MECHANICAL SYSTEMS:
EXISITNG CONDITIONS EVALUATION

TRY STREET TERMINAL BUILDING
620 SECOND AVENUE
PITTSBURGH, PA

PREPARED FOR:
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MECHANICAL OPTION
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Throughout this report an analysis of existing mechanical systems for the Try Street Terminal Building is presented. For this 230,000 square foot renovation project, all major equipment used in the mechanical systems is explained and corresponding schematics are provided.

Because the project includes renovations to an industrial building originally constructed in 1910, special historic considerations were taken in order to preserve the appearance of the building's façade. Other design objectives included minimizing costs, while maximizing occupant comfort and control.

Also, included in this report is a summary of the ventilation requirements performed for Technical Assignment 1. This ventilation analysis was completed in accordance with ASHRAE Standard 62.1. The design heating and cooling loads and energy analysis performed in Carrier's Hourly Analysis Program are presented as well.

DESIGN OBJECTIVES AND REQUIREMENTS

The Try Street Terminal Building project involves renovations to the 10 story, 230,000 square foot building originally constructed in 1910. Although the main function is to provide apartments for the Art Institute of Pittsburgh, other features include: an atrium, exercise room, first-floor retail space and possibly a convenience store and casual dining restaurant.

Because the building was originally built in 1910 as an industrial building, some special considerations such as historically accurate windows were selected in order to respect the building's exterior facade. In fact, according to a news article on The Art Institute's website, the building is in the process of being designated a historic landmark.

Other objectives include providing thermal comfort and control to the occupants while minimizing the first cost to the owner. The building must also comply with the requirements set for in the IBC 2003. One such requirement includes providing natural light in the living areas. This condition led to the addition of a lightwell in the core of the building.

ENERGY SOURCES & RATES

The source of energy for the Try Street Terminal Building is both electric and natural gas sources. The energy rates are assumed based on the respective energy provider websites.

The electric provider referenced in the electrical drawing set was The Duquesne Light Company. The appropriate rates and tariffs were provided on the website (www.duquesnelight.com). Based on the information provided for residential services and medium and large services, an average of $0.087 per kWh was assumed. Averages for Pennsylvania on the Department of Energy website were also considered.

A common natural gas provider available in Pittsburgh, Pennsylvania is Equitable Gas Company (www.eqt.com). In addition to the rates provided on their website, the average rates for Pennsylvania on the Department of Energy website were considered. As a result, an average of $1.594 per therm was assumed based on the information obtained.

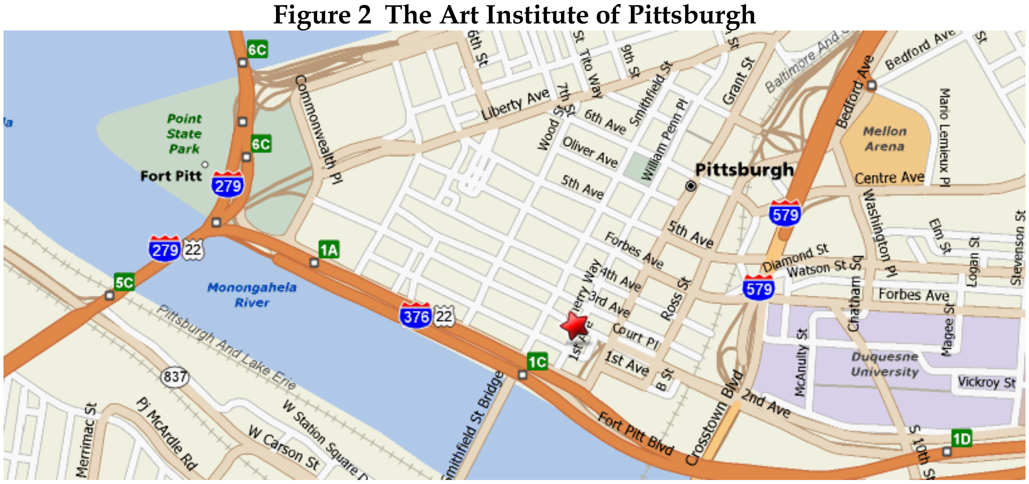
COST AND SITE FACTORS

In terms of cost, money can be potentially saved on electricity by minimizing on-peak usage and maximizing off-peak usage.

After The Art Institute of Pittsburgh moved across town to its current location on 420 Boulevard of the Allies, a considerable distance was created between the college and its housing. Therefore, the location of the Try Street Terminal Building provides a housing solution that is much closer to the college. The maps below depict the locations of both the Try Street Terminal Building and The Art Institute of Pittsburgh. The locations are denoted by a star.

Figure 1 Try Street Terminal Building

Figure 2 The Art Institute of Pittsburgh



OUTDOOR/INDOOR DESIGN CONDITIONS

According to the 2005 ASHRAE Handbook, the outdoor air design conditions for Pittsburgh, Pennsylvania are:

- Summer Design Dry Bulb = 89.8F
- Summer Coincident Wet Bulb = 72.5F
- Winter Design Dry Bulb = 4.5F

The indoor air design conditions depend on the resident control.

DESIGN VENTILATION REQUIREMENTS

The Try Street Terminal Building was evaluated in Technical Assignment 1 using ASHRAE Standard 62.1-2004. It was found that the building's ventilation rates were compliant with the standard. The following chart provides a brief summary of the results found in the analysis:

SUMMARY OF UNITS			
UNIT NAME	V_{ot} (cfm)	OA SUPPLIED (cfm)	COMPLIES WITH Std 62.1?
MAU-1	3,461	5,625	YES
MAU-2	1,988	4,820	YES
MAU-3	3,049	7,550	YES
MAU-4	2,896	5,830	YES
AHU-1	2,193	2,490	YES
AHU-2	907	1,300	YES
AHU-3	2,085	2,220	YES
AHU-4	752	960	YES
FCU-6	2,365	4,000	YES

DESIGN HEATING AND COOLING LOADS

Carrier's Hourly Analysis Program (HAP) was used to estimate the building's heating and cooling loads. The tables below provide a summary of this information for the water source heat pumps (WSHPs), make-up air units (MAUs), and air-handling units (AHUs). For the WSHPs that serve the apartments and exercise room, the calculated values were compared to the scheduled heating and cooling capacities of the assigned space heat pump. The make-up air units that provide these spaces with the required ventilation are also shown below. In addition to the comparison of the heating and cooling loads, ventilation air in cfm/ft^2 is also included for the make-up units. Information for the AHUs is also provided below. It should be noted that for AHUs 1-4, assumptions for the distribution were made because the spaces that the units serve on the basement and first floors are unassigned. Therefore, while the calculated and scheduled values appear to differ, the total calculated and scheduled loads seem to correspond better.

WATER SOURCE HEAT PUMPS						
			COOLING LOAD		HEATING LOAD	
			CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED CAPACITY
NO.	SPACE	FCU	BTU/hr	BTU/hr	BTU/hr	BTU/hr
1	1A LAUNDRY	1	5,294	16,218	239	12,009
2	1A - A	4	33,111	32,938	8,097	29,290
3	1A - B	2	25,505	25,339	6,121	18,153
4	1A - C	2	23,148	25,339	3,832	18,153
5	1A - D	2	24,106	25,339	5,360	18,153
6	1A - E	2	22,715	25,339	5,420	18,153
7	1A - F	2	22,040	25,339	5,849	18,153
8	1A - J	3	30,567	31,520	8,201	23,628
9	1A - K	3	32,007	31,520	7,046	23,628
10	1A - L	3	32,335	31,520	7,499	23,628
11	1A - M	2	18,125	25,339	3,108	18,153
12	1A - N	4	37,173	32,938	9,287	29,290
13	1A - P	4	30,705	32,938	4,042	29,290
14	1J	3	27,452	31,520	5,585	23,628
15	1K	3	27,501	31,520	5,069	23,628
16	1M	2	16,542	25,339	2,409	18,153
17	1MAIL RM	2	13,831	25,339	3,387	18,153
18	1N	4	32,657	32,938	5,694	29,290

WATER SOURCE HEAT PUMPS						
			COOLING LOAD		HEATING LOAD	
			CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED CAPACITY
NO.	SPACE	FCU	BTU/hr	BTU/hr	BTU/hr	BTU/hr
19	2 LAUNDRY	1	5,162	16,218	0	12,009
20	2A	4	33,116	32,938	8,697	29,290
21	2B	2	25,394	25,339	6,571	18,153
22	2C	2	23,367	25,339	4,226	18,153
23	2D	2	23,974	25,339	5,204	18,153
24	2E	2	22,762	25,339	5,449	18,153
25	2F	2	21,306	25,339	4,985	18,153
26	2G	3	30,158	31,520	7,884	23,628
27	2H	3	33,651	31,520	6,512	23,628
28	2J	3	26,402	31,520	4,599	23,628
29	2K	3	32,698	31,520	7,686	23,628
30	2L	3	31,963	31,520	7,655	23,628
31	2M	2	17,832	25,339	3,259	18,153
32	2N	4	37,831	32,938	10,084	29,290
33	2P	4	30,655	32,938	5,110	29,290
34	2Q	3	31,807	31,520	2,060	23,628
35	2R	3	28,548	31,520	2,246	23,628
36	3 LAUNDRY	1	5,162	16,218	0	12,009
37	3A	4	32,381	32,938	8,306	29,290
38	3B	2	24,377	25,339	5,719	18,153
39	3C	2	23,367	25,339	4,226	18,153
40	3D	2	23,974	25,339	5,204	18,153
41	3E	2	22,762	25,339	5,449	18,153
42	3F	2	20,795	25,339	4,734	18,153
43	3G	3	30,158	31,520	7,884	23,628
44	3H	3	33,651	31,520	6,512	23,628
45	3J	3	26,402	31,520	4,599	23,628
46	3K	3	32,698	31,520	7,686	23,628
47	3L	3	31,963	31,520	7,655	23,628
48	3M	2	17,832	25,339	3,259	18,153
49	3N	4	38,677	32,938	11,183	29,290
50	3P	4	32,981	32,938	6,362	29,290
51	3Q	3	31,807	31,520	2,060	23,628
52	3R	3	28,548	31,520	2,246	23,628

WATER SOURCE HEAT PUMPS						
			COOLING LOAD		HEATING LOAD	
			CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED CAPACITY
NO.	SPACE	FCU	BTU/hr	BTU/hr	BTU/hr	BTU/hr
53	4 LAUNDRY	1	41,903	16,218	0	12,009
54	4A	4	30,761	32,938	8,306	29,290
55	4B	2	23,297	25,339	5,719	18,153
56	4C	2	23,367	25,339	4,226	18,153
57	4D	2	23,974	25,339	5,204	18,153
58	4E	2	22,762	25,339	5,449	18,153
59	4F	2	20,795	25,339	4,734	18,153
60	4G	3	30,158	31,520	7,884	23,628
61	4H	3	33,651	31,520	6,512	23,628
62	4J	3	26,402	31,520	4,599	23,628
63	4K	3	32,698	31,520	7,686	23,628
64	4L	3	31,963	31,520	7,655	23,628
65	4M	2	17,832	25,339	3,259	18,153
66	4N	4	38,677	32,938	11,183	29,290
67	4P	4	32,981	32,938	6,362	29,290
68	4Q	3	31,807	31,520	2,060	23,628
69	4R	3	28,548	31,520	2,246	23,628
70	5 LAUNDRY	1	5,162	16,218	0	12,009
71	5A	4	32,481	32,938	8,306	29,290
72	5B	2	24,377	25,339	5,719	18,153
73	5C	2	23,367	25,339	4,226	18,153
74	5D	2	23,974	25,339	5,204	18,153
75	5E	2	22,762	25,339	5,449	18,153
76	5F	2	20,795	25,339	4,734	18,153
77	5G	3	30,158	31,520	7,884	23,628
78	5H	3	33,651	31,520	6,512	23,628
79	4J	3	26,402	31,520	4,599	23,628
80	5K	3	32,698	31,520	7,686	23,628
81	5L	3	31,963	31,520	7,655	23,628
82	5M	2	17,832	25,339	3,259	18,153
83	5N	4	38,677	32,938	11,183	29,290
84	5P	4	32,981	32,938	6,362	29,290
85	5Q	3	31,807	31,520	2,060	23,628
86	5R	3	28,548	31,520	2,246	23,628

WATER SOURCE HEAT PUMPS						
			COOLING LOAD		HEATING LOAD	
			CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED CAPACITY
NO.	SPACE	FCU	BTU/hr	BTU/hr	BTU/hr	BTU/hr
87	6 LAUNDRY	1	5,162	16,218	0	12,009
88	6A	4	32,390	32,938	8,306	29,290
89	6B	2	24,377	25,339	5,719	18,153
90	6C	2	23,367	25,339	4,226	18,153
91	6D	2	23,974	25,339	5,204	18,153
92	6E	2	22,762	25,339	5,449	18,153
93	6F	2	20,795	25,339	4,734	18,153
94	6G	3	30,158	31,520	7,884	23,628
95	6H	3	33,651	31,520	6,512	23,628
96	6J	3	26,402	31,520	4,599	23,628
97	6K	3	32,698	31,520	7,686	23,628
98	6L	3	31,963	31,520	7,655	23,628
99	6M	2	17,832	25,339	3,259	18,153
100	6N	4	38,677	32,938	11,183	29,290
101	6P	4	32,981	32,938	6,362	29,290
102	6Q	3	31,807	31,520	2,060	23,628
103	6R	3	28,548	31,520	2,246	23,628
104	7 LAUNDRY	3	5,162	31,520	0	23,628
105	7A	4	32,381	32,938	8,306	29,290
106	7B	2	24,377	25,339	5,719	18,153
107	7C	2	23,367	25,339	4,226	18,153
108	7D	2	230,064	25,339	5,204	18,153
109	7E	2	22,762	25,339	5,449	18,153
110	7F	2	198,236	25,339	4,734	18,153
111	7G	3	30,931	31,520	9,326	23,628
112	7H	3	34,414	31,520	9,831	23,628
113	7J	3	26,402	31,520	4,599	23,628
114	7K	3	32,698	31,520	7,686	23,628
115	7L	3	31,963	31,520	7,655	23,628
116	7M	2	17,832	25,339	3,259	18,153
117	7N	4	38,677	32,938	11,183	29,290
118	7P	4	32,981	32,938	6,362	29,290
119	7Q	3	31,807	31,520	2,060	23,628
120	7R	3	28,548	31,520	2,246	23,628

WATER SOURCE HEAT PUMPS						
			COOLING LOAD		HEATING LOAD	
			CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED CAPACITY
NO.	SPACE	FCU	BTU/hr	BTU/hr	BTU/hr	BTU/hr
121	8A	4	32,381	32,938	8,306	29,290
122	8B	2	24,377	25,339	5,719	18,153
123	8C	2	23,367	25,339	4,226	18,153
124	8D	2	23,974	25,339	5,204	18,153
125	8E	2	22,762	25,339	5,449	18,153
126	8F	2	20,942	25,339	5,560	18,153
127	8J	3	26,641	31,520	5,281	23,628
128	8K	3	32,698	31,520	7,686	23,628
129	8L	3	31,963	31,520	7,655	23,628
130	8M	2	17,832	25,339	3,259	18,153
131	8N	4	38,677	32,938	11,183	29,290
132	8P	4	32,981	32,938	6,362	29,290
133	8Q	3	31,807	31,520	2,060	23,628
134	8R	3	28,548	31,520	2,246	23,628
135	9A	5	32,381	41,560	8,306	33,684
136	9B	3	24,930	31,520	7,396	23,628
137	9C	3	23,367	31,520	4,226	23,628
138	9D	3	23,974	31,520	5,204	23,628
139	9E	3	23,367	31,520	7,358	23,628
140	9F	3	21,271	31,520	6,294	23,628
141	9J	3	26,409	31,520	6,560	23,628
142	9K	3	32,578	31,520	10,764	23,628
143	9L	3	32,371	31,520	9,477	23,628
144	9M	3	18,128	31,520	4,176	23,628
145	9N	5	40,475	41,560	13,726	33,684
146	9P	5	34,365	41,560	9,246	33,684
147	9Q	4	32,502	32,938	4,945	29,290
148	9R	4	30,607	32,938	5,214	29,290
149	EXER. RM	6	227,143	147,334	280,869	114,148

MAKE-UP AIR UNITS								
			COOLING LOAD			HEATING LOAD		
	VENTILATION AIR	SUPPLY AIR	CALCULATED	CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED INPUT	SCHEDULED OUTPUT
UNIT	CFM/FT^2	CFM/FT^2	FT^2/TON	BTU/hr	BTU/hr	BTU/hr	BTU/hr	BTU/hr
MAU-1	0.12	0.12	7,320	91,380	354,000	356,965	780,000	632,000
MAU-2	0.15	0.15	5,851	65,065	294,000	252,747	480,000	389,000
MAU-3	0.16	0.16	5,398	109,042	450,000	422,613	780,000	632,000
MAU-4	0.13	0.13	6,785	80,952	357,000	315,661	780,000	632,000

AIR HANDLING UNITS								
			COOLING LOAD			HEATING LOAD		
	CALCULATED VENTILATION AIR	CALCULATED SUPPLY AIR	CALCULATED	CALCULATED	SCHEDULED CAPACITY	CALCULATED	SCHEDULED CAPACITY OF EDH	SCHEDULED CAPACITY OF EDH
UNIT	CFM/FT^2	CFM/FT^2	FT^2/TON	BTU/hr	BTU/hr	BTU/hr	BTU/hr	KW
AHU-1	0.31	1.03	359.8	206,787	163,800	176,429	119,413	35
AHU-2	0.27	0.89	735	63,639	143,800	9,425	119,413	35
AHU-3	0.31	0.95	369	208,008	163,800	130,039	119,413	35
AHU-4	0.30	0.99	665	45,099	88,800	9,956	68,236	20
			TOTAL	**523,533**	**560,200**	**325,849**	**426,476**	

Note: EDH is an abbreviation for Electric Duct Heater

ANNUAL ENERGY USE

Because the Try Street Terminal Building is still currently under construction actual energy data was not available. An energy analysis from the designer was not available for comparison because one was not performed. An analysis was not completed because first cost was the primary concern of the project. However, for Technical Assignment 2 an energy analysis was conducted using Carrier's HAP. Since the building's primary function is apartments, a 24 hour fully occupied schedule was assumed. The only exception to this schedule that was made was for an assumed first floor retail space. In that case, the schedule was estimated from 8:00am to 9:00pm. On the following pages charts and figures are shown that depict the building's annual component and energy costs. For additional charts and graphs please refer to Appendix A. It should also be noted that many assumptions were made in order to simplify the calculation process. Therefore, these assumptions may be the source of any inaccuracies.

Figure 3 Annual Component Costs

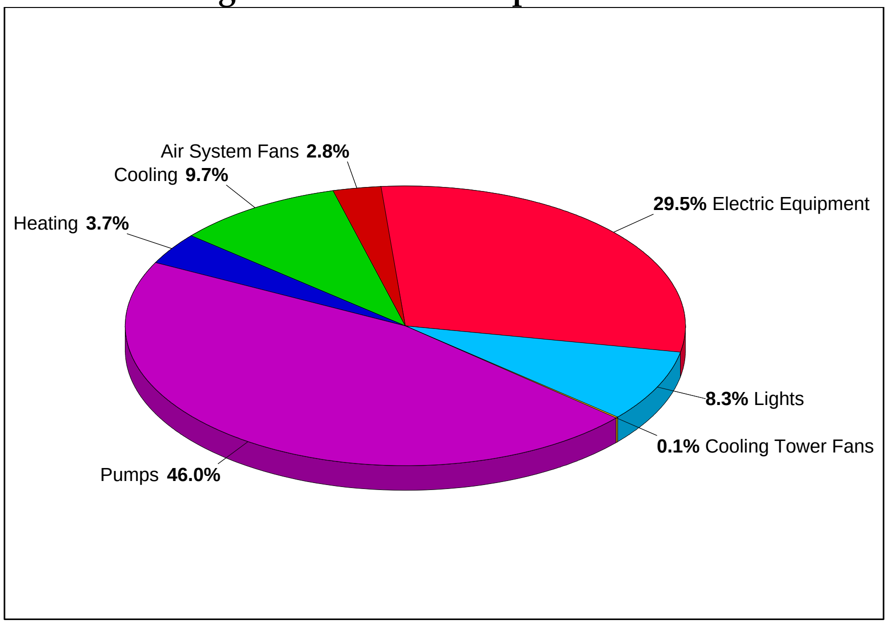


Table 1: Annual Component Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	42,725	0.196	2.8
Cooling	149,681	0.687	9.7
Heating	56,700	0.260	3.7
Pumps	709,743	3.260	46.0
Cooling Tower Fans	1,647	0.008	0.1
HVAC Sub-Total	**960,496**	**4.411**	**62.2**
Lights	128,097	0.588	8.3
Electric Equipment	455,037	2.090	29.5
Misc. Electric	0	0.000	0.0
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**583,135**	**2.678**	**37.8**
Grand Total	**1,543,631**	**7.089**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **217737.0** ft²
Conditioned Floor Area .... **217737.0** ft²

Figure 4 Annual Energy Costs

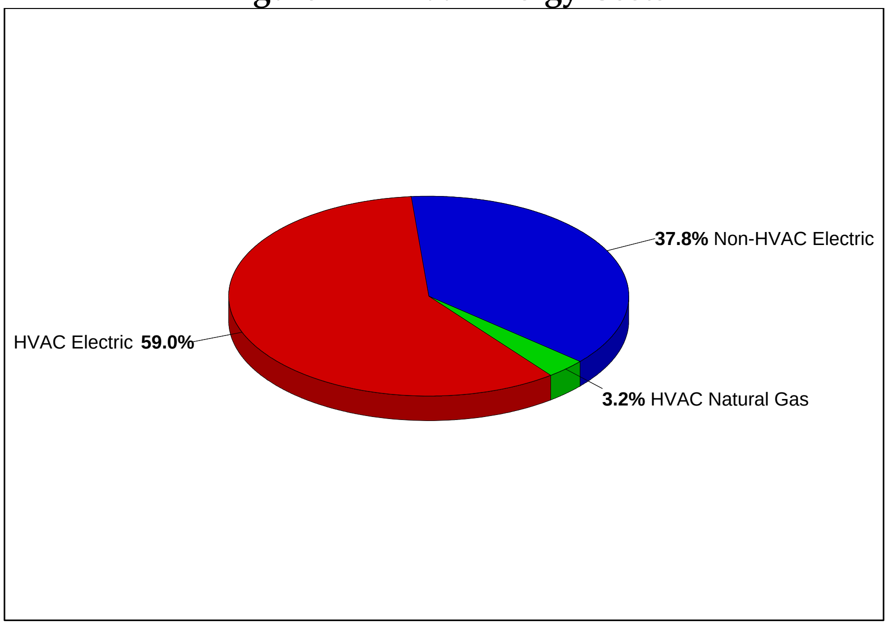


Table 2: Annual Energy Costs

Component	Annual Cost ($/yr)	($/$ft^2$)	Percent of Total (%)
HVAC Components			
Electric	910,048	4.180	59.0
Natural Gas	49,625	0.228	3.2
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**959,673**	**4.408**	**62.2**
Non-HVAC Components			
Electric	583,056	2.678	37.8
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**583,056**	**2.678**	**37.8**
Grand Total	**1,542,729**	**7.085**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **217737.0** ft^2
Conditioned Floor Area .... **217737.0** ft^2

MECHANICAL EQUIPMENT SCHEDULES

PUMP SCHEDULE									
						MOTOR			
NAME	TYPE	LOCATION	GLYCOL %	GPM	HEAD (FT)	RPM	HP	VOLTAGE	IMPELLER SIZE DIA.
P - 1,2	BASE MTD	MER 1003	30	663	90	1,750	25	208-3	10.75"

FLUID COOLER SCHEDULE											
NAME	LOCATION	FLOW RATE (GPM)	PRESSURE DROP (PSI)	HEAT REJECTION (MBH)	FLUID INLET TEMP. (F)	FLUID OUTLET TEMP. (F)	WET BULB TEMP. (F)	FAN MOTOR (HP)	PUMP MOTOR (HP)	BASIN HEATER (KW)	VOLTAGE
FC - 1	ROOF	663	663	4,453	104	90	78	25	5	16	208-3

ELECTRIC UNIT HEATER SCHEDULE						
NAME	CFM	KW	AMPS	MBH	HP	VOLTAGE
EUH - 1	350	2.2/3.0	11.0/12.5	7.5/10.2	1/100	208/240-3-60

EXPANSION TANK SCHEDULE				
NAME	CAPACITY (GAL)	DIMENSIONS	ACCECPTANCE (GAL)	TANK CONNECTION
ET - 1	53	24" x 38"	25	1"

COMBUSTION AIR UNIT SCHEDULE								
		HEATING CAP.						
NAME	CFM	INPUT MBH	OUTPUT MBH	GAS PRESSURE	VOLTAGE	E.S.P.	FAN HP	FLA
CAU - 1	2,900	150	120	14"W.C.	208/3	0.75	2	7.5

