existing air handling system. See previous strategies for scopes of work.

**Implementation Plan:** Owner shall coordinate with controls contractor to begin preliminary implementation of M&V plan.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	Yes
Significant capital expenditure to implement:	Yes
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate

## 10. DAY LIGHTING AND OCCUPANCY SENSORS

**Finding Description:** The existing building is not wired for daylight controls or dual switching. In the Franklin property there are several occupancy sensors, however, these are not installed throughout the building. During commissioning, a detailed list of spaces served by dual switching and/or occupancy controls should be documented. In the meantime, the Owner can de-lamp existing fixtures and install point of use occupancy sensors throughout on a case-by-case basis.

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	No
Demand Savings:	Yes
Comfort:	No
Maintenance and reliability:	No

**Recommendation:** It is recommended that the owner monitor lighting levels within each space and de-lamp fixtures as required to achieve that value.

**Implementation Plan:** Commissioning of building is recommended. Actual implementation would be for maintenance staff to document lumen levels in work areas and de-lamp as necessary.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	No
Significant capital expenditure to implement:	No
Further investigation/testing required of the owner:	Yes
Savings calculation method:	Spreadsheet/Estimate

## 11. LIGHTING EFFICIENCY

**Finding Description:** Existing lamps throughout buildings appears to be T-12 lighting which utilize 20% additional energy for similar lighting values as T-8 fluorescent lighting. T-8 lighting also has a 25% greater life expectancy than T-12. (DoVA, May 1, 2006)

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	No
Indoor Air Quality:	No
Demand Savings:	Yes
Comfort:	No
Maintenance and reliability:	No

**Recommendation:** It is recommended that the owner replace the existing T-12 lamps with T-8 lighting.

**Implementation Plan:** Owner shall investigate rebate programs available through the utility company to provide financial assistance for lighting replacement.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	No
Significant capital expenditure to implement:	No
Further investigation/testing required of the owner:	No
Savings calculation method:	Estimate

## 12. DUCT CLEANING

**Finding Description:** Interior inspection of the duct systems was not performed during the site investigation, however, during any construction of equipment, the owner should take the opportunity to clean the interior surfaces of the ductwork in order to reduce fan static pressure loss.

### General Finding Impacts

Energy Savings:	Yes
Natural Gas Savings:	Yes
Indoor Air Quality:	Yes
Demand Savings:	No
Comfort:	No
Maintenance and reliability:	Yes

**Recommendation:** During any potential equipment change, ductwork cleaning shall be performed.

**Implementation Plan:** Owner shall coordinate with HVAC contractor during construction for duct cleaning.

Further investigation required by 15000 Inc. under current scope:	No
Further engineering needed outside current scope:	Yes
Significant capital expenditure to implement:	No
Further investigation/testing required of the owner:	No
Savings calculation method:	Spreadsheet/Estimate