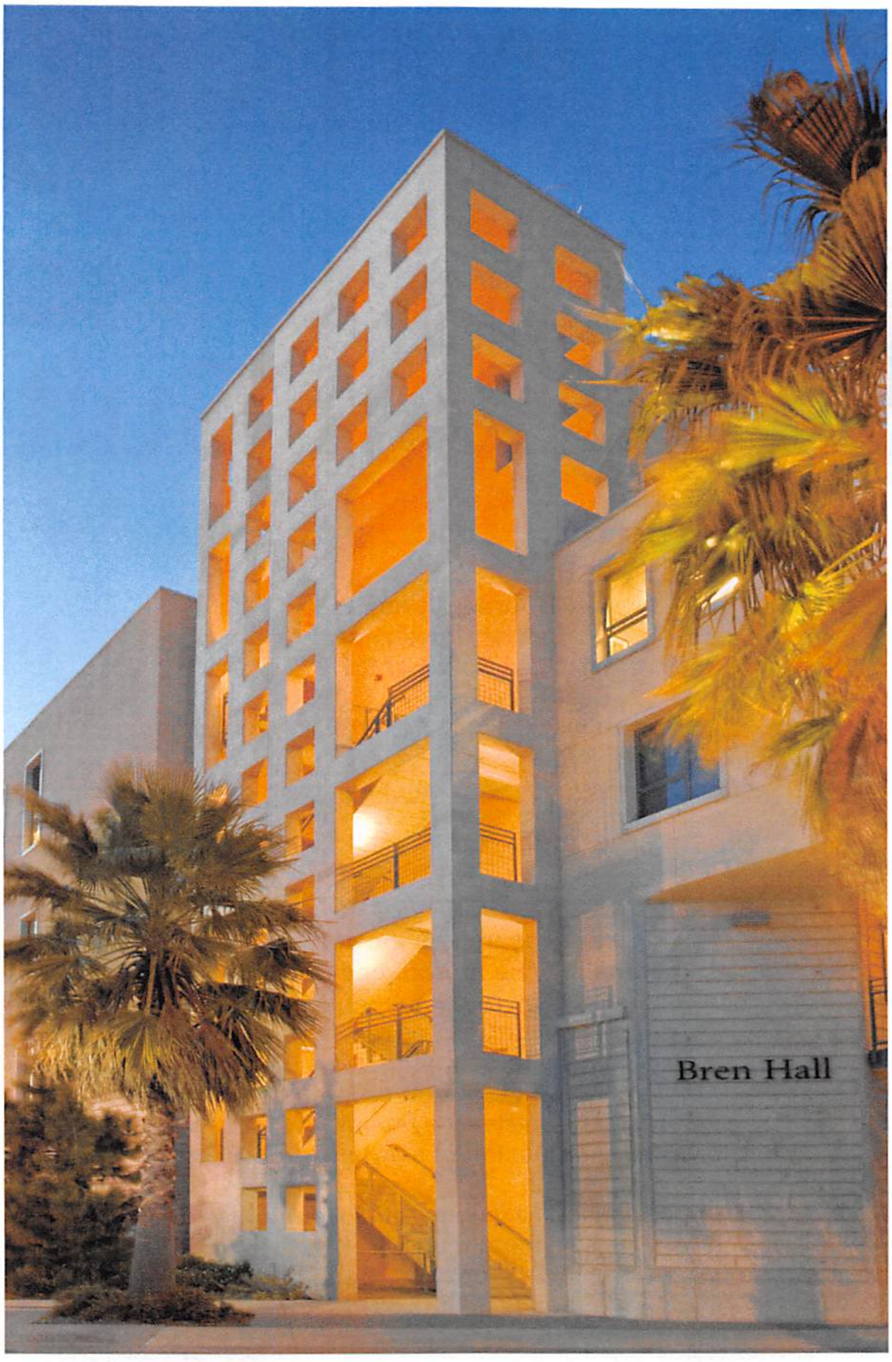
Energy Simulation for Commercial Buildings – Trinidad and Tobago August 23-24, 2017

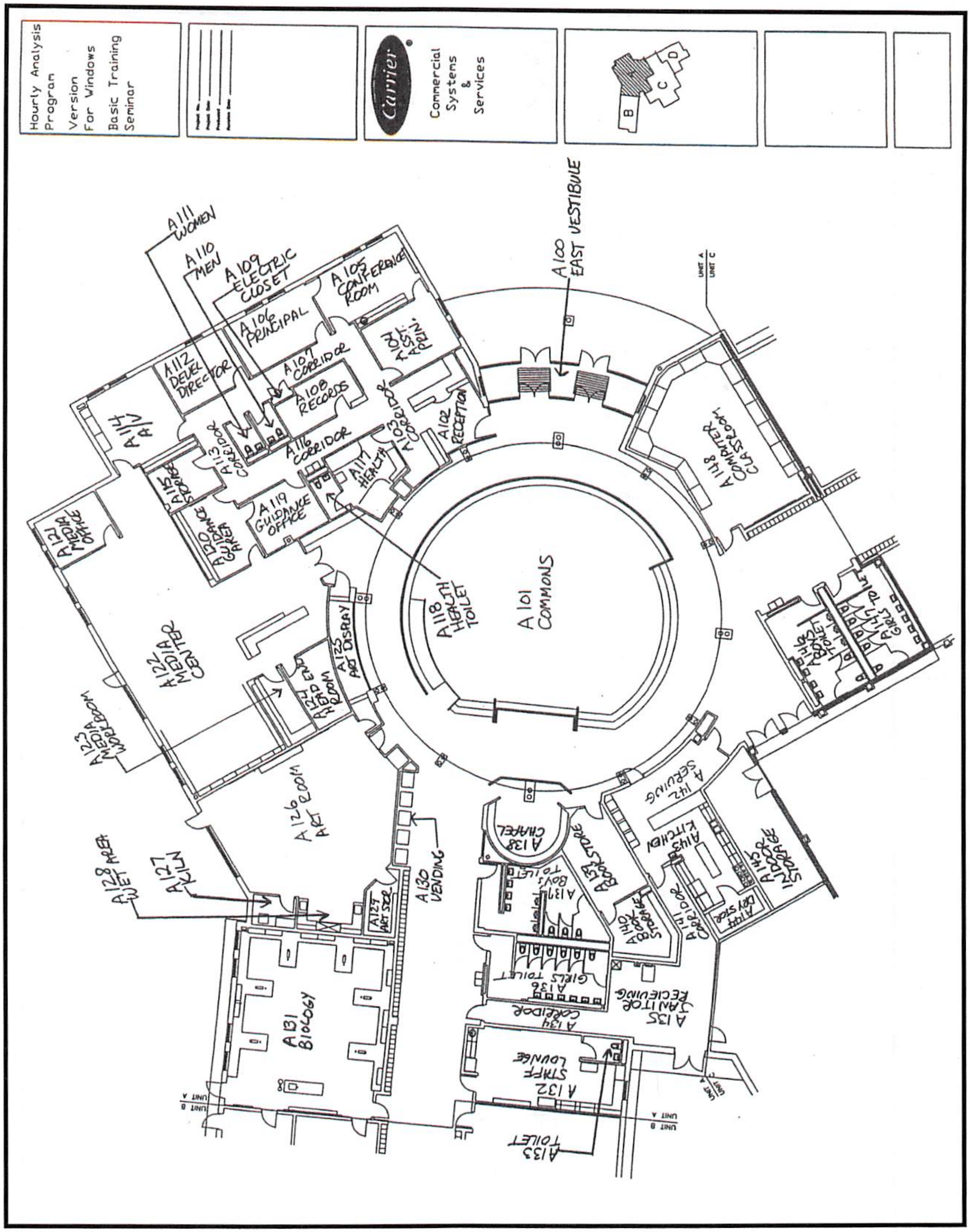


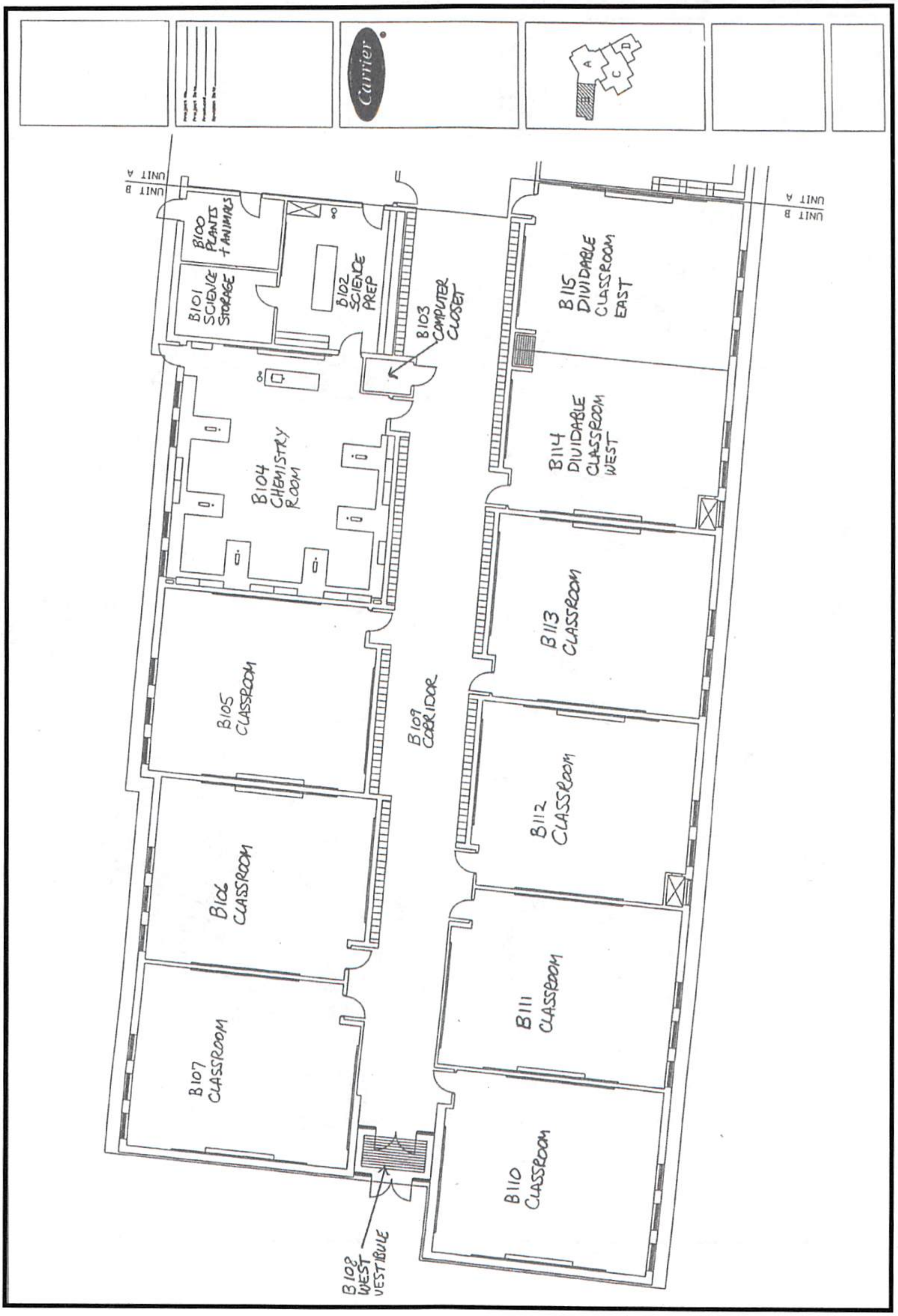
UCSB Bren Hall LEED® Double Platinum

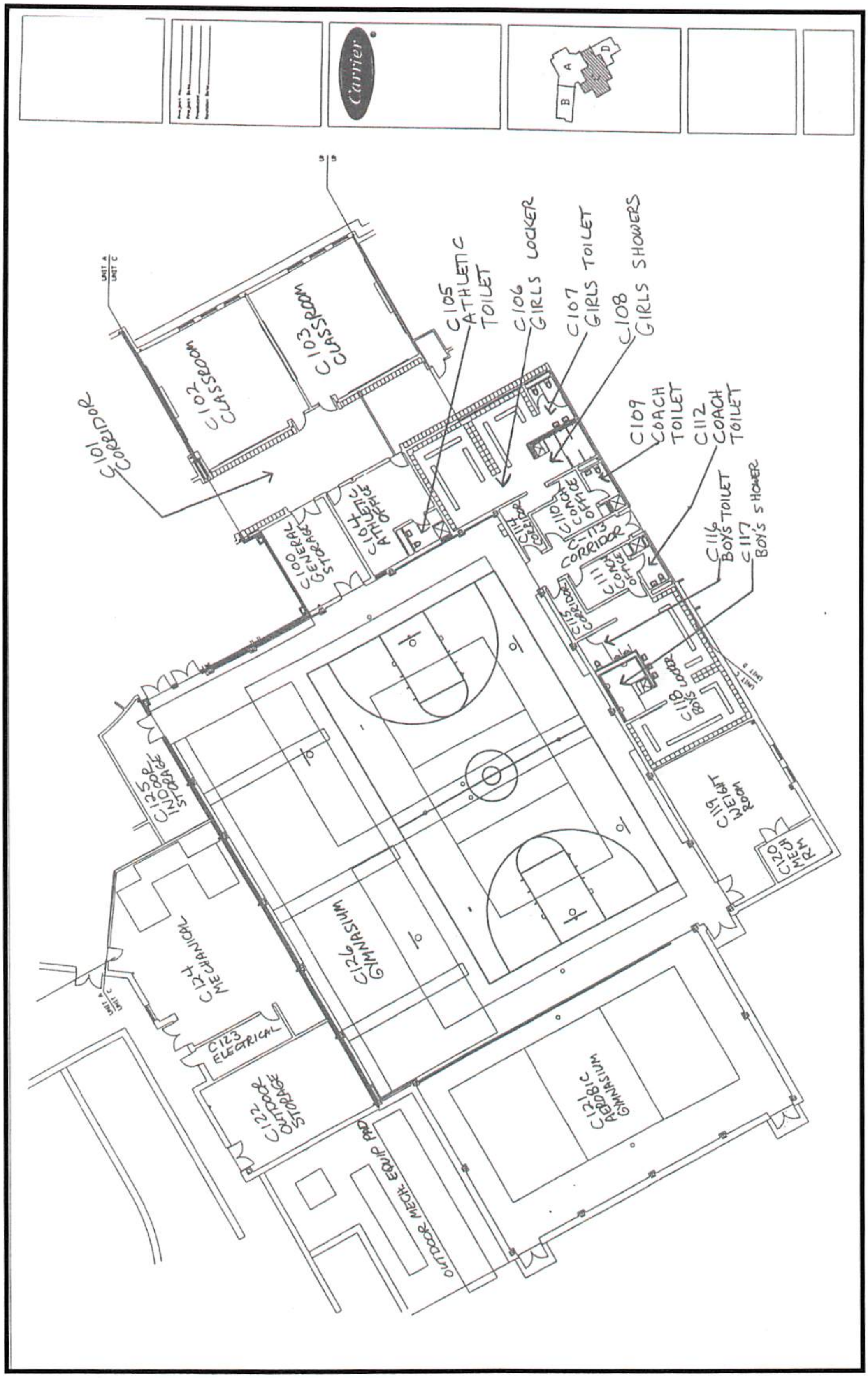
Carrier Corporation
Software Systems Network
Carrier University

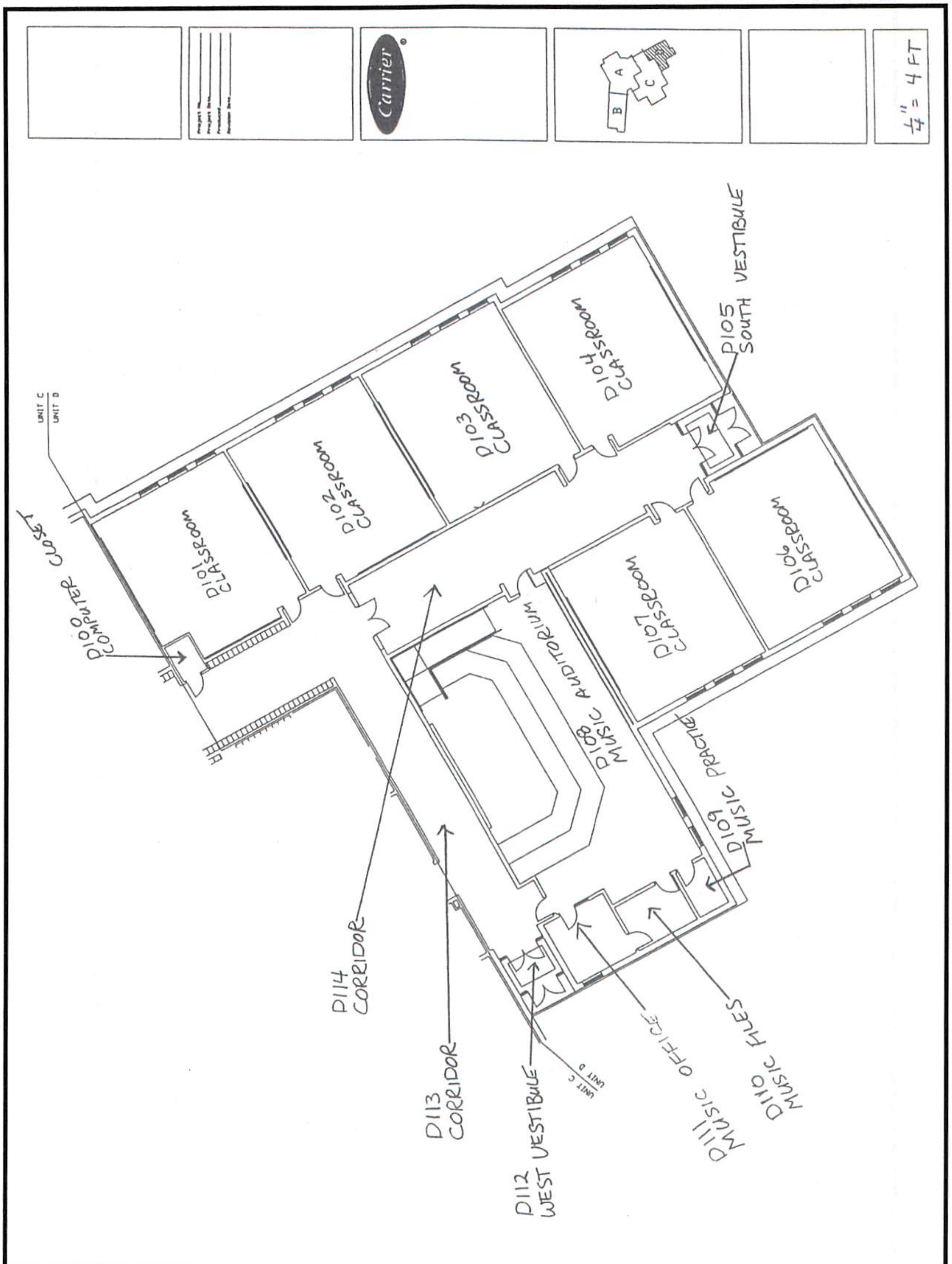
eDesign Suite

Carrier University
6540 Old Collamer Rd. S.
East Syracuse, NY 13057
Phone 800.253.1794 • Fax 315.432.6844
e-Mail: software.systems@carrier.utc.com
World Wide Web: www.commercial.carrier.com


Hourly Analysis Program
Version For Windows
Basic Training Seminar
Carrier
Commercial Systems & Services
B
C
D
A100 EAST VESTIBULE
A101 COMMONS
A102 RECEPTION
A103 CORRIDOR
A104 ASST. PRIN.
A105 CONFERENCE ROOM
A106 PRINCIPAL
A107 CORRIDOR
A108 RECORDS
A109 ELECTRIC CLOSET
A110 MEN
A111 WOMEN
A112 DEVEL DIRECTOR
A113 CORRIDOR
A114 A/V
A115 STORAGE
A116 CORRIDOR
A117 HEALTH
A118 HEALTH TOILET
A119 GUIDANCE OFFICE
A120 GUIDANCE AREA
A121 MEDIA OFFICE
A122 MEDIA CENTER
A123 MEDIA WORKROOM
A124 HEAD END ROOM
A125 ART DISPLAY
A126 ART ROOM
A127 KILN
A128 WET AREA
A129 ART STOR.
A130 VENDING
A131 BIOLOGY
A132 STAFF LOUNGE
A133 TOILET
A134 CORRIDOR
A135 JANITOR RECEIVING
A136 GIRLS TOILET
A137 BOYS TOILET
A138 CHAPEL
A139 BOOKSTORE
A140 BOOK STORAGE
A141 CORRIDOR
A142 SERVING
A143 KITCHEN
A144 DRY STOR.
A145 INDOOR STORAGE
A146 BOYS TOILET
A147 GIRLS TOILET
A148 COMPUTER CLASSROOM
UNIT A
UNIT B
UNIT C


UNIT A
UNIT B
B100 PLANTS + ANIMALS
B101 SCIENCE STORAGE
B102 SCIENCE PREP
B103 COMPUTER CLOSET
B104 CHEMISTRY ROOM
B105 CLASSROOM
B106 CLASSROOM
B107 CLASSROOM
B108 WEST VESTIBULE
B109 CORRIDOR
B110 CLASSROOM
B111 CLASSROOM
B112 CLASSROOM
B113 CLASSROOM
B114 DIVIDABLE CLASSROOM WEST
B115 DIVIDABLE CLASSROOM EAST


Carrier
C101 CORRIDOR
C102 CLASSROOM
C103 CLASSROOM
C105 ATHLETIC TOILET
C106 GIRLS LOCKER
C107 GIRLS TOILET
C108 GIRLS SHOWERS
C109 COACH TOILET
C112 COACH TOILET
C116 BOYS TOILET
C117 BOY'S SHOWER
C100 GENERAL STORAGE
C104 ATHLETIC OFFICE
C114 CORRIDOR
C110 COACH OFFICE
C113 CORRIDOR
C111 COACH OFFICE
C115 CORRIDOR
C118 BOYS LOCKER
C119 WEIGHT ROOM
C120 MECH RM
C125 INDOOR STORAGE
C124 MECHANICAL
C126 GYMNASIUM
C123 ELECTRICAL
C122 OUTDOOR STORAGE
C121 AEROBIC GYMNASIUM
OUTDOOR MECH. EQUIP PAD


Carrier
A
B
C
1/4" = 4 FT
UNIT C
UNIT D
D100 COMPUTER CLOSET
D101 CLASSROOM
D102 CLASSROOM
D103 CLASSROOM
D104 CLASSROOM
D105 SOUTH VESTIBULE
D106 CLASSROOM
D107 CLASSROOM
D108 MUSIC AUDITORIUM
D109 MUSIC PRACTICE
D110 MUSIC FILES
D111 MUSIC OFFICE
D112 WEST VESTIBULE
D113 CORRIDOR
D114 CORRIDOR

Workshops 1 & 2

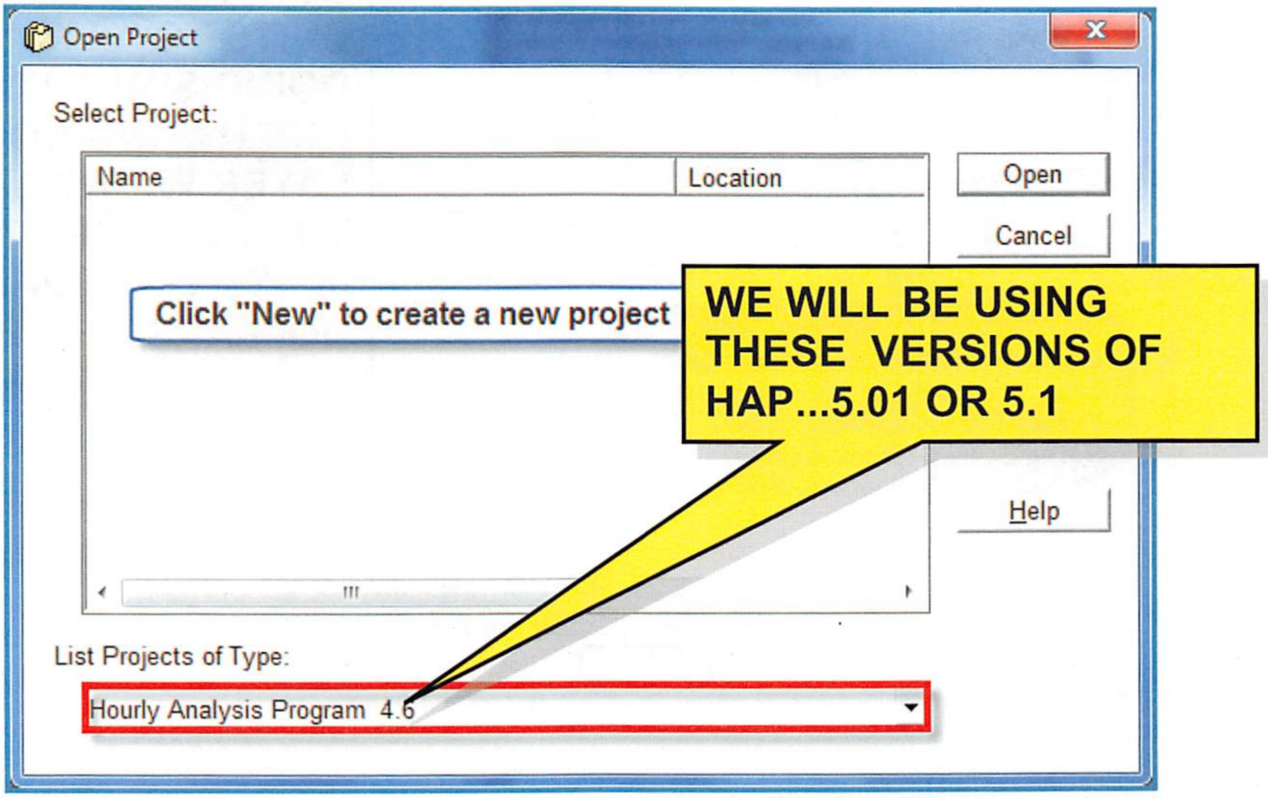
Blank Page

Workshop 1 Inputs - Create New Project and Link Simulation Weather

Our first workshop focuses on expanding an existing design load analysis to include a complete energy simulation. Our first step is retrieving an archived system design load project developed in the HAP for Load Estimating Basic Training Seminar. The retrieval of this project includes all spaces, air systems and library items so we can focus on the additional input requirements for completing an energy analysis. Take the following steps to begin this workshop.

First open windows explorer, navigate to the class flash drive, find the "**Trinidad Energy**" Folder, **copy the entire folder "1.Unsolved Workshops "** <u>**to your desktop**</u>. Then launch HAP and create a new project as shown in Figure 1.1 below.

Figure1.1 - Create New Project in HAP



Setting Project Preferences

Once we create the New Project, HAP prompts us to choose the applicable ventilation standard for the project. This first step in our design process links our project to the appropriate database in determining the ventilation requirements for the spaces and air systems in our project. The choices include:

- User Defined
- ASHRAE 62-2001
- ASHRAE 62.1-2004

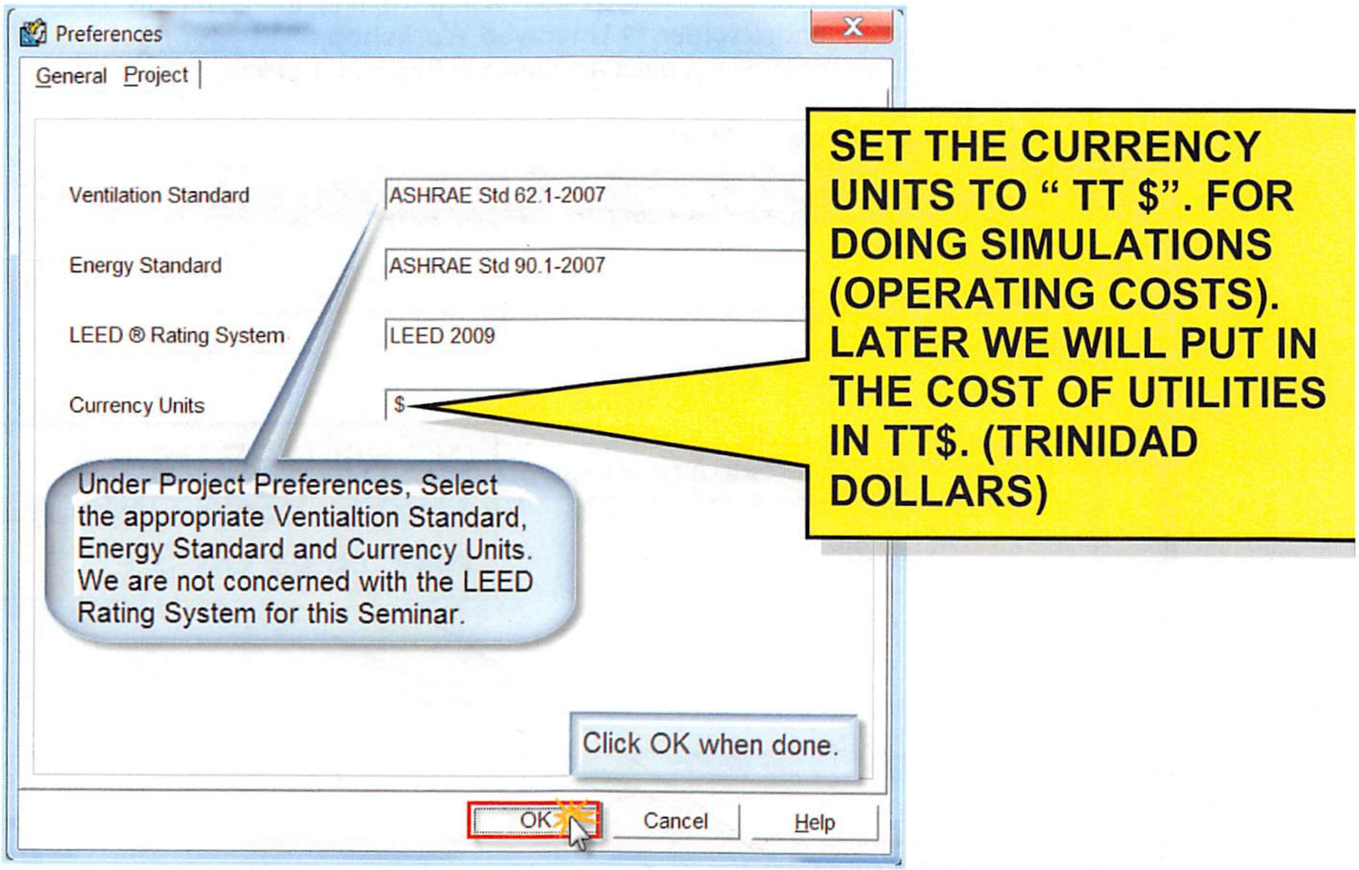
- ASHRAE 62.1-2007

After assigning the appropriate ventilation standard, we assign the appropriate Energy Standard. The choices are:

- ASHRAE 90.1-2004
- ASHRAE 90.1-2007 OR 90.1-2010

Please refer to Fig 1.2 below for additional details.

Figure1.2 – Setting Project Preferences



Select the ASHRAE 62.1-2007 Ventilation Standard, ASHRAE 90.1-2007 Energy Standard and the $ Dollar Currency Symbol $ for our workshop and class project.

Users can set HAP program preferences under the General Tab. Please refer to Figures 1.3 and 1.4 below for additional details of the General HAP program preferences.

Figure 1.3 – HAP Program Preferences

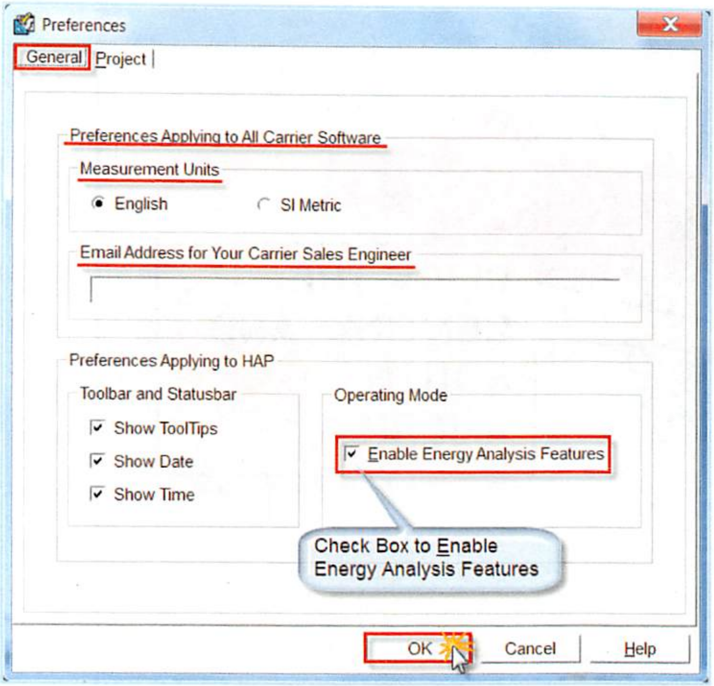
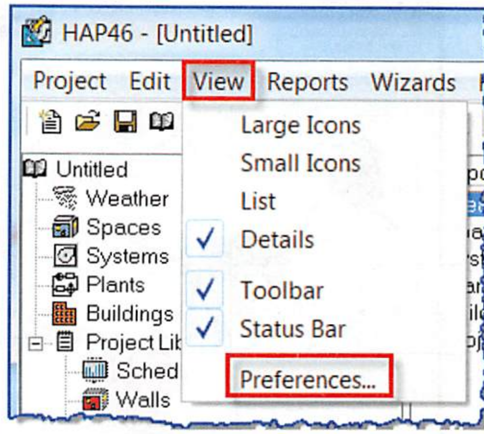


Figure1.4 – View/Preferences



Note: Users can access the Program Preferences anytime by going to the View item on the menu bar and selecting Preferences as shown in Figure1.4