BOILER SCHEDULE					
	MBH NAT. GAS				
NAME	INPUT	OUTPUT	FLUE DIA.	VOLTAGE	ELEC. RATING (AMPS)
B - 1,2	1,630.0	1,336.6	18	120	4

SUPPLY FAN SCHEDULE

NAME	CFM	TYPE	LOCATION	S.P.	RPM	HP	VOLTAGE
SF - 1	12,000	STAIR PRESSURIZATION	ROOF	0.35	1,725	7.5	208-3
SF - 2	18,000	STAIR PRESSURIZATION	ROOF	0.35	1,725	10	208-3

AIR HANDLING UNIT SCHEDULE

NAME	NOM. CFM	NOM. TON	COOLING CAP. (MBH)	S.P.	ELECTRICAL DATA		
					VOLTAGE	MCA	MOCP
AHU - 1	6,000	15.0	163.8	1.0	208/230-3-60	69.9	80
AHU - 2	5,000	12.5	143.8	1.0	208/230-3-60	67.9	80
AHU - 3	6,000	15.0	163.8	1.0	208/230-3-60	69.9	80
AHU - 4	3,000	7.5	88.8	1.0	208/230-3-60	37.7	50

FAN COIL UNIT SCHEDULE

NAME	NOM. TON	NOM. HTG CAP. @ 75 BTUH	NOM. CLG. CAP. @ 85 BTUH	NOM. CFM	ELECTRICAL DATA					
					COMPRESSOR		FAN MOTOR RLA	MCA	MAX FUSE	VOLTAGE
					RLA	LRA				
FCU - 1	1.0	16,218	12,009	400	5.9	29.0	0.8	8.2	15	208/230-3-60
FCU - 2	1.5	25,339	18,153	600	9.0	48.0	1.1	12.4	20	208/230-3-60
FCU - 3	2.0	31,520	23,628	800	12.8	61.0	1.5	17.5	30	208/230-3-60
FCU - 4	2.5	32,938	29,290	1,000	15.4	81.0	1.5	20.8	30	208/230-3-60
FCU - 5	3.0	41,560	33,684	1,200	17.6	87.0	2.7	24.7	35	208/230-3-60
FCU - 6	10.0	147,334	114,148	4,000	16.7	150.0	+	47.4	60	208/230-3-60
FCU - 7	0.5	10,215	6,979	230	3.9	17.7	+	5.3	15	208/230-3-60

AIR SEPERATOR SCHEDULE

NAME	GPM	CONNECTION SIZE	VENT TAP
AS - 1	663	6"	1.5"

ELECTRIC CABINET UNIT HEATER SCHEDULE

NAME	VOLTS	KW	AMPS	BTUH
ECUH - 1	208/3	4.0	14	13,700

ELECTRIC DUCT HEATER SCHEDULE

NAME	SERVES	CFM	KW	VOLTAGE
EDH - 1	AHU - 1	6,000	35	208-3
EDH - 2	AHU - 2	5,000	35	208-3
EDH - 3	AHU - 3	6,000	35	208-3
EDH - 4	AHU - 4	3,000	20	208-3

MAKE UP AIR UNIT SCHEDULE

NAME	CFM	COOLING CAP. MBH	HEATING CAP.		GAS PRESSURE	VOLTAGE	E.S.P.	FAN HP	FLA	MCA	MOCP
			INPUT MBH	OUTPUT MBH							
MAU - 1	5,625	354	780	632	6"-10.5"W.C.	208-3	1.5	5	128	133	150
MAU - 2	2,620	294	480	389	6"-10.5"W.C.	208-3	2.0	5	117	128	150
MAU - 3	7,550	450	780	632	6"-10.5"W.C.	208-3	2.0	10	173	180	200
MAU - 4	5,830	357	780	632	6"-10.5"W.C.	208-3	1.5	5	138	133	150

SPLIT SYSTEM SCHEDULE - INDOOR UNIT

NAME	NOM. TONS	LOCATION	CFM	VOLTAGE	HEATER		POWER		
					KW	FLA	MCA	MOCP	FLA
SS - 1	5	ELEV. PENTHOUSE #1004	1,600	208/230-1	5.0	21.7	28.7	30.0	24.3
SS - 2	4	ELEV. PENTHOUSE #1002	1,130	208/230-1	4.0	17.4	23.8	25.0	19.0

SPLIT SYSTEM SCHEDULE - OUTDOOR UNIT

NAME	NOM. TONS	LOCATION	NET COOLING (BTUH)	NET HEATING (BTUH)	SEER	VOLTAGE	POWER		
							MCA	MOCP	FLA
SS - 1	5	ELEV. PENTHOUSE #1004	58,000	57,000	11.0	208/230-3	27.0	45.0	21.9
SS - 2	4	ELEV. PENTHOUSE #1002	48,000	45,500	10.2	208/230-3	20.6	35.0	16.8

EXHAUST FAN SCHEDULE							
NAME	**CFM**	**TYPE**	**LOCATION**	**S.P.**	**VOLTAGE**	**HP**	**EMERGENCY POWER**
EF - 1	450	ROOF	MAIN ROOF	0.5	115	1/6	YES
EF - 2	675	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 3	675	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 4	1,125	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 5	675	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 6	675	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 7	450	ROOF	MAIN ROOF	0.5	115	1/6	YES
EF - 8	800	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 9	900	ROOF	7th FLOOR ROOF	0.5	115	1/4	YES
EF - 10	3,960	ROOF	7th FLOOR ROOF	1.25	208-3	3	YES
EF - 11	600	ROOF	7th FLOOR ROOF	0	115	1/6	YES
EF - 12	900	ROOF	7th FLOOR ROOF	0.5	115	1/4	YES
EF - 13	500	ROOF	MAIN ROOF	0.5	115	1/6	YES
EF - 14	900	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 15	725	ROOF	MAIN ROOF	0.7	115	1/4	YES
EF - 16	1,225	ROOF	MAIN ROOF	0.5	115	1/4	YES
EF - 17	1,200	ROOF	MAIN ROOF	1.2	115	1/2	YES
EF - 18	1,100	ROOF	MAIN ROOF	0.7	115	1/4	YES
EF - 19	475	ROOF	MAIN ROOF	0.5	115	1/6	YES
EF - 20	1,460	ROOF	MAIN ROOF	0.7	115	1/3	YES
EF - 21	450	ROOF	MAIN ROOF	0.5	115	1/6	YES
EF - 22	440	IN-LINE	8th FLOOR ROOF	0.125	115	1/3	NO
EF - 23	440	IN-LINE	9th FLOOR ROOF	0.125	115	1/3	NO
EF - 24	50	CEILING	DATA ROOMS	0.12	115	+	NO
EF - 25	75	CEILING	1st FLOOR TOILET	0.35	115	+	NO
EF - 26	190	IN-LINE	1st FLOOR EXHAUST	0.50	115	+	NO
EF - 27	400	DRY BOOSTER	1st FLOOR LAUNDRY	0.25	115	+	NO
EF - 28	150	IN-LINE	BASEMENT TOILET	0.25	115	+	NO

SYSTEM OPERATION DESCRIPTION

Although schedules for all of the mechanical equipment were presented in the prior section, only systems with major equipment will be described in this section.

<u>Make-up Air Units</u>

The four rooftop make-up air units (MAUs) are 100% outdoor air units. They supply the required ventilation to all the apartments and corridors on floors 1-9. The lobby is also served by the MAUs. Aaon RN series units are used for MAU-1, 3 and 4, while the RM series is used for MAU-2. The main difference between the two types is that the RM series is capable of 780 MBH while the RN series provides 480 MBH. The RM series also only has 2 stages of direct exchange (DX) cooling and a 1″ double wall cabinet constructions. The RN series has 4 stages and a 2″ double wall cabinet. However, both types still have many similar characteristics. A list of similar features is shown below.

- fully charged with R-22 refrigerant
- hot gas bypass (HGB) on all DX
- modulating hot gas reheat coil for humidity control
- modulating natural gas heat
- stainless steel heat exchanger
- turndown ratio to 30% of total burner capacity
- no return air connection
- 2-position OA dampers
- 2″ pleated throw away filters
- vertical discharge

Both RM/RN series units have the same refrigeration controls and options. For refrigeration control a 5 MTDR off and 20 STDR Delay are used. A 5 MTDR off is a five minute time delay relay for a minimum of five minutes of compressor off time. This timer prevents unnecessary wear on the compressors by preventing short cycling. The 20 second time delay relay prevents both cooling stages from starting simultaneously. In terms of options, a HGB Lead/Lag prevents coil freeze up, while the modulating hot gas reheat coils help to maintain discharge temperature.

Water Source Heat Pumps

The water source heat pumps (WSHPs) used in the Try Street Terminal Building apartments and exercise room are referred to as fan coil units (FCUs) 1-7. These Whalen Series VI units are capable of performing at entering water temperatures between 60-95 degrees Fahrenheit. One of the advantages of the WSHP system is its ability to simultaneously heat and cool. This feature allows the occupant to control their thermal comfort level.

In heating mode, hot refrigerant flow through the air coil which then warms the air to be supplied to the conditioned space. Heat added to the room is removed from the water through the water coil and through the rejected compressor heat.

In cooling mode, cold refrigerant flows through the coil which then cools the conditioned supply air. Heat removed from the air is transferred to the water flowing through the water coil.

Fluid Cooler

A Baltimore Aircoil Company, FXV closed circuit cooling tower was used for the Try Street Terminal Building. In the design documents, the cooling tower is referred to as a fluid cooler. The fluid cooler provides the necessary condenser water to the heat pumps when additional cooling is required. This occurs when the building piping loop temperature rises above the upper limit of 95F.

The main difference between the open and closed circuit cooling tower is the process in which heat is rejected. With the closed circuit, the heat to be rejected is transferred from the fluid being cooled to the ambient air through an exchange coil. This coil isolates the fluid from the outside air which keeps it clean and contaminate free within the closed loop.

Boilers

Two Raypak gas fired boilers are used to provide the necessary hot water to the heat pumps when additional heating is required. This occurs when the building piping loop temperature falls below the lower limit of 60F.

Pumps

Two Bell & Gossett pumps are located in the mechanical penthouse. These pump the necessary water to water source heat pumps.