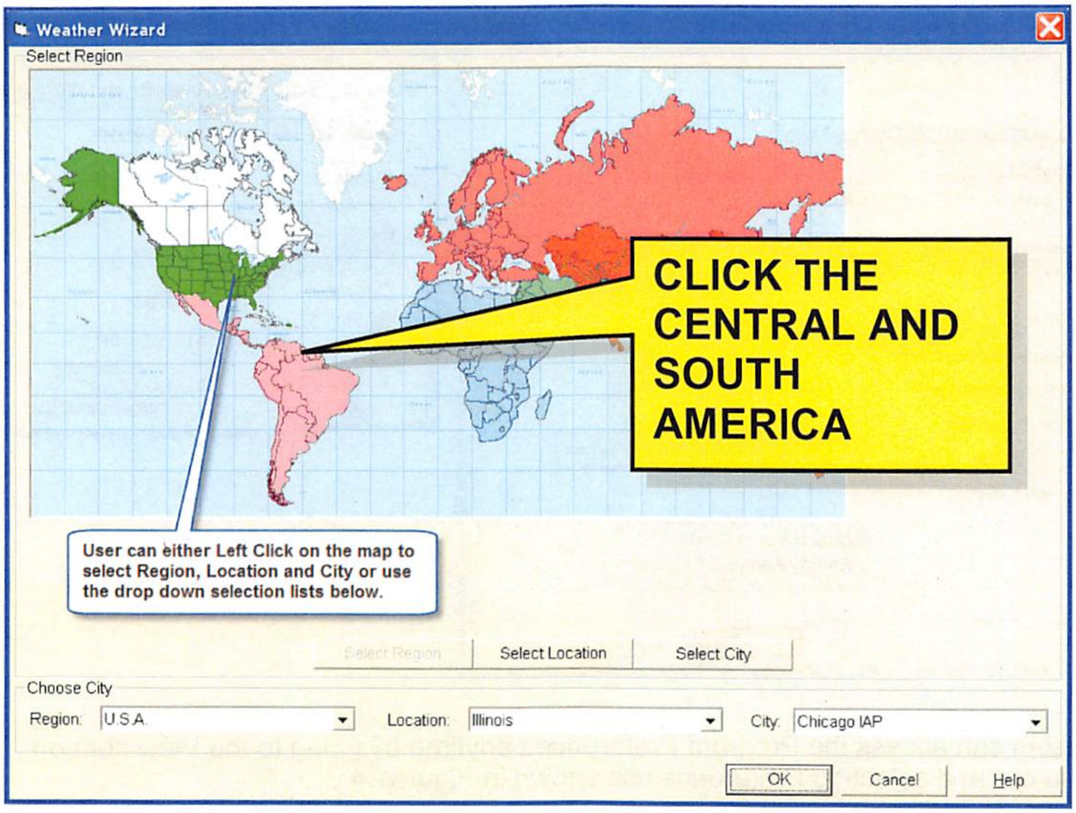
Enter Design and Simulation Weather Properties

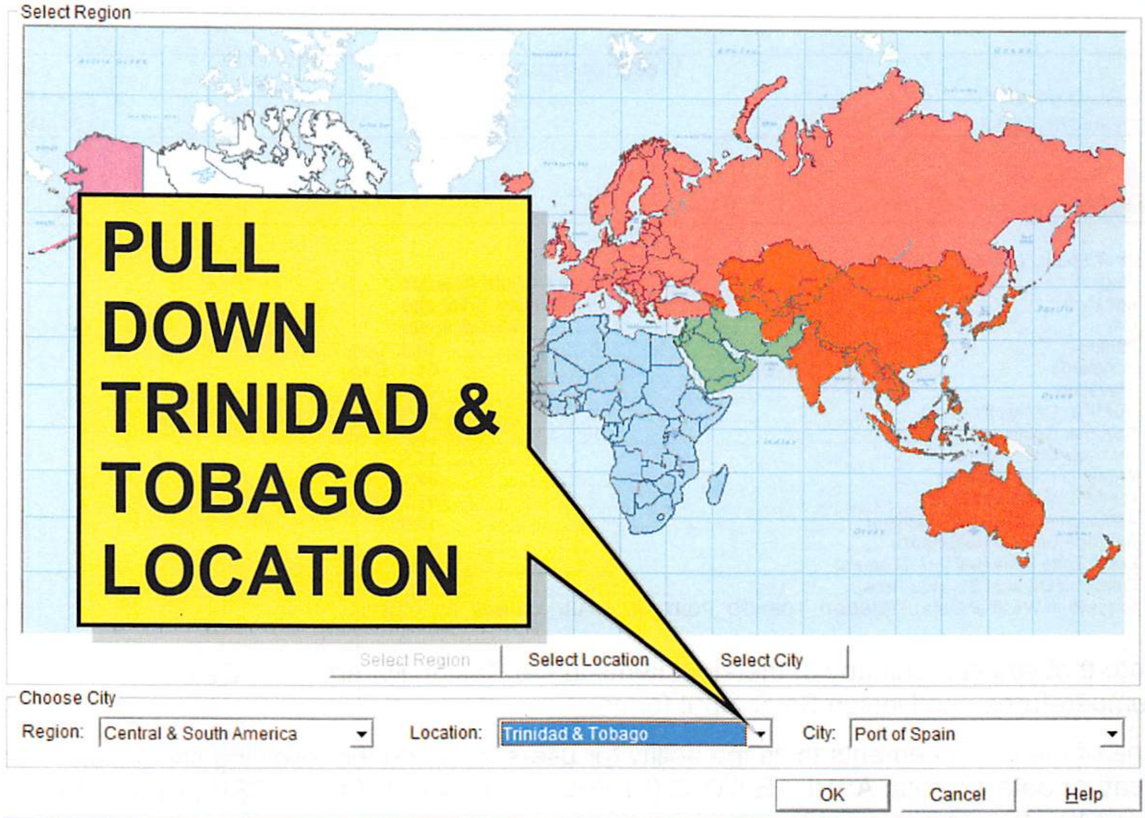
Next, we define the project design weather properties and link the 8760 hour TMY simulation weather file used in energy simulations using one of the following methods. We can assign the defaulted ASHRAE design weather properties by using the "Weather Wizard" or using the Weather Properties input forms. Let's first look at the Weather Wizard.

Go to the "Wizards" item on the menu bar and select "Weather Wizard." When selecting the weather wizard, HAP presents the following graphical interface where the user selects the region, location and city either from the drop down or by clicking on the map. Refer to Fig 1.5 and 1.6 below for details.

Figure1.5 – Selecting Weather Wizard

Figure 1.6 – HAP Weather Wizard





After accepting the wizard inputs HAP converts the Wizard Data to the HAP interface as shown in Figure 1.8.

Weather Inputs

Project: Untitled — 07/23/2017
Prepared By: carrier — 10:26 AM

Weather Inputs

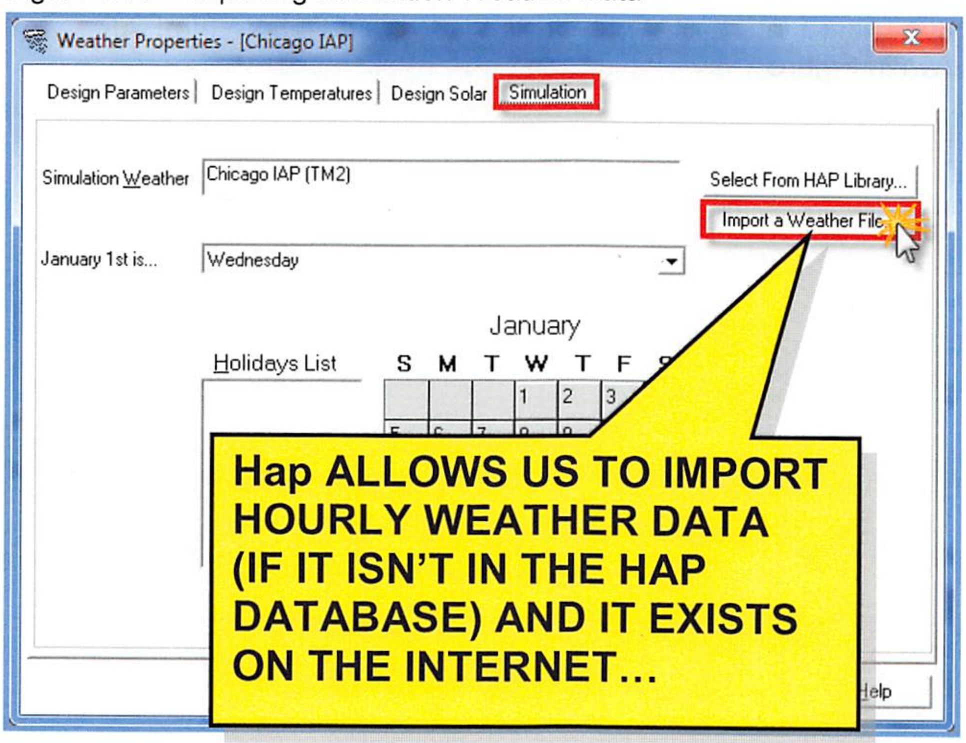
Port of Spain, Trinidad & Tobago

Region	Central & South America	
Location	Trinidad & Tobago	
City	Port of Spain	
Latitude	10.6	Deg.
Longitude	61.3	Deg.
Elevation	49.0	ft
Summer Design Dry-Bulb	92.8	°F
Summer Coincident Wet-Bulb	78.0	°F
Summer Daily Range	13.8	°F
Winter Design Dry-Bulb	69.1	°F
Winter Design Wet-Bulb	57.7	°F
Atmospheric Clearness Number	1.00	
Average Ground Reflectance	0.20	
Local Time Zone (GMT +/- N hours)	4.0	hours
Consider Daylight Savings Time	No	
Simulation Weather Data	TRINIDAD_TOBAGO_PORT_OF_SPAIN_ASHRAE_IWEC2.HW1	

Note that you can edit any of the input items in the Design Parameters, Design Temperatures and Design Solar input forms.

One of the enhancements to is the ability for users to import the following simulation weather data formats: ASHRAE IWEC (*.IWEC), ASHRAE IWEC2 (*.CSV), Energy Plus (*.EPW), USA TMY2 (*.TM2) or USA TMY3 (*.CSV). See Figure 1.10 Below for additional details.

Figure 1.10 – Importing Simulation Weather Data



THAT EXERCISE SHOWED US HOW TO USE THE WEATHER WIZARD. FOR OUR WORKSHOP WE WILL NOW IMPORT A HAP ARCHIVE WITH THE TRINIDAD WEATHER DATA ALREADY CONFIGURED:

1. OPEN A "NEW" PROJECT. SAY "OK" TO PREFERENCES
2. GO TO 'PROJECT", "RETRIEVE HAP 5.0 DATA"
3. BROWSE TO THE DESKTOP AND YOUR FOLDER "2. CLASS FLASH DRIVE TRINIDAD 2017.

4. DOUBLE CLICK ON THE FOLDER CALLED "1. HAP ARCHIVES LOADS AND ENERGY"
5. HIGHLIGHT AND OPEN "UNSOLVED LOADS AND ENERGY"
6. HIGHLIGHT "TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 "
7. OPEN THEN RETRIEVE IT INTO HAP
8. CLICK "PROJECT" "SAVE AS" AND KEEP THE SAME TITLE

Defining the Holiday Schedule

In the simulation input form under the simulation tab, configure energy simulation data for the same city. Note that the first day of the year selection defaults to Sunday and determines where the weekends occur. **Please change day of the week for January 1st to Friday.**

Figure 1.11 – Adding Holidays

The next step is adding the following National Trinidad Holiday dates to the Holidays List by double left clicking the date on the calendar:

Jan 01
Apr 18,21
May 30
June 14,19
July 28
Aug 1,31
Sep 24
Oct 24

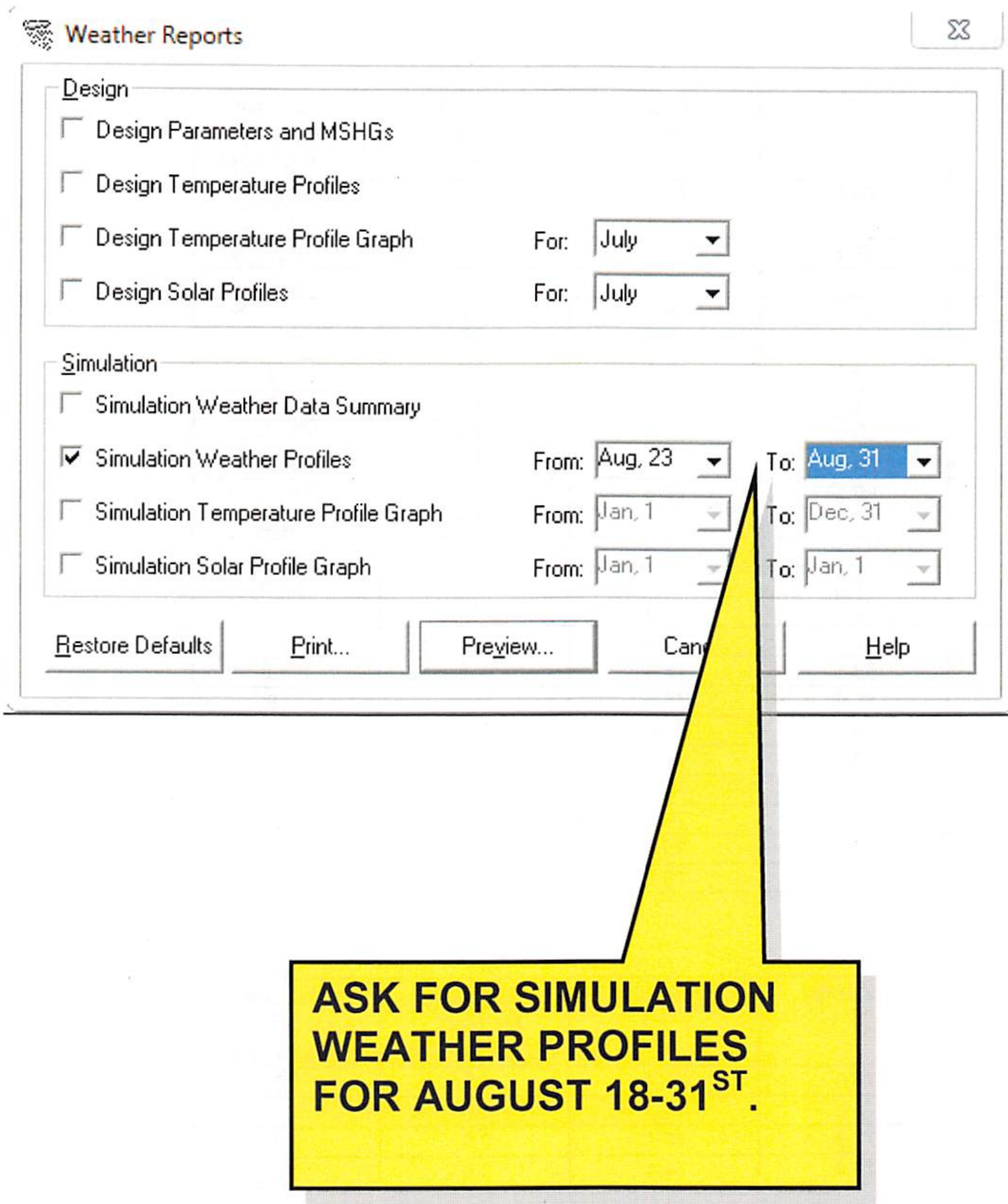
Dec 25,26

Note: Please remember to "**save early and save often**"

Design and simulation weather reports are displayed on the following pages.
Use one of the following procedures to preview the weather input details.

1. Weather reports are available by highlighting "weather" in the left tree then left clicking on "Reports" and choosing "Print/View Input Data"

.


Weather Reports
Design
Design Parameters and MSHGs
Design Temperature Profiles
Design Temperature Profile Graph For: July
Design Solar Profiles For: July
Simulation
Simulation Weather Data Summary
Simulation Weather Profiles From: Aug, 23 To: Aug, 31
Simulation Temperature Profile Graph From: Jan, 1 To: Dec, 31
Simulation Solar Profile Graph From: Jan, 1 To: Jan, 1
Restore Defaults
Print...
Preview...
Help
ASK FOR SIMULATION WEATHER PROFILES FOR AUGUST 18-31ST.