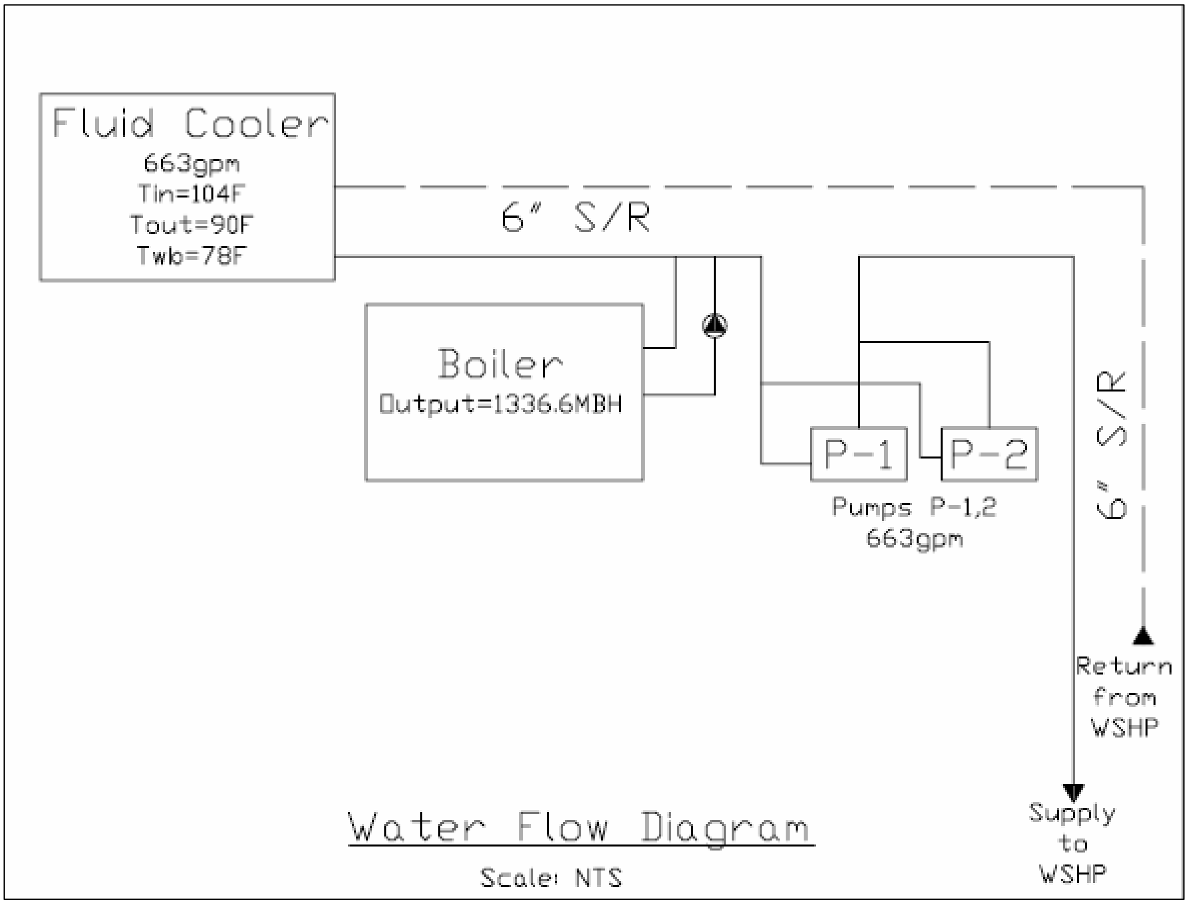
Exhaust Fans

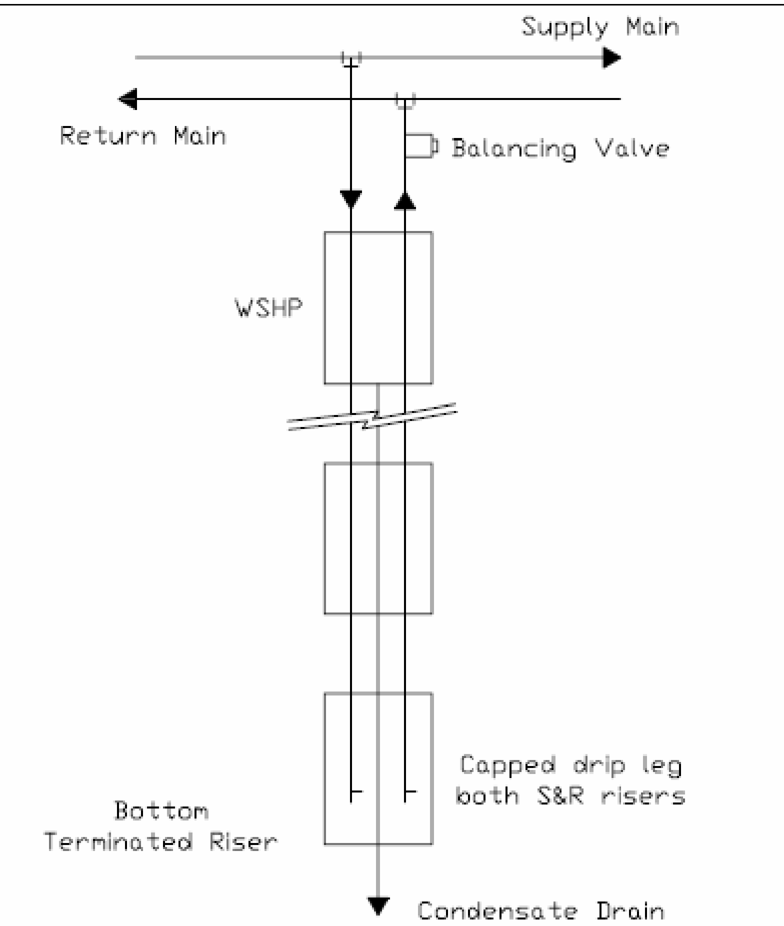
Of the exhaust fans, 21 of the 28 are located on the roof and exhaust air from the apartment bathroom and kitchen areas. Because it is a residential building the exhausted amount was increased above code requirements in order to minimize the transfer of odors into other apartments and corridors. To view additional information refer to the exhaust fan schedule.

Air Handling Units

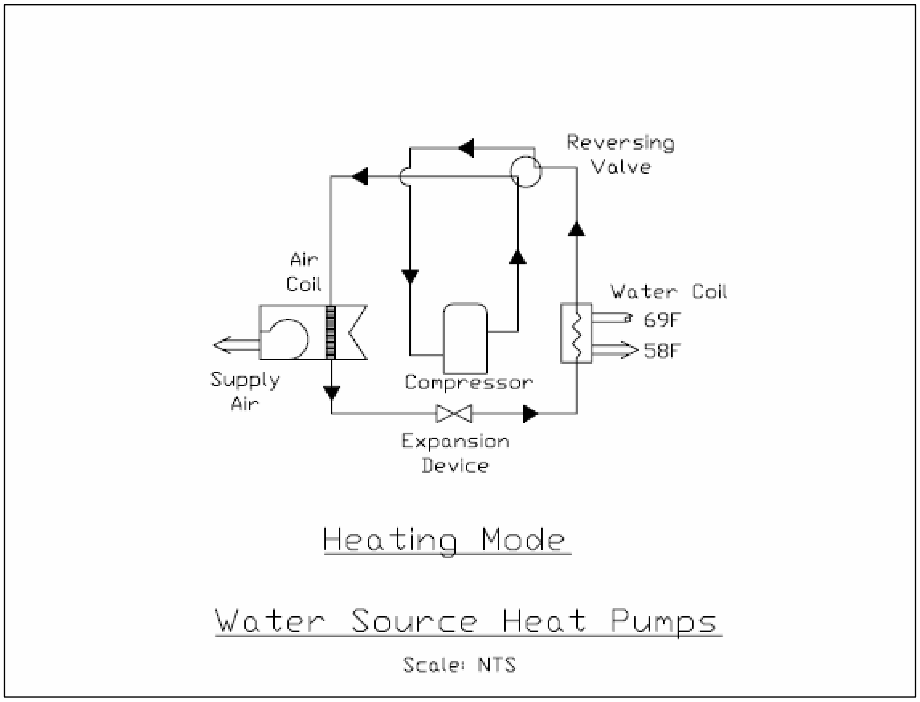
Four Carrier indoor self contained, air-cooled vertical package units supply constant volume cooling to the basement and first floor unassigned spaces. The units are complete with a belt drive evaporator section and built in ductable air–cooled condenser. Each unit is equipped with electric open coil duct heaters which provide the necessary heating.

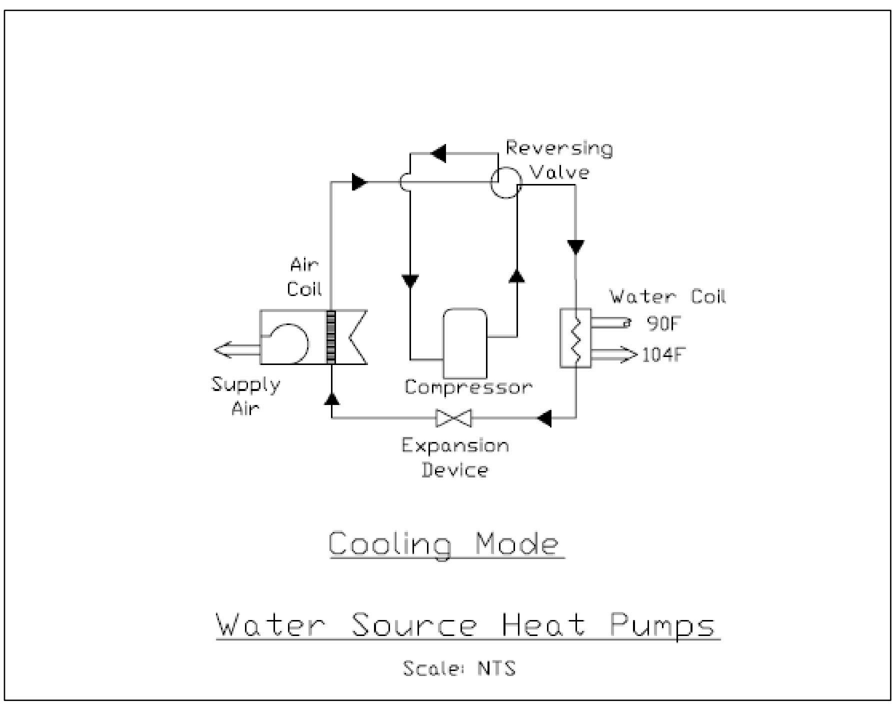
MECHANICAL SYSTEM SCHEMATICS





Typical Piping Detail:
Downfeed-Direct Return Risers
Scale: NTS


Reversing Valve
Air Coil
Water Coil
69F
58F
Supply Air
Compressor
Expansion Device
Heating Mode
Water Source Heat Pumps
Scale: NTS


Reversing Valve
Air Coil
Water Coil
90F
104F
Supply Air
Compressor
Expansion Device
Cooling Mode
Water Source Heat Pumps
Scale: NTS

OPERATING HISTORY

The Try Street Terminal Building is still currently under construction. Therefore, no information is available regarding the buildings mechanical system operating history.

SYSTEM CRITIQUE

The design chosen for the Try Street Terminal apartments was the conventional water source heat pump system which has many advantages and disadvantages. Some advantages of the WSHP system include:

- ability to simultaneously heat and cool
- system remains operation if another heat pump unit fails
- electrical energy for heat pumps can be individually metered
- lower installation costs

The primary disadvantage is the added maintenance of not only the individual heat pump units, but of the boiler and fluid cooler as well.

Because first cost was the primary concern, other system types were not considered. Central heating and cooling or geothermal heat pumps are just a couple examples of other system options that could have been considered. When analyzing systems such as these, it would be important to compare first cost and life cycle cost. Completion of a life cycle cost or even energy analysis may show the client that a more effiecient, cost effective solution is available in the long term.

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Mapquest, Map of 620 Second Avenue and 420 Blvd. of the Allies, Pittsburgh, PA

McKamish, Documents for the Try Street Terminal Building.

TKA Architects, Documents and rendering for the Try Street Terminal Building.

The Pennsylvania State University Department of Architectural Engineering Faculty Advisors

Past Penn State AE Thesis Technical Reports

APPENDIX A

Table A.1 Annual Costs

Component	TRY STREET TERMINAL BLDG ($)
HVAC Components	
Electric	910,048
Natural Gas	49,625
HVAC Sub-Total	**959,673**
Non-HVAC Components	
Electric	583,056
Natural Gas	0
Non-HVAC Sub-Total	**583,056**
Grand Total	**1,542,729**

Table A.2 Annual Energy Consumption

Component	TRY STREET TERMINAL BLDG
HVAC Components	
Electric (kWh)	10,460,330
Natural Gas (Therm)	31,132
Non-HVAC Components	
Electric (kWh)	6,701,790
Natural Gas (Therm)	0
Totals	
Electric (kWh)	17,162,120
Natural Gas (Therm)	31,132

Table A.3 Monthly Component Costs

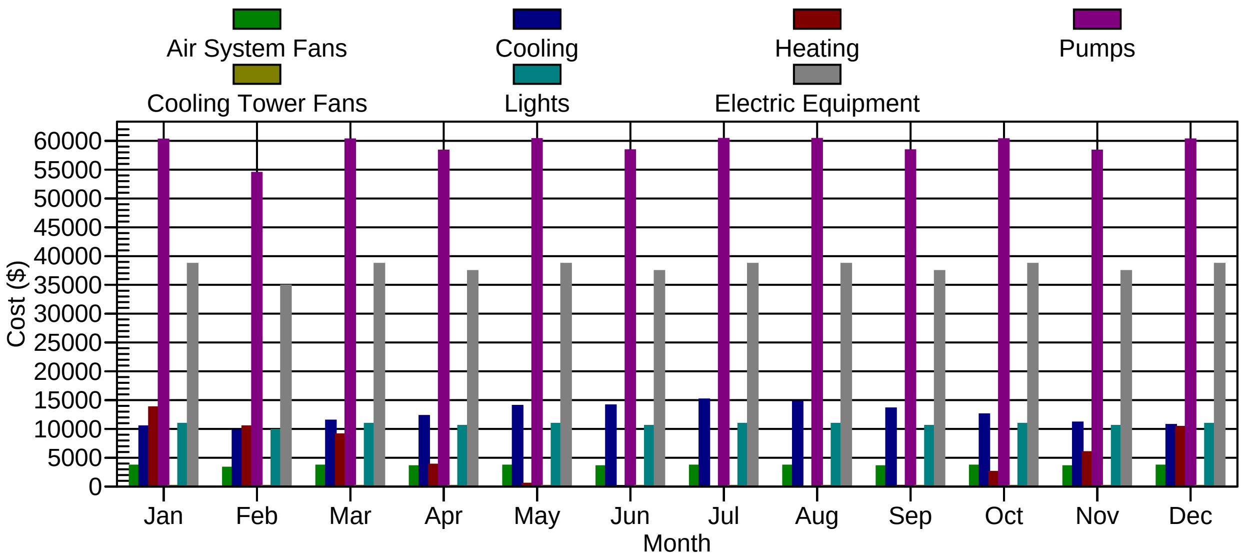

Table A.4 Monthly Energy Costs