Monday, August 23

Hour	Dry-Bulb (°F)	Wet-Bulb (°F)	Beam Solar on Horiz. (BTU/(hr·ft²))	Total Solar on Horiz. (BTU/(hr·ft²))
0000	78.1	75.8	0.0	0.0
0100	77.5	75.4	0.0	0.0
0200	77.0	75.7	0.0	0.0
0300	76.8	75.4	0.0	0.0
0400	76.5	75.0	0.0	0.0
0500	77.0	74.4	0.0	0.0
0600	80.6	76.6	6.7	21.6
0700	83.7	78.0	33.6	78.9
0800	86.0	79.2	54.8	132.5
0900	89.6	77.6	94.1	191.4
1000	90.3	77.8	90.4	214.0
1100	89.6	77.7	97.0	232.0
1200	91.4	77.0	110.1	241.3
1300	91.0	76.7	124.4	238.5
1400	91.4	77.0	119.6	213.4
1500	89.6	76.5	85.1	161.5
1600	88.5	76.6	50.3	101.0
1700	86.0	76.8	14.1	36.6
1800	80.6	76.6	0.0	0.6
1900	80.2	76.4	0.0	0.0
2000	78.8	76.1	0.0	0.0
2100	78.8	76.1	0.0	0.0
2200	77.7	75.6	0.0	0.0
2300	77.0	75.7	0.0	0.0

Tuesday, August 24

Hour	Dry-Bulb (°F)	Wet-Bulb (°F)	Beam Solar on Horiz. (BTU/(hr·ft²))	Total Solar on Horiz. (BTU/(hr·ft²))
0000	77.0	75.7	0.0	0.0
0100	76.6	75.2	0.0	0.0
0200	77.0	75.7	0.0	0.0
0300	77.0	74.4	0.0	0.0

Workshop 2 – Editing Schedules

This workshop focuses on editing the previously created schedules from our system design load calculations and were included in the retrieved archive. **Please add the following profiles to the schedule as noted:**

Lights Classroom Schedule

Add Profile #4 – Energy Weekday

Hours 00-06: 05%
07: 25%
08-11: 90%
12: 05%
13-15: 90%
16: 40%
17-23: 05%

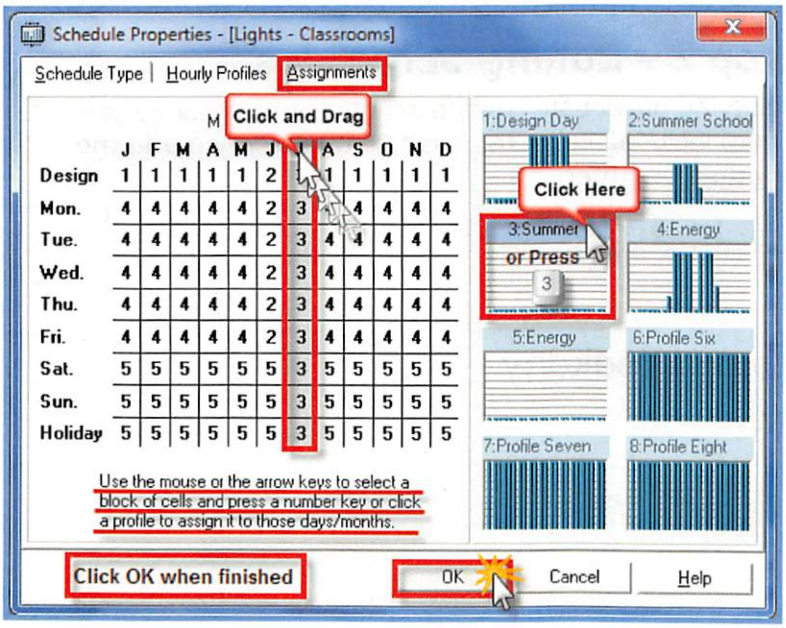
Add Profile #5 – Energy Weekend

Hours 00-23: 05%

On the Assignments tab, assign **Profile #4** to **Monday thru Friday** in all months **except June and July**. Assign existing **Profile #2** from the design load phase to **Monday thru Friday in the month of June only**. Assign existing **Profile #3** to **Monday thru Holiday** for the month of **July** only.

Assign **Profile #5** to day types **Saturday, Sunday, and Holiday** for all months **except July**. Refer to Figure 2.1 for additional details.

Figure 2.1 - Schedule - Profile Assignments-Lights Classrooms


Schedule Properties - [Lights - Classrooms]
Schedule Type
Hourly Profiles
Assignments
Click and Drag
Click Here
1:Design Day
2:Summer School
3:Summer
or Press
3
4:Energy
5:Energy
6:Profile Six
7:Profile Seven
8:Profile Eight
Design
Mon.
Tue.
Wed.
Thu.
Fri.
Sat.
Sun.
Holiday
Use the mouse or the arrow keys to select a block of cells and press a number key or click a profile to assign it to those days/months.
Click OK when finished
OK
Cancel
Help

People Classroom Schedule THIS ONE IS DONE ALREADY IN THE ARCHIVE

Add Profile #4 – Energy Weekday

Hours 00-06: 00%

Hour 07: 10%

Hours 08-11: 90%

Hour 12: 10%

Hours 13-15: 90%

Hour 16: 25%

Hour 17: 10%

Hours 18-23: 00%

Add Profile #5 – Energy Saturday

Hours 00-07: 00%

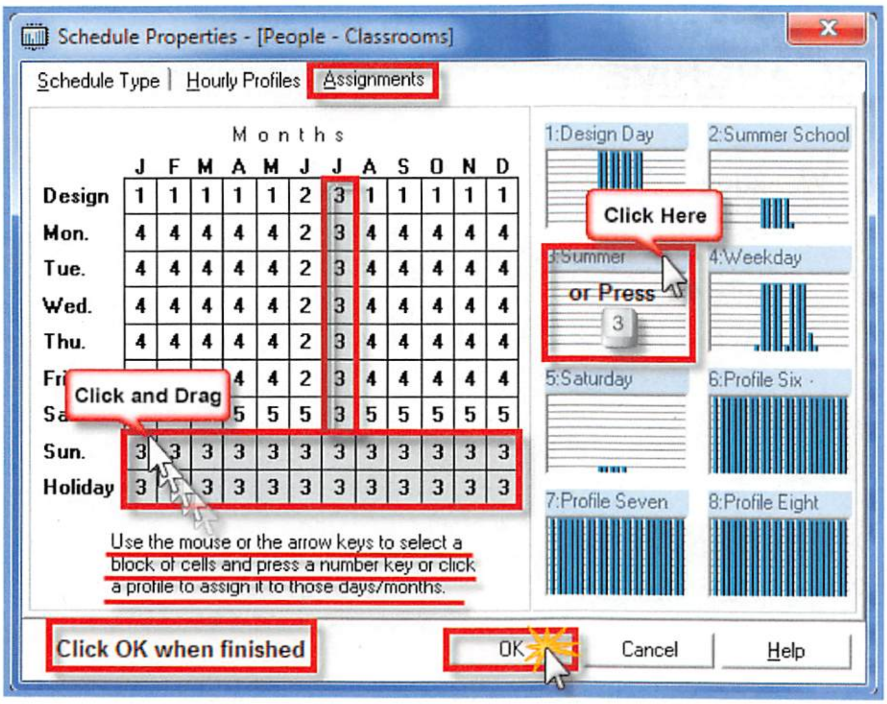
Hours 08-12: 10%

Hours 13-23: 00%

On the Assignments tab, assign **Profile #4** to day types **Monday thru Friday** in **all months except June and July**. Assign **Profile #2** to day types **Monday through Friday** for **June** only and **Profile #3** to **Monday thru Holiday** in **July** only ***plus*** **Sunday and Holiday** for all twelve (12) months.

Assign **Profile #5** to day type **Saturday** for all months **except July.** Refer to Figure 2.2 for details.

Figure 2.2 - Schedule–Profile Assignments-People-Classrooms



The remaining schedules were completed and included in the retrieved archive. They are shown below for reference only.

Schedule Profile Assignments Input Details

Lights - Classrooms (Fractional)

Hourly Profiles:

1:Design Day

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	10	10	10	10	10	10	10	10	100	100	100	100	100	100	100	100	30	10	10	10	10	10	10	10

2:Summer School

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	5	5	5	5	5	5	5	5	60	60	60	60	60	25	5	5	5	5	5	5	5	5	5	5

3:Summer Shutdown

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

4:Energy Weekdays

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	5	5	5	5	5	5	5	5	90	90	90	90	5	90	90	90	40	5	5	5	5	5	5	5

5:Energy Weekends

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Assignments:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Design	1	1	1	1	1	2	3	1	1	1	1	1
Monday	4	4	4	4	4	2	3	4	4	4	4	4
Tuesday	4	4	4	4	4	2	3	4	4	4	4	4
Wednesday	4	4	4	4	4	2	3	4	4	4	4	4
Thursday	4	4	4	4	4	2	3	4	4	4	4	4
Friday	4	4	4	4	4	2	3	4	4	4	4	4
Saturday	5	5	5	5	5	5	3	5	5	5	5	5
Sunday	5	5	5	5	5	5	3	5	5	5	5	5
Holiday	5	5	5	5	5	5	3	5	5	5	5	5

People - Classrooms (Fractional)

Hourly Profiles:

1:Design Day

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	5	100	100	100	100	100	100	100	100	40	10	0	0	0	0	0	0

2:Summer School

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	0	40	40	40	40	40	10	0	0	0	0	0	0	0	0	0	0

3:Summer Shutdown

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4:Weekday Energy

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	10	90	90	90	90	10	90	90	90	25	10	0	0	0	0	0	0

5:Energy Saturday

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	0	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0

Assignments:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Design	1	1	1	1	1	2	3	1	1	1	1	1
Monday	4	4	4	4	4	2	3	4	4	4	4	4
Tuesday	4	4	4	4	4	2	3	4	4	4	4	4
Wednesday	4	4	4	4	4	2	3	4	4	4	4	4
Thursday	4	4	4	4	4	2	3	4	4	4	4	4
Friday	4	4	4	4	4	2	3	4	4	4	4	4
Saturday	5	5	5	5	5	5	3	5	5	5	5	5
Sunday	3	3	3	3	3	3	3	3	3	3	3	3
Holiday	3	3	3	3	3	3	3	3	3	3	3	3

People - Corridors (Fractional)

Hourly Profiles:

1:Design Day

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	50	100	100	100	100	100	100	100	100	30	10	0	0	0	0	0	0

2:Summer School

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0

3:Summer Shut[illegible]

Hour	00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18	19	20	21	22	23
Value	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0

4:Weekday Ener[illegible]

Hour	00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18	19	20	21	22	23
Value	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0

ALL THE SCHEDULES SHOWN HERE ARE ALREADY COMPLETED IN YOUR ARCHIVE. I PRINTED THE INPUTS AS SHOWN ON THESE FOLLOWING PAGES.

5:Energy Weekends

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Assignments:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Design	1	1	1	1	1	2	3	1	1	1	1	1
Monday	4	4	4	4	4	2	3	4	4	4	4	4
Tuesday	4	4	4	4	4	2	3	4	4	4	4	4
Wednesday	4	4	4	4	4	2	3	4	4	4	4	4
Thursday	4	4	4	4	4	2	3	4	4	4	4	4
Friday	4	4	4	4	4	2	3	4	4	4	4	4
Saturday	5	5	5	5	5	5	3	5	5	5	5	5
Sunday	5	5	5	5	5	5	3	5	5	5	5	5
Holiday	5	5	5	5	5	5	3	5	5	5	5	5

People IT Room (Fractional)

Hourly Profiles:

1:Design Day

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	10	100	0	0	0	100	0	0	100	0	10	0	0	0	0	0	0

2:Summer School

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	0	0	0	0	0	0	0	0	0	40	0	0	40	0	0	0	0	0	0	0	0	0	0	0

3:Summer Shutdo[illegible]

Hour	00	01	[illegible]	19	20	21	22	23
Value	0	0	[illegible]	0	0	0	0	0

ALL THE SCHEDULES SHOWN HERE ARE ALREADY COMPLETED IN YOUR ARCHIVE. I PRINTED THE INPUTS AS SHOWN ON THESE FOLLOWING PAGES.

Assignments:

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Nov	Dec
Design	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1
Monday	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1
Tuesday	1	1	1	1	1	2	3	1	1	1	1	1
Wednesday	1	1	1	1	1	2	3	1	1	1	1	1
Thursday	1	1	1	1	1	2	3	1	1	1	1	1
Friday	1	1	1	1	1	2	3	1	1	1	1	1
Saturday	3	3	3	3	3	3	3	3	3	3	3	3
Sunday	3	3	3	3	3	3	3	3	3	3	3	3
Holiday	3	3	3	3	3	3	3	3	3	3	3	3

Equipment IT (Fractional)

Hourly Profiles:

1:design

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	25	25	25	25	25	25	25	80	80	50	50	50	80	70	60	50	80	50	25	25	25	25	25	25

2:Summer

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25

Assignments:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Design	1	1	1	1	1	2	2	1	1	1	1	1
Monday	1	1	1	1	1	2	2	1	1	1	1	1
Tuesday	1	1	1	1	1	2	2	1	1	1	1	1
Wednesday	1	1	1	1	1	2	2	1	1	1	1	1
Thursday	1	1	1	1	1	2	2	1	1	1	1	1
Friday	1	1	1	1	1	2	2	1	1	1	1	1
Saturday	2	2	2	2	2	2	2	2	2	2	2	2
Sunday	2	2	2	2	2	2	2	2	2	2	2	2
Holiday	2	2	2	2	2	2	2	2	2	2	2	2

Occupied Schedule - Classroom (Fan / Thermostat)

Hourly Profiles:

1:Design Day

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	U	U	U	U	U	U	O	O	O	O	O	O	O	O	O	O	O	O	U	U	U	U	U	U

2:Summer School

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Value	U	U	U	U	U	U	O	O	O	O	O	O	O	O	U	U	U	U	U	U	U	U	U	U

3:Summer Shutdn Wee[illegible]

Hour	00	01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19	20	21	22	23
Value	U	U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	U	U	U	U	U

4:Energy Weekdays

Hour	00	01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19	20	21	22	23
Value	U	U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	U	U	U	U	U

O = Occupied; U = U[illegible]

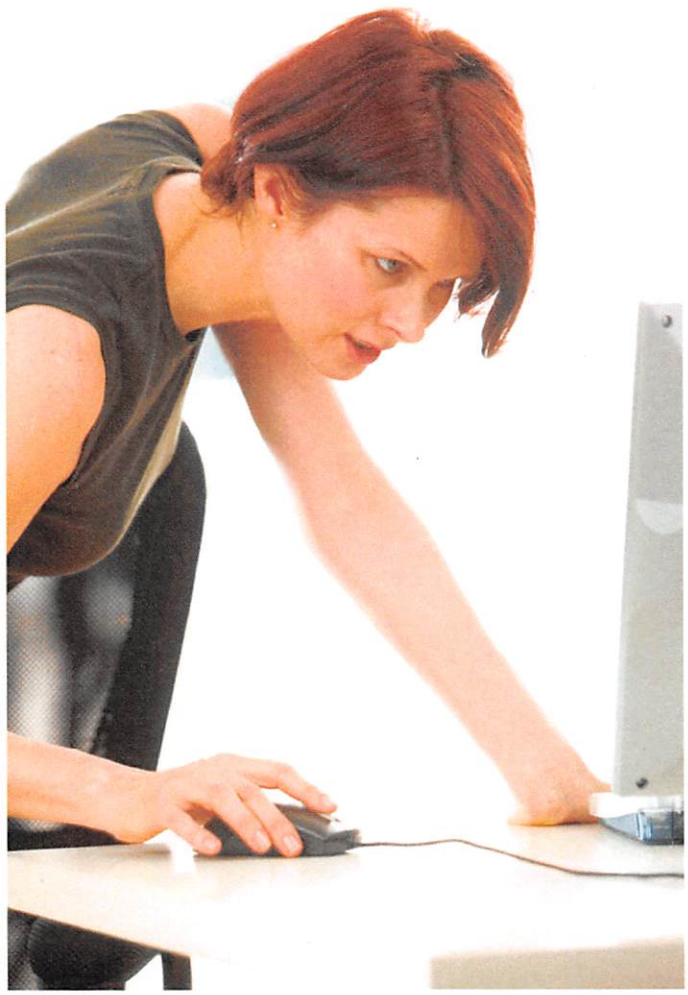
ALL THE SCHEDULES SHOWN HERE ARE ALREADY COMPLETED IN YOUR ARCHIVE. I PRINTED THE INPUTS AS SHOWN ON THESE FOLLOWING PAGES.

Assignments:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Design	1	1	1	1	1	2	3	1	1	1	1	1
Monday	4	4	4	4	4	2	3	4	4	4	4	4
Tuesday	4	4	4	4	4	2	3	4	4	4	4	4
Wednesday	4	4	4	4	4	2	3	4	4	4	4	4
Thursday	4	4	4	4	4	2	3	4	4	4	4	4
Friday	4	4	4	4	4	2	3	4	4	4	4	4
Saturday	3	3	3	3	3	3	3	3	3	3	3	3
Sunday	3	3	3	3	3	3	3	3	3	3	3	3
Holiday	3	3	3	3	3	3	3	3	3	3	3	3

Blank Page

Workshop 3 Inputs

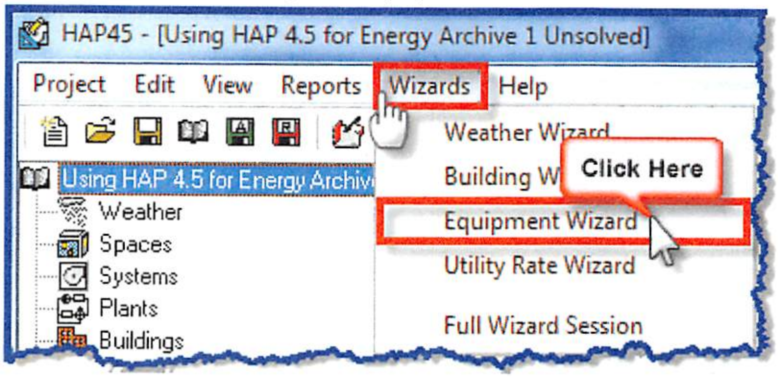


Blank Page

Workshop 3 - Modeling 4-Pipe Fan Coil Unit Air Systems - Using the Equipment Wizard.

Launch the Equipment Wizard by selecting the Wizard item on the Menu bar and clicking the Equipment Wizard on the list. See Figure 3.1 for details.

Figure 3.1 - Launching the Equipment Wizard



Next add the following spaces top the system. **Assign spaces D100 through D114 to the building and click OK. Refer to Figure 3.2 for additional details.**

Figu

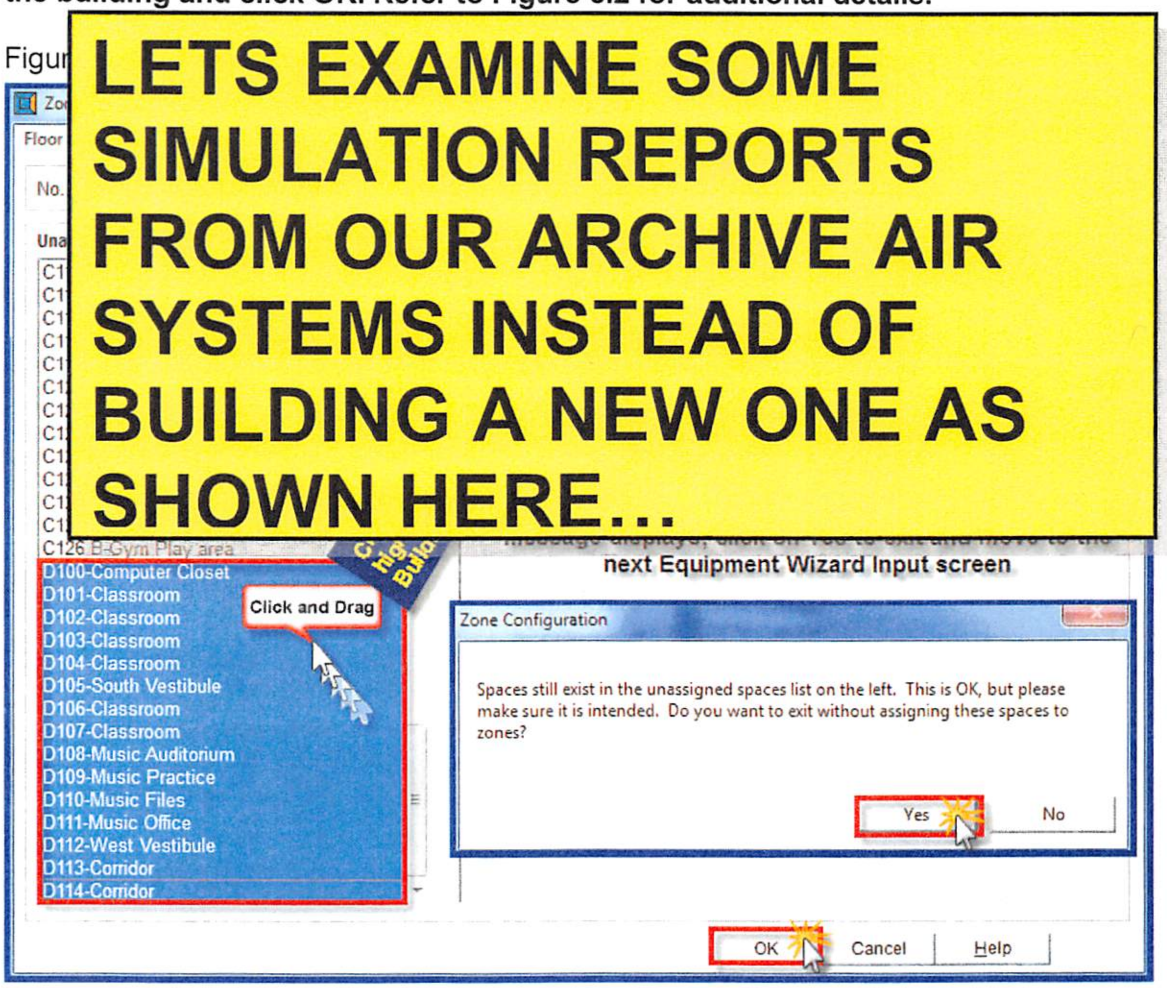
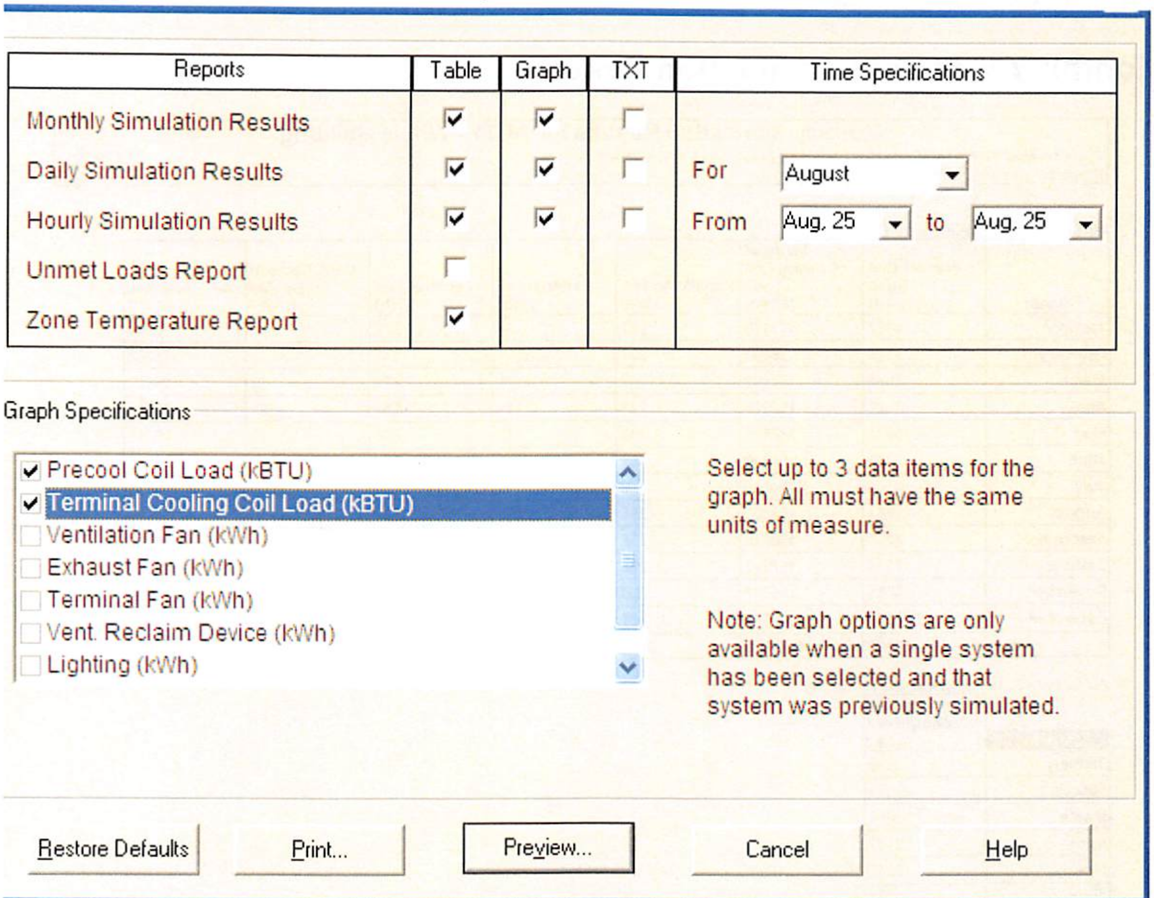


Figure 3.8 - Rerun and View all Air System Simulation Results



LETS EXAMINE SIMULATION REPORTS REFLECTING OUR LOCATION

System Simulation Reports Monthly, Daily and Hourly Simulation Results

Monthly Air System Simulation Results

Monthly Simulation Results for ALT1 - Whole Building

Project Name: TRINIDAD ENERGY UNSOLVED ARCHIVE 1 WK THRU 10/19/2013
Prepared by: carrier corporation 07:23AM

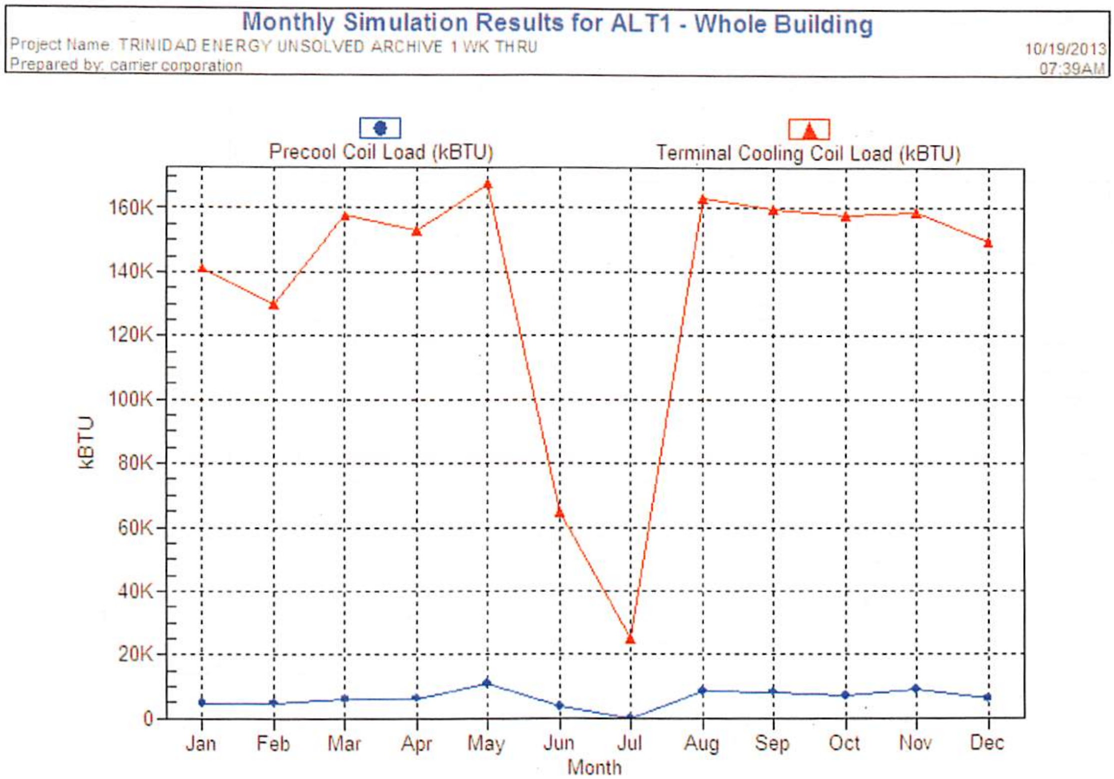
Air System Simulation Results (Table 1) :

Month	Precool Coil Load (kBTU)	Terminal Cooling Coil Load (kBTU)	Ventilation Fan (kWh)	Exhaust Fan (kWh)	Terminal Fan (kWh)	Vent. Reclaim Device (kWh)	Lighting (kWh)
January	4866	141110	227	151	578	47	16641
February	4875	129863	227	151	547	46	15283
March	6036	157599	261	174	616	55	16997
April	6327	152996	238	159	589	50	16249
May	10873	167656	238	159	606	50	16818
June	3709	64740	159	106	338	34	5849
July	0	24926	0	0	64	0	611
August	8701	163062	238	159	603	50	16643
September	8297	159810	238	159	595	50	16249
October	7048	157940	238	159	607	50	16818
November	8963	158677	250	166	599	53	16426
December	6215	149672	261	174	604	55	16822
Total	**75909**	**1628050**	**2574**	**1716**	**6346**	**541**	**171404**

Air System Simulation Results (Table 2) :

Month	Electric Equipment (kWh)
January	3227
February	2931
March	3252
April	3137
May	3235
June	1454
July	506
August	3235
September	3137
October	3235

Monthly Air System Simulation Graph



Daily Air System Simulation Results

Daily Air System Simulation Results for August (Table 1):

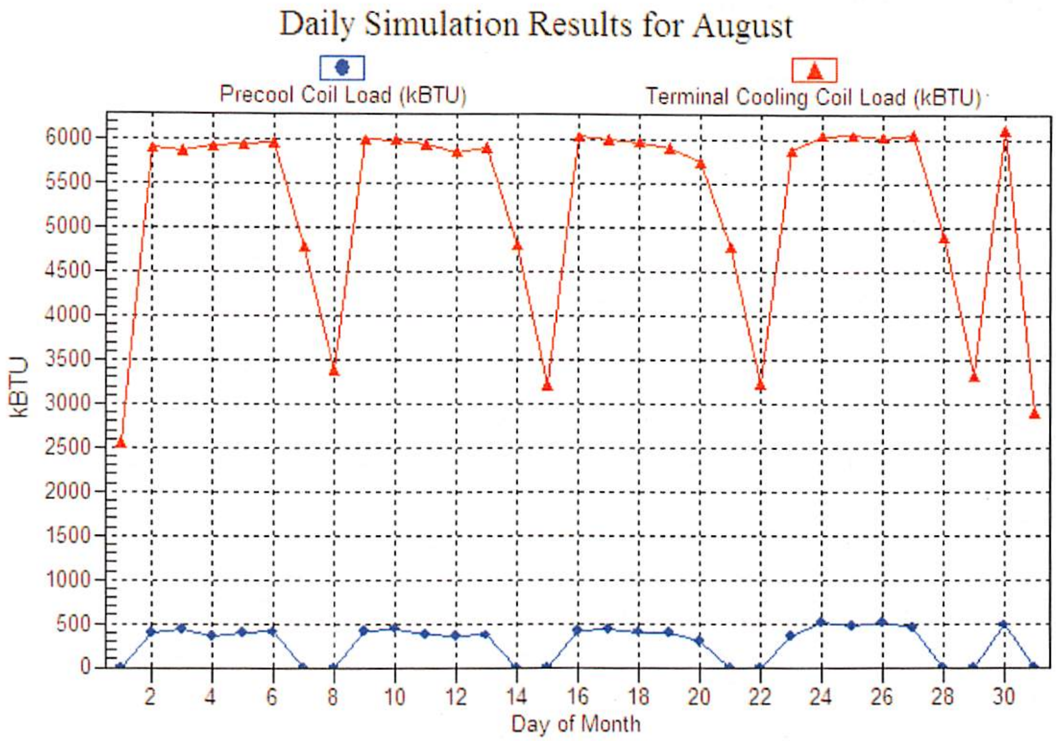
Daily Simulation Results for ALT1 - Whole Building

Project Name: TRINIDAD ENERGY UNSOLVED ARCHIVE 1 WK THRU — 10/19/2013
Prepared by: carrier corporation — 07:23AM

Daily Air System Simulation Results for August (Table 1):

Day	Precool Coil Load (kBTU)	Terminal Cooling Coil Load (kBTU)	Ventilation Fan (kWh)	Exhaust Fan (kWh)	Terminal Fan (kWh)	Vent. Reclaim Device (kWh)	Lighting (kWh)
1	0	2555	0	0	8	0	394
2	398	5903	11	8	22	2	571
3	431	5868	11	8	23	2	571
4	359	5921	11	8	23	2	571
5	393	5942	11	8	23	2	571
6	408	5967	11	8	23	2	571
7	0	4779	0	0	15	0	570
8	0	3386	0	0	11	0	394
9	417	5998	11	8	23	2	571
10	443	5995	11	8	23	2	571
11	383	5950	11	8	23	2	571
12	360	5862	11	8	23	2	571
13	370	5907	11	8	23	2	571
14	0	4800	0	0	15	0	570
15	0	3208	0	0	11	0	394
16	416	6037	11	8	23	2	571
17	434	6012	11	8	23	2	571
18	404	5974	11	8	23	2	571
19	395	5909	11	8	23	2	571
20	299	5746	11	8	23	2	571
21	0	4779	0	0	15	0	570
22	0	3227	0	0	11	0	394
23	359	5863	11	8	23	2	571
24	514	6053	11	8	23	2	571
25	473	6058	11	8	23	2	571
26	508	6032	11	8	23	2	571
27	455	6066	11	8	23	2	571
28	0	4901	0	0	16	0	570
29	0	3318	0	0	11	0	394
30	463	6120	11	8	23	2	571
31	0	2906	0	0	9	0	394
Total	8701	163062	238	159	603	50	16643

Daily Air System Simulation Results



Hourly Air System Simulation Results

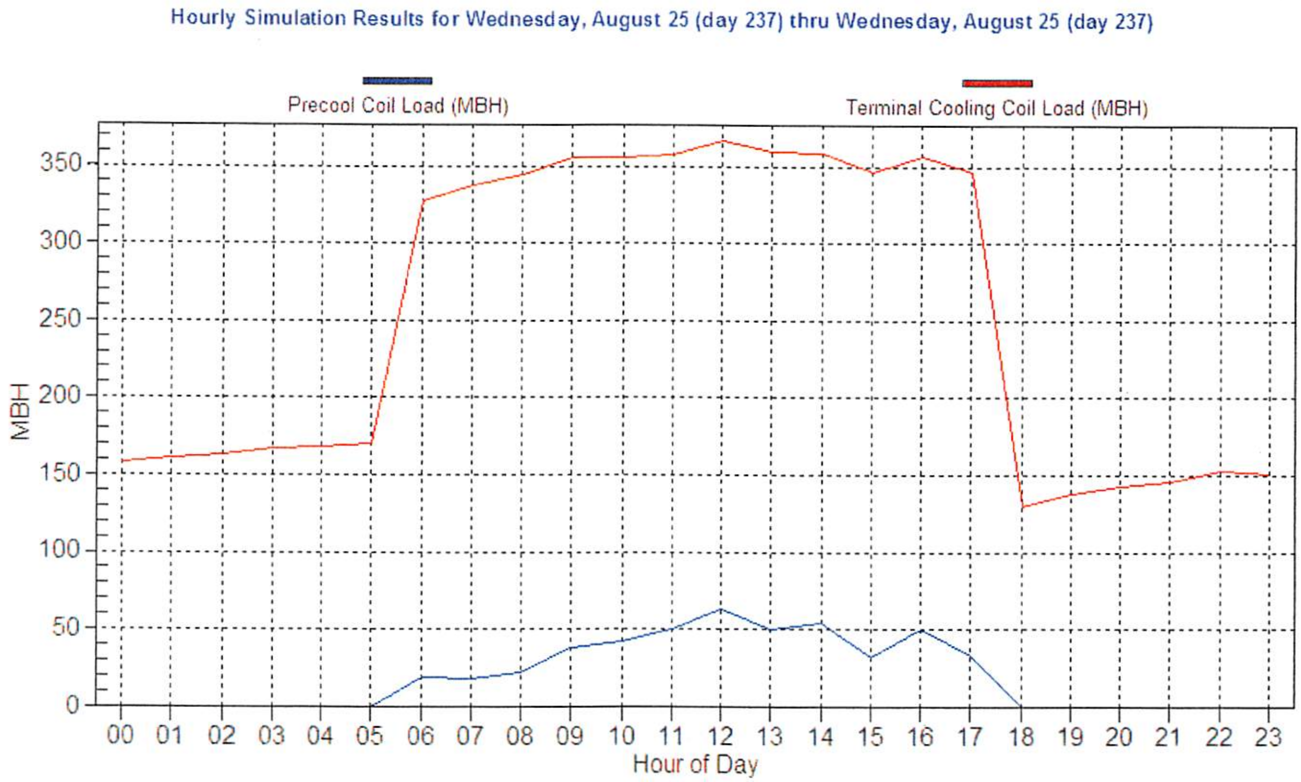
Hourly Simulation Results for ALT1 - Whole Building

Project Name: TRINIDAD ENERGY UNSOLVED ARCHIVE 1 WK THRU — 10/19/2013
Prepared by: carrier corporation — 07:23AM

Table 1.1 Hourly Air System Simulation Results for Wednesday, August 25

Hour	Precool Coil Load (MBH)	Terminal Cooling Coil Load (MBH)	Ventilation Fan (kW)	Exhaust Fan (kW)	Terminal Fan (kW)	Vent. Reclaim Device (kW)	Lighting (kW)
0000	0.0	157.9	0.0	0.0	0.5	0.0	23.7
0100	0.0	161.0	0.0	0.0	0.5	0.0	23.7
0200	0.0	163.4	0.0	0.0	0.5	0.0	23.7
0300	0.0	166.7	0.0	0.0	0.5	0.0	23.7
0400	0.0	168.4	0.0	0.0	0.5	0.0	23.7
0500	0.0	170.3	0.0	0.0	0.5	0.0	23.7
0600	18.7	327.0	0.9	0.6	1.4	0.2	23.7
0700	18.1	337.2	0.9	0.6	1.4	0.2	23.8
0800	21.6	344.3	0.9	0.6	1.4	0.2	24.0
0900	38.5	355.8	0.9	0.6	1.4	0.2	23.9
1000	42.0	355.4	0.9	0.6	1.4	0.2	23.9
1100	50.4	357.9	0.9	0.6	1.4	0.2	23.9
1200	63.7	366.1	0.9	0.6	1.4	0.2	24.0
1300	50.6	359.6	0.9	0.6	1.4	0.2	23.9
1400	54.2	358.4	0.9	0.6	1.4	0.2	23.9
1500	31.8	346.3	0.9	0.6	1.4	0.2	23.9
1600	50.1	356.3	0.9	0.6	1.4	0.2	23.8
1700	33.5	346.0	0.9	0.6	1.4	0.2	23.8
1800	0.0	129.3	0.0	0.0	0.4	0.0	23.7
1900	0.0	137.5	0.0	0.0	0.4	0.0	23.7
2000	0.0	142.5	0.0	0.0	0.4	0.0	23.7
2100	0.0	146.2	0.0	0.0	0.4	0.0	23.7
2200	0.0	153.1	0.0	0.0	0.5	0.0	23.7
2300	0.0	151.2	0.0	0.0	0.5	0.0	23.7
Total	473.2	6057.8	11.3	7.6	23.0	2.4	571.3

Hourly Air System Simulation Results Graph



Zone Temperature Report

1. Zone Temperature Statistics

Zone Temperature Report for ALT1 - Whole Building

Project Name: TRINIDAD ENERGY UNSOLVED ARCHIVE 1 WK THRU — 10/19/2013
Prepared by: carrier corporation — 07:56AM

1. Zone Temperature Statistics

Zone Name	Occ Max Zone Temp (°F)	Occ Hours More Than 5.0 °F Above Throt. Range	Occ Hours 1.0 to 5.0 °F Above Throt. Range	Occ Cooling Setpoint plus Throt. Range (°F)	Occ Hours Within Throt. Range or Dead-band	Occ Heating Setpoint minus Throt. Range (°F)	Occ Hours 1.0 to 5.0 °F Below Throt. Range	Occ Hours More Than 5.0 °F Below Throt. Range	Occ Min Zone Temp (°F)	Unocc Max Zone Temp (°F)	Unocc Cooling Setpoint plus Throt. Range (°F)	Unocc Heating Setpoint minus Throt. Range (°F)	Unocc Min Zone Temp (°F)
D100 - IT Room	74.1	0	0	73.5	2724	68.5	0	0	71.9	82.3	83.5	63.5	82.2
D101 - Classroom	76.5	0	2417	73.5	307	68.5	0	0	72.5	82.9	83.5	63.5	78.1
D102 - Classroom	76.5	0	2417	73.5	307	68.5	0	0	72.5	82.9	83.5	63.5	78.1
D103 - Classroom	76.5	0	2417	73.5	307	68.5	0	0	72.5	82.9	83.5	63.5	78.1
D104 - Classroom	75.8	0	1503	73.5	1221	68.5	0	0	72.5	82.8	83.5	63.5	79.5
D105 - South Vestibule	73.8	0	0	73.5	2724	68.5	0	0	72.4	82.4	83.5	63.5	77.3
D106 - Classroom	75.9	0	1158	73.5	1566	68.5	0	0	72.5	82.8	83.5	63.5	78.2
D107 - Classroom	76.2	0	2119	73.5	605	68.5	0	0	72.5	82.8	83.5	63.5	78.0
D108 - Music Room	77.6	0	2556	73.5	168	68.5	0	0	72.3	82.9	83.5	63.5	76.9
D109 - Music Practice	75.7	0	152	73.5	2572	68.5	0	0	72.4	82.8	83.5	63.5	77.6
D110 - Music Files	76.8	0	1385	73.5	1339	68.5	0	0	72.5	82.7	83.5	63.5	76.5
D111 - Music Office	74.8	0	1	73.5	2723	68.5	0	0	72.6	82.7	83.5	63.5	79.4
D112 - West Vestibule	73.7	0	0	73.5	2724	68.5	0	0	72.5	82.4	83.5	63.5	77.3
D113 - Corridor	78.6	13	2591	73.5	120	68.5	0	0	72.7	82.6	83.5	63.5	75.0
D114 - Corridor	78.8	46	2576	73.5	102	68.5	0	0	72.7	82.7	83.5	63.5	74.9

Note: For any occupied hours in which cooling is unavailable or scheduled off, zone temperature out of range statistics are not reported.
Note: For any occupied hours in which heating is unavailable or scheduled off, zone temperature out of range statistics are not reported.

Note: For any occupied hours in which cooling is unavailable or scheduled off, zone temperature out of range statistics are not reported.

Workshop 4 Inputs

Blank Page

Workshop 4 Modeling Chillers, Towers, (Boilers), and Hydronic Plants

This workshop consists of entering primarily cooling plant information including detailed performance on chillers, towers, (we will also cover boilers) and the distribution piping and pumping.

There are several ways to enter the data into HAP. One option is using the Equipment Wizard found in HAP. Utilizing this wizard creates not only the Air Systems but also the hydronic plants that connect to the air systems. When we used the Equipment Wizard to create the 2Pipe FCU air system in workshop 3 the wizard automatically created the Chiller plant for the air system's source of cooling and heating. Refer to Figures 3.3b and c for additional details. The wizard created plants use the "auto-size" feature when creating the chillers.

We will now create specific chillers, and towers (and boilers) for our design alternatives.

The first step in this workshop is retrieving the second class archive which contains all air systems for our design alternatives.

In the previous workshop #3, we used the Equipment Wizard to
Highlight and retrieve HAP v4.6 for **Energy Simulation Archive 2 Unsolved** into the existing project and then save the project.

In this workshop we create several chillers, and a cooling tower. We will not create boiler plants as would be done in most areas of the USA, we will just use electric heat in our air systems for Trinidad.

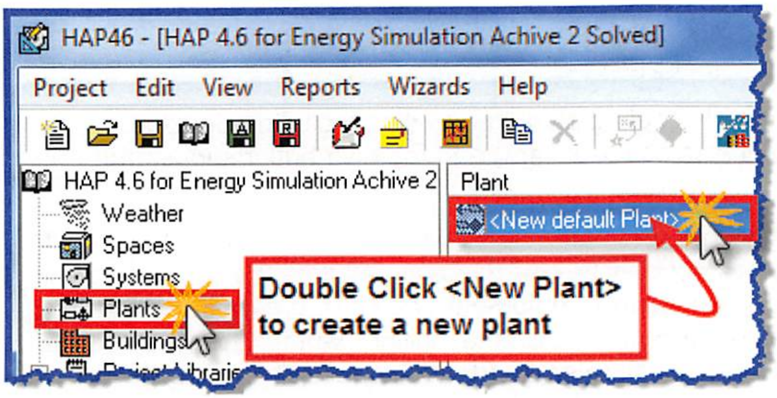
HAP considers all the air systems assigned to the plant in determining the peak coincident, or "block" cooling load, taking into account diversity on several levels. Diversity is defined as the block load divided by the sum of the individual peak loads.

HAP considers diversity between the zones within an air system and between systems when a plant serves multiple air systems. The plant design load calculation analyses the total plant load (sum of air system loads) for each hour and finds the largest load. This analysis includes the zone and air system diversity. When using air system multipliers for identical air systems, the resulting plant sizing includes those requirements in determining the peak plant load.

HAP calculates the total building, project or campus block (cooling) load accounting for diversity in sizing the plant and plant equipment.

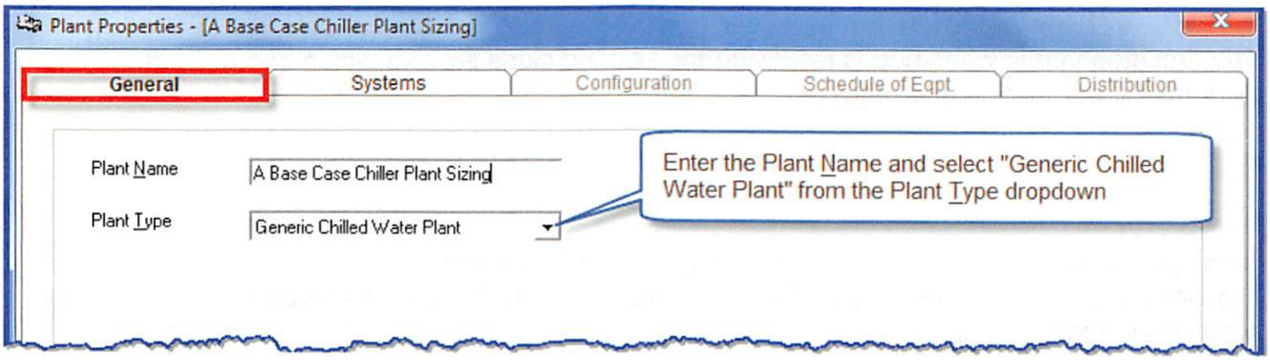
We begin the process by determining the chiller plant sizing for the A Base Case and also the C Alt #2 design Case. In the HAP main window, click on the Plant item in the tree and select "create new plant" in the detail pane. Refer to Figure 4.2 for details.

Figure 4.2 - Create New Chiller Plant



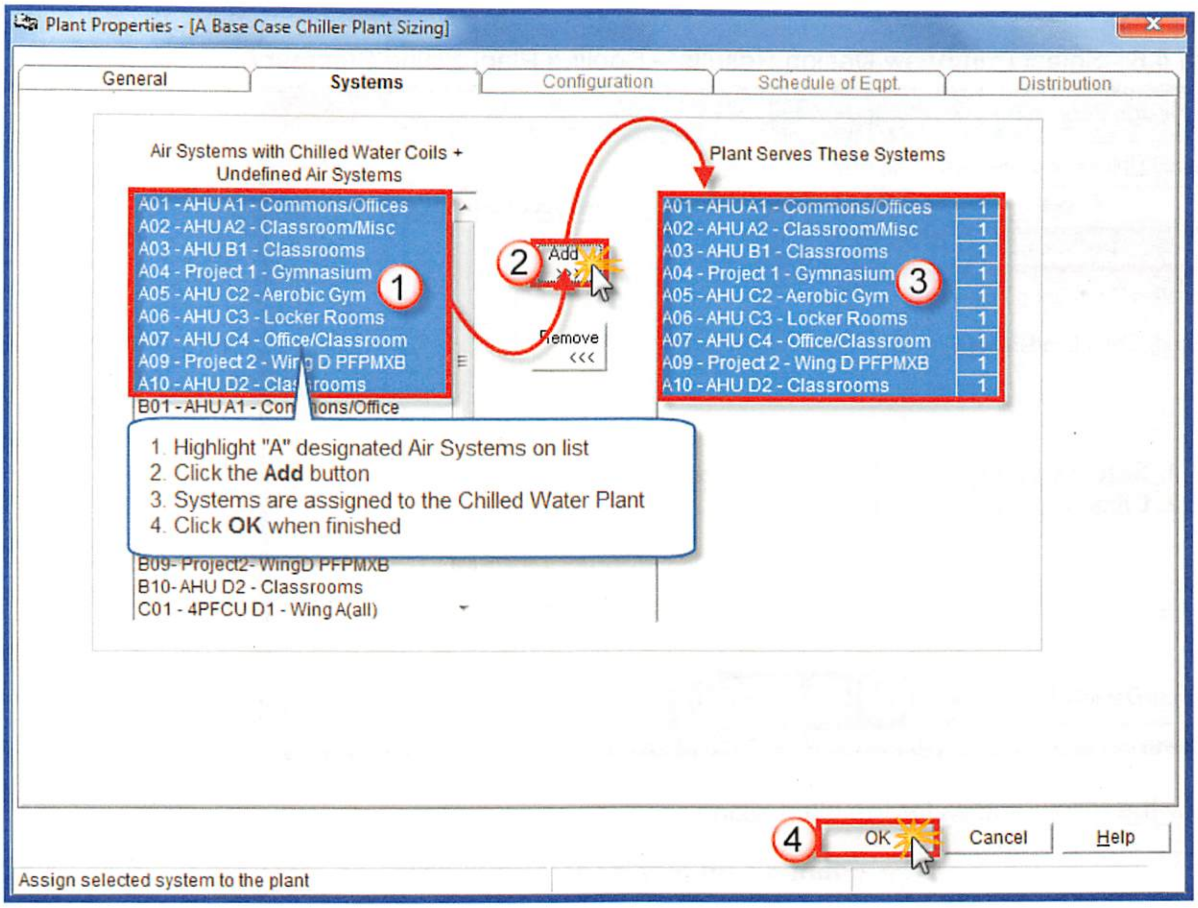
This opens the Plant Input form for data entry. Please refer to Figure 4.3 for A Base Case Chilled Water Plant sizing procedure.

Figure 4.3 - Generic Chiller Plant Sizing Details



Next click on the "Systems" tab and add the A Base Case air systems to the chilled water plant and left click on the OK button. Refer to Figure 4.4 for details.

Figure 4.4 - Add "A Base Case" Air Systems to the Generic Chilled Water Plant



This takes us back to the HAP plant screen showing the newly created plant on the list. Highlight the plant and use the right mouse click then select "print/view design results" from the selection list. Refer to Figures 4.5 and 4.6 for additional details.

Figure 4.5 - Calculate Chiller Plant Design Load

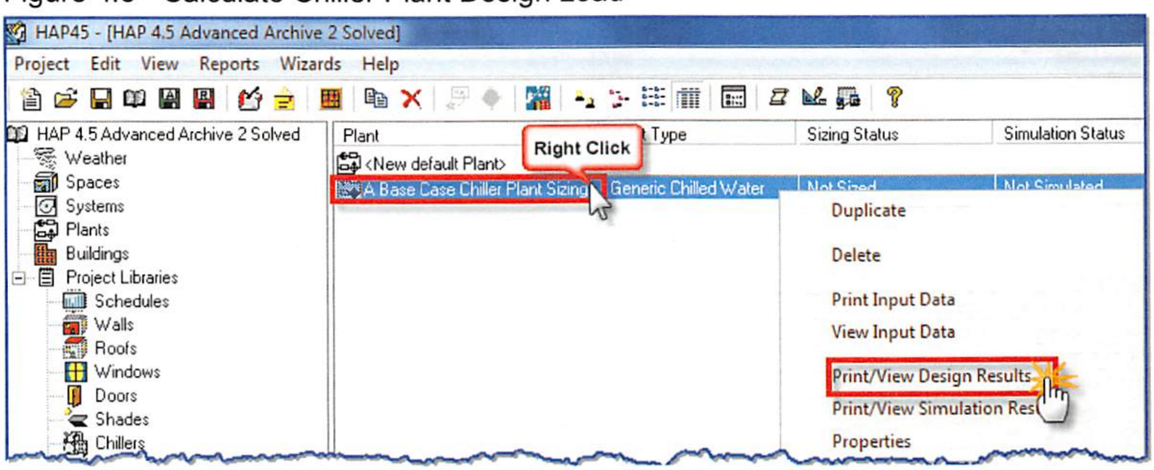
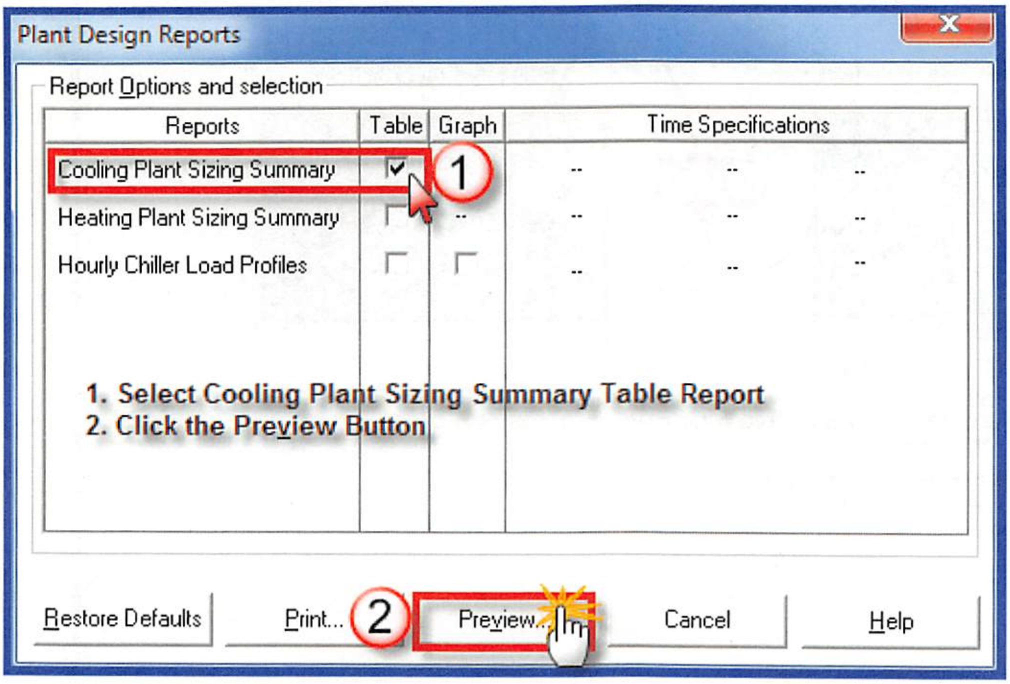


Figure 4.6 - Select Print/View Design Results – Cooling Plant Sizing Summary



Review the follow details for the plant sizing.

Plant Sizing Summary for A SIZING

TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru carrier — 07/24/2017 08:58PM

1. Plant Information:

Plant Name .... A SIZING
Plant Type .... Generic Chilled Water
Design Weather .... Port of Spain, Trinidad & Tobago

2. Cooling Plant Sizing Data:

Maximum Plant Load .... 267.6 Tons
Load occurs at .... Sep 1500
ft²/Ton .... 222.6 ft²/Ton
Floor area served by plant .... 59553.0 ft²

3. Coincident Cooling Loads for Sep 1500

Air System Name	Mult.	System Cooling Coil Load [Tons]
A01 - AHU A1 - Commons/Offices	1	45.6
A02 - AHU A2 - Classroom/Misc.	1	40.3
A03 - AHU B1 - Classrooms	1	44.5
A04 - Project 1 Gymnasium	1	42.6
A05 - AHU C2 - Aerobics Gym	1	15.1
A06 - AHU C3 - Locker Rooms	1	30.2
A07 - AHU C4 - Office/Classroom	1	11.9
A09 - Project 2 - Wing D PFPMXB	1	18.4
A10 - AHU D2 - Classrooms	1	19.1

Air system loads are for coils whose cooling source is ' Chilled Water ' or ' Any '.

System loads are for coils whose cooling source is ' Chilled Water ' or ' Any '.

Figure 4.7 details the chiller plant sizing summary for the A Base Design Case air systems.

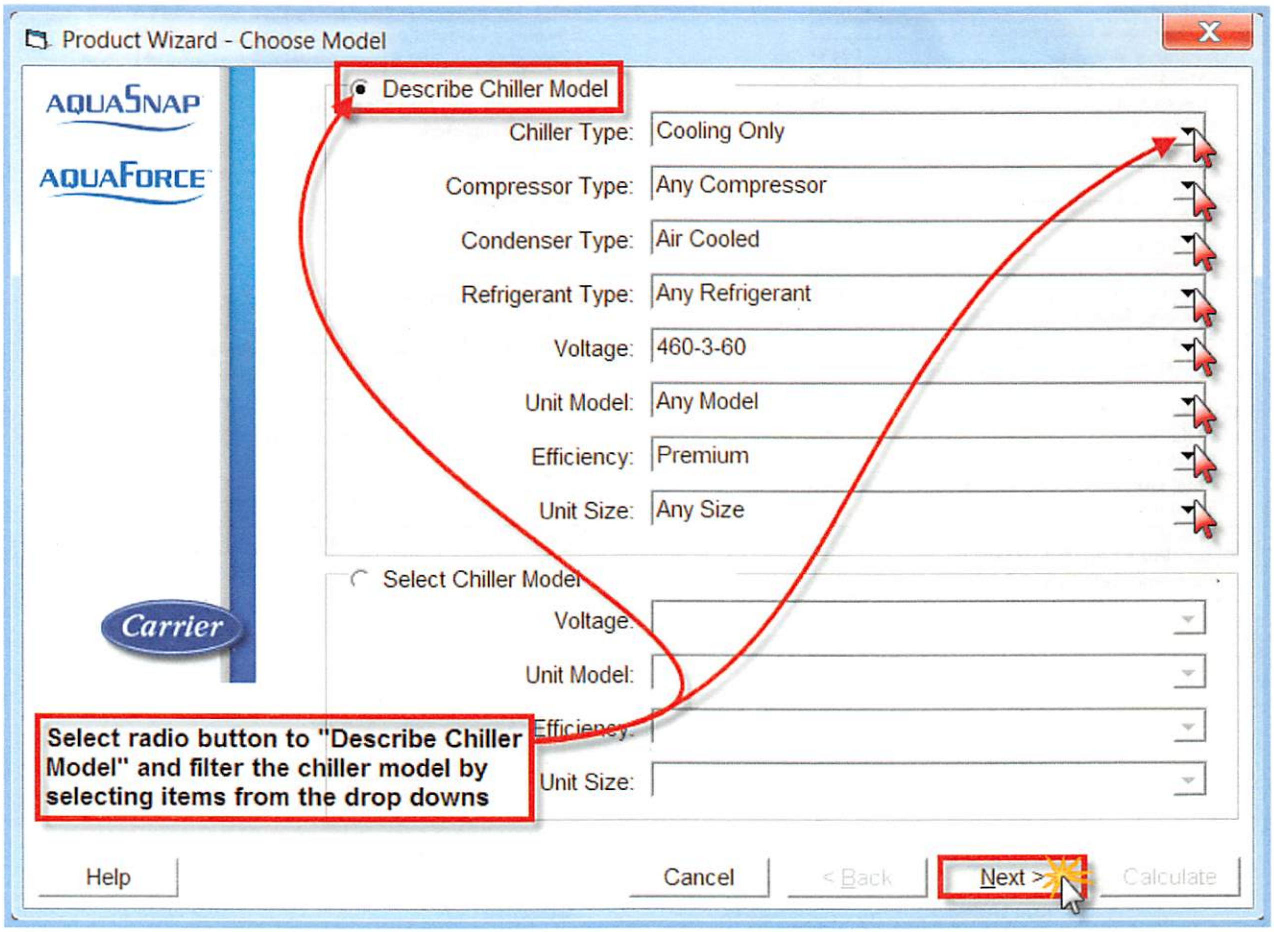
The resulting peak plant load for the "A Base Case" is 268 tons. This peak load includes diversity as discussed above. **For our "A Base Case" design we decide to use two (2) equally sized air-cooled chillers in our chiller plant**With the maximum plant load determined, we can select specific chillers for the chiller plant. This is accomplished in one of several ways. For our exercise we selected the chillers in the e-Cat Chiller Builder program. After finalizing the selection, we exported the chiller data for use in our project. This allows us to import the actual chiller performance for a detailed energy analysis of the chiller plant. Copies of the chiller data files are on the accompanying flash drive.

Air Cooled Chiller Selection

Design based on the following parameters.

Quantity:	2 Air-Cooled Packaged Rotary Screw Chillers
Capacity:	140 Tons each at 95° F plus a safety factor of 15%
LCHWT:	44° F
ECHWT:	56° F

Figure 4.8 - Details of Chiller Selection using e-Cat Selection Software.



Run the calculations and generate the Chiller Performance Report.

See following page for details.

AquaForce™ Air-Cooled Screw Chiller

Unit Information

Tag Name:	B Alt 1 A/C Chillers	
Model Number:	30XA140	
Quantity:	1	
Manufacturing Source:	Charlotte, NC USA	
Refrigerant:	R134A	
Independent Refrigerant Circuits:	2	
Shipping Weight:	10497	lb
Operating Weight:	10629	lb
Unit Length:	236	in
Unit Width:	89	in
Unit Height:	90	in

Evaporator Information

Fluid Type:	Fresh Water	
Fouling Factor:	0.00010	(hr-sqft-F)/BTU
Number of Passes:	2	
Leaving Temperature:	44.0	°F
Entering Temperature:	54.0	°F
Fluid Flow:	318.7	gpm
Pressure Drop:	13.3	ft

Condenser Information

Altitude:	564	ft
Number of Fans:	10	
Total Condenser Fan Air Flow:	93000	CFM
Entering Air Temperature:	95.0	°F

Integrated Pump Information

No Pump Selected

Performance Information

Cooling Capacity:	133.3	Tons
Total Compressor Power:	133.7	kW
Total Fan Motor Power:	12.9	kW
Total Unit Power (without pump):	146.6	kW
Efficiency (without pump):	10.91	EER
A-Weighted Sound Power Level:	101	dbA

Accessories and Installed Options

Freeze Protection
Micro Channel
XL Starter
Single Point
No Coil Trim Panels
Touch Pilot Display

Electrical Information

Unit Voltage:	460-3-60	V-Ph-Hz
Connection Type:	Single Point	
Minimum Voltage:	414	Volts
Maximum Voltage:	506	Volts

Amps	Electrical Circuit 1	Electrical Circuit 2
MCA	267.3	---
MOCP	400.0	---
ICF	1030.4	---

WE MADE A SELECTION IN THE CARRIER CHILLER BUILDER FOR A 140 TON CHILLER. IT IS IN THE “3. CHILLERS FOR IMPORT” FOLDER ON YOUR DESKTOP

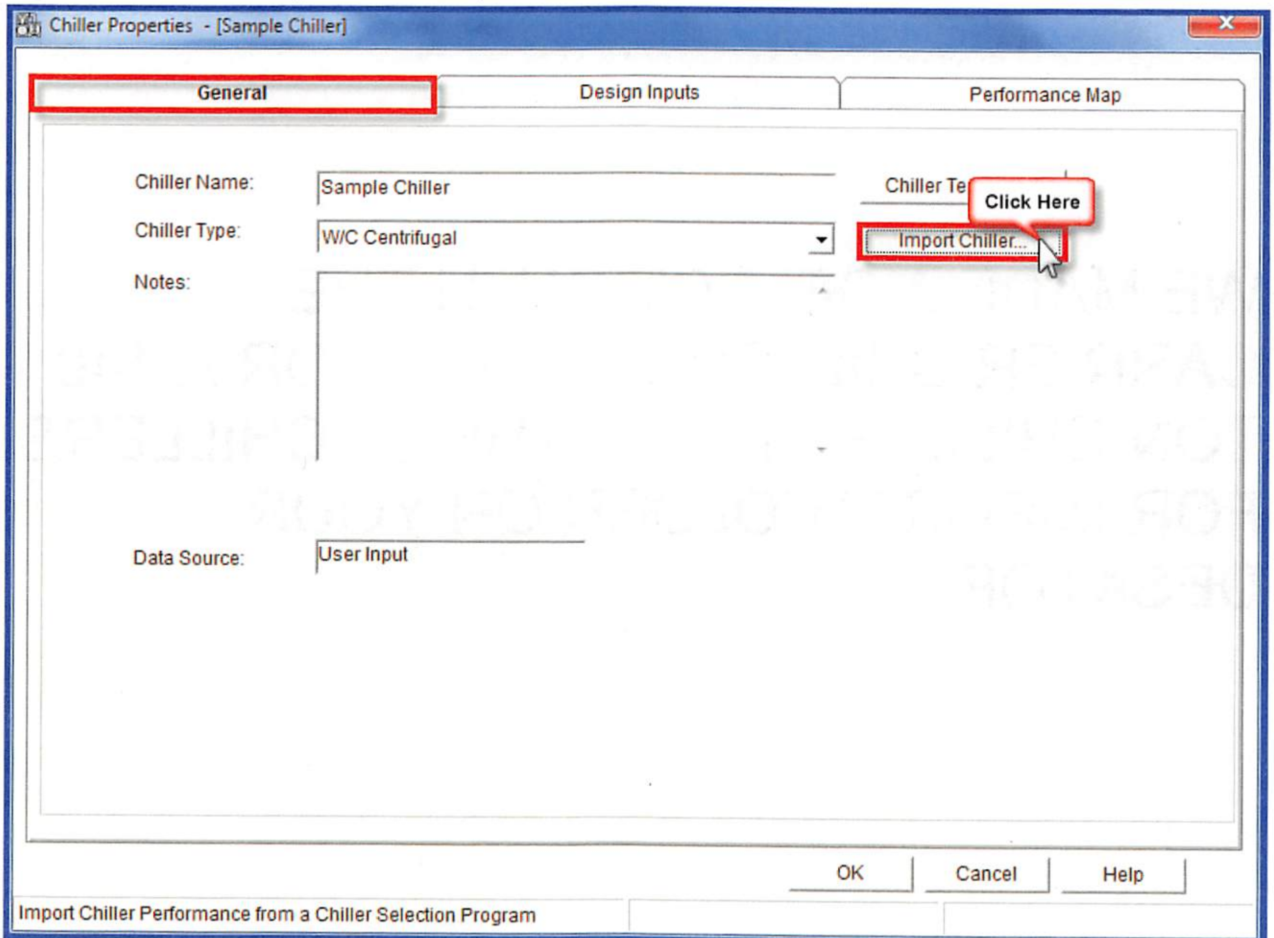
Entering Chiller Performance Data

There are three (3) methods to enter chiller data into HAP.
1. Import Chiller
2. Chiller Template
3. User Defined Chiller Type
In this Workshop, we enter chiller data using method 1 and method 2. We will demonstrate method 3 but not use it in a workshop.

For our Air Cooled Packaged Screw Chiller we selected using the Packaged Chiller Builder program, we have included in your flashdrive a file that contains the detailed chiller performance for use by HAP. To import the actual performance matrix of our chiller for use in our plant model we use the "Import Chiller" method in the chiller properties input form. Refer to Figure 4.9a through Figure 4.9d for details.

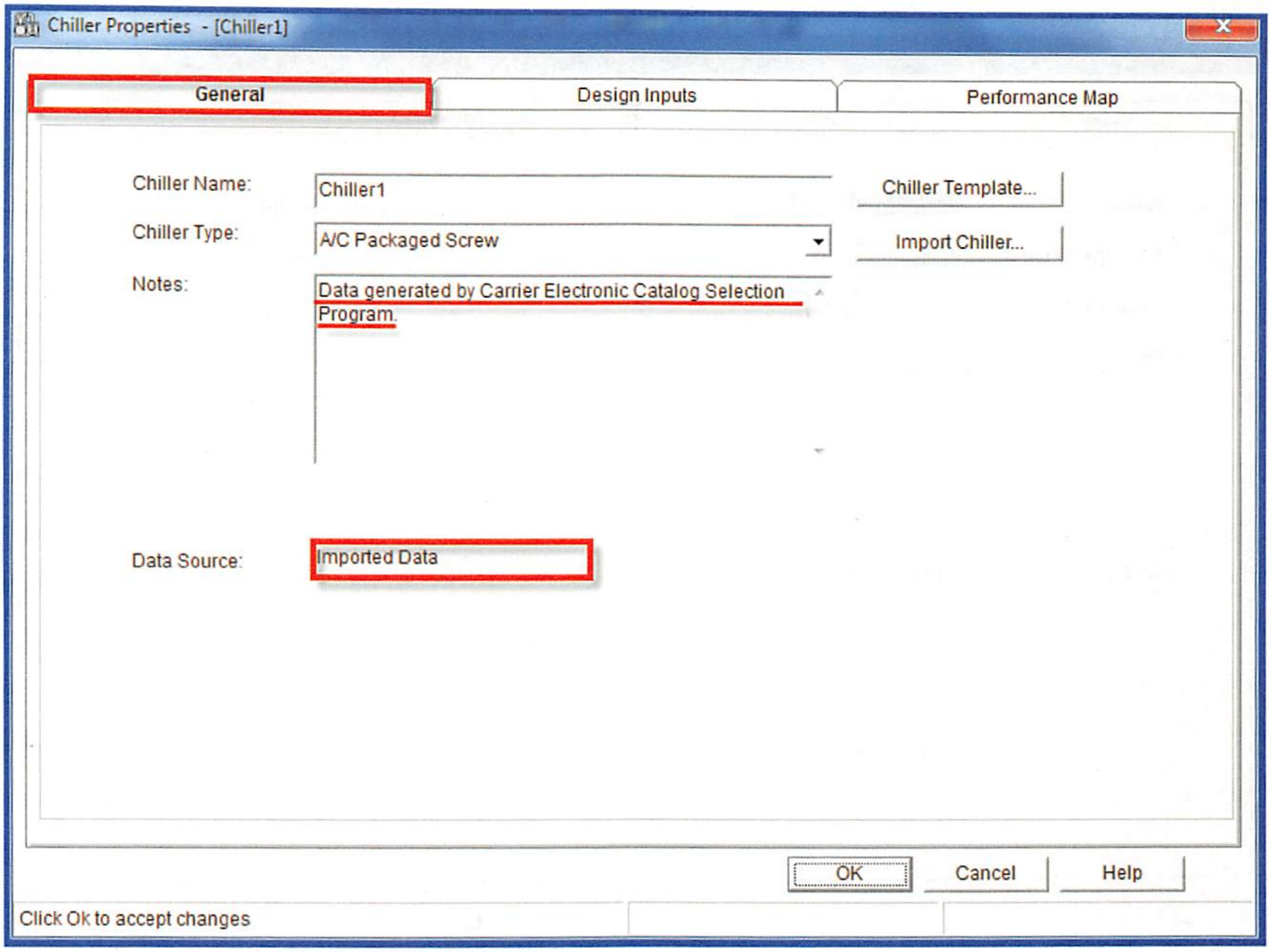
We placed the Chiller Export Archive file on the accompanying Flash Drive. To Import this chiller for this exercise open the chiller properties form and Double Click on the "New Default Chiller" in the chiller Library, then click on the Import Chiller button as detailed in Figure 4.9a.

Figure 4.9a - Chiller Input Form – Import Chiller Data



<u>**Navigate to your desktop go to the chiller tab**</u> and select the **" 30 XA 140"** Click the OPEN button to import the chiller into HAP.

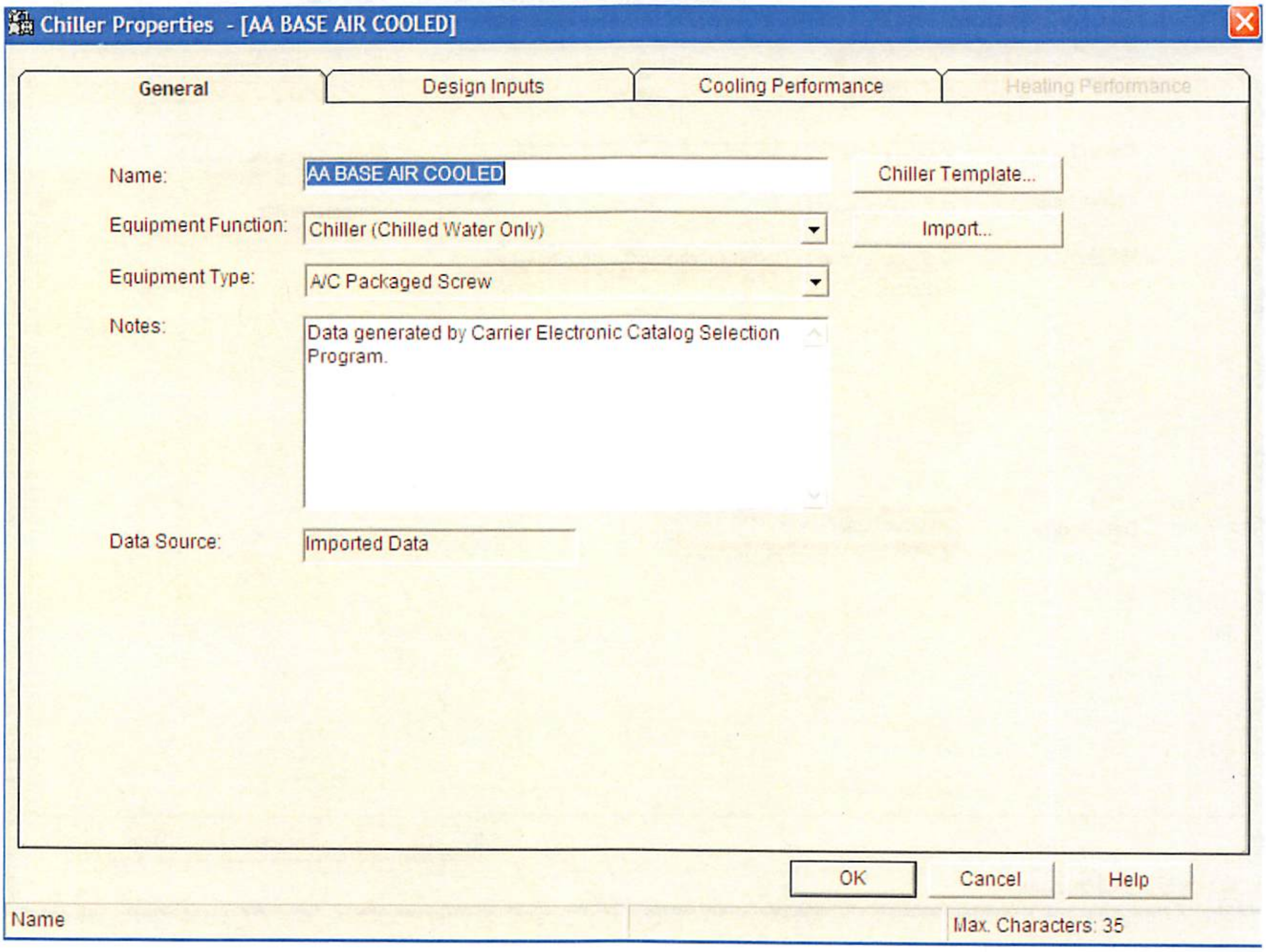
Figure 4.9b – Chiller Properties General Tab – Imported Chiller Data



Note: The Chiller properties are imported from the archived file and include all selection design inputs and calculated performances for IPLV and NPLV using the full operating matrix of the chiller.

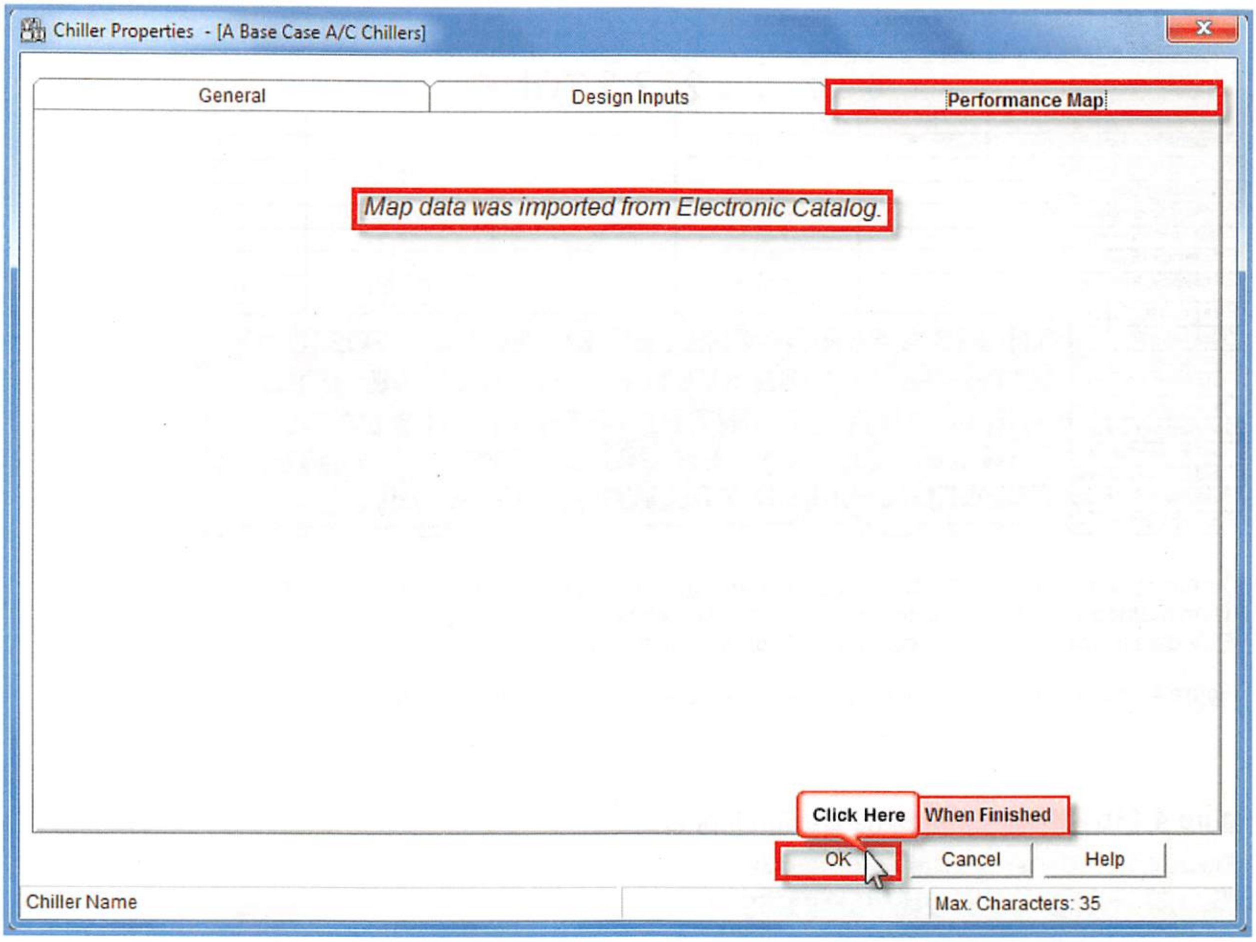
We should rename the default Chiller1 name to something that makes more sense i.e. "A Base Case AC Chillers" or similar.

Figure 4.9c - Chiller Properties Design Inputs – Imported Chiller Data



Note: All data is part of the import file.

Figure 4.9d – Chiller Properties Performance Map – Imported Chiller Data



Next, let's run the plant block load on the "C" air systems.

Use the following information for modeling the water-cooled screw chiller for the C Alt 2 design.

Now calculate the design load for the "C" Alt-2 chiller plant.

Note: The **calculated load for C Alt 2 is 213.2 TONS.**

Figure 4.10 – Non-Integrated Part Load Value **C Alt 3 Water-cooled screw**

Figure 4.10 – Non-Integrated Part Load Value

Integrated Part Load Value (ARI)

IPLV:.. **0.537** kW/Ton **222.5 TONS**

Unit Performance				
Percent Full Load Cooling Capacity, %	100	75	50	25
Percent of Full Load Power, %	100.0	61.6	36.9	29.1
Unloading Sequence	Default	Default	Default	Default
Cooling Capacity, Tons	222.5	166.9	111.3	55.6
Total Unit Power, kW	147.7	91.0	54.4	43.0
Efficiency, EER	18.08	22.02	24.52	15.51
Efficiency, kW/Ton	**0.664**	**0.545**	**0.489**	**0.774**
Evaporator Data				
Fluid Entering Tem				5
Fluid Leaving Tem				0
Fluid Flow Rate, gp				.1
Fouling Factor, (hr-				01
Condenser Data				
Fluid Entering Tem				0
Fluid Leaving Tem				4
Fluid Flow Rate, gp				.6
Fouling Factor, (hr-				025

THIS IS A SCREW CHILLER SELECTION FOR USE WITH THE "C" AIR SYSTEMS. NOTICE WE HAVE THE QUARTER POINT DATA (PLV). THIS DATA CAN REFLECT ANY BRAND OR TYPE OF WATER-COOLED CHILLER YOU WANT TO MODEL.

Double click "New Default Chiller" and we will enter th chiller for the "C" air systems into HAP using method # 2, the "Template" method which uses a quarter point PLV approach. Enter the IPLV data from Figure 4.10 as detailed in Figures 4.11a through 4.11e.

Figure 4.11a – Define Chiller Part Load Perfomance Method # 2 "Template" method.

Figure 4.11b – Chiller Template Design Inputs

Figure 4.11b – Chiller Template Design Inputs

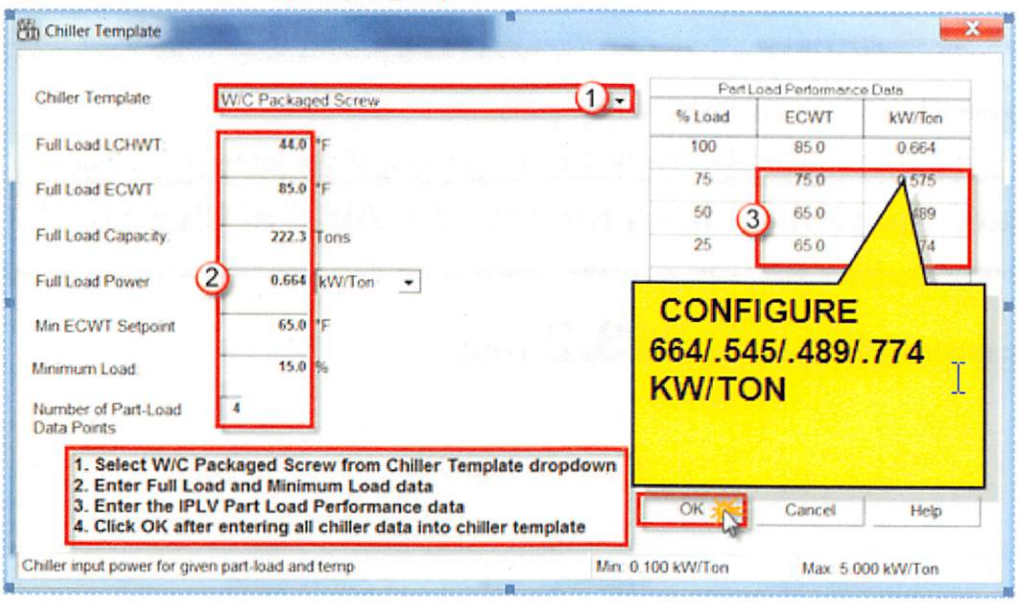


Figure 4.11c - Chiller Properties General Tab Template Data

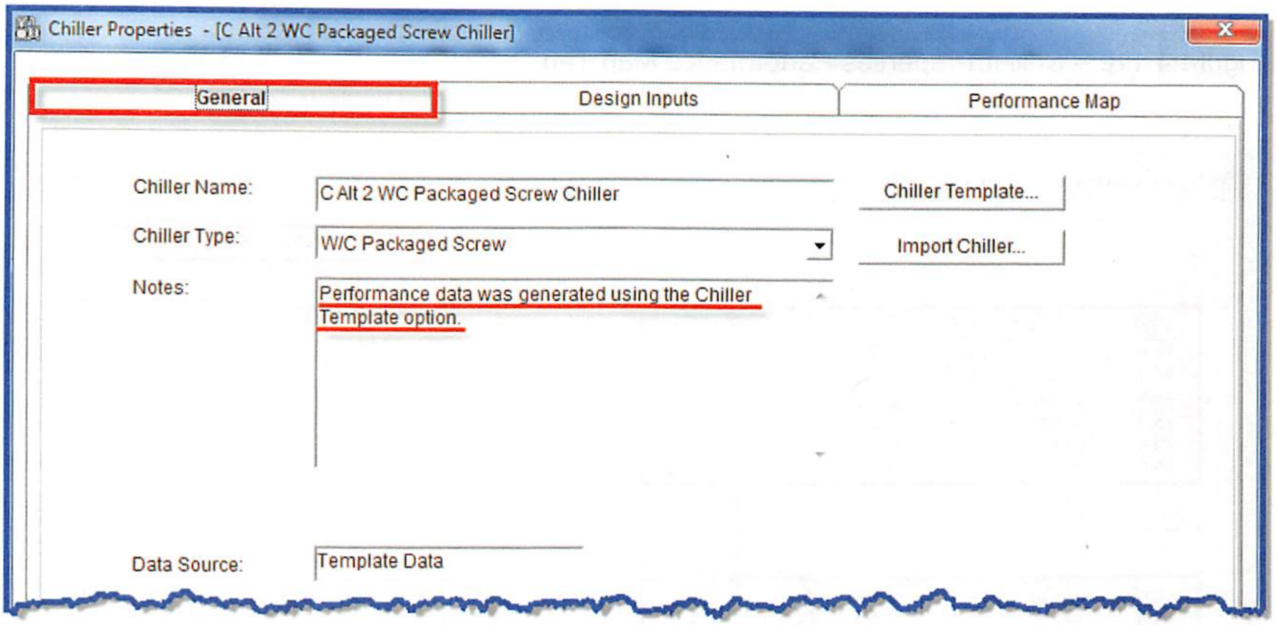


Figure 4.11d - Chiller Properties Design Inputs Tab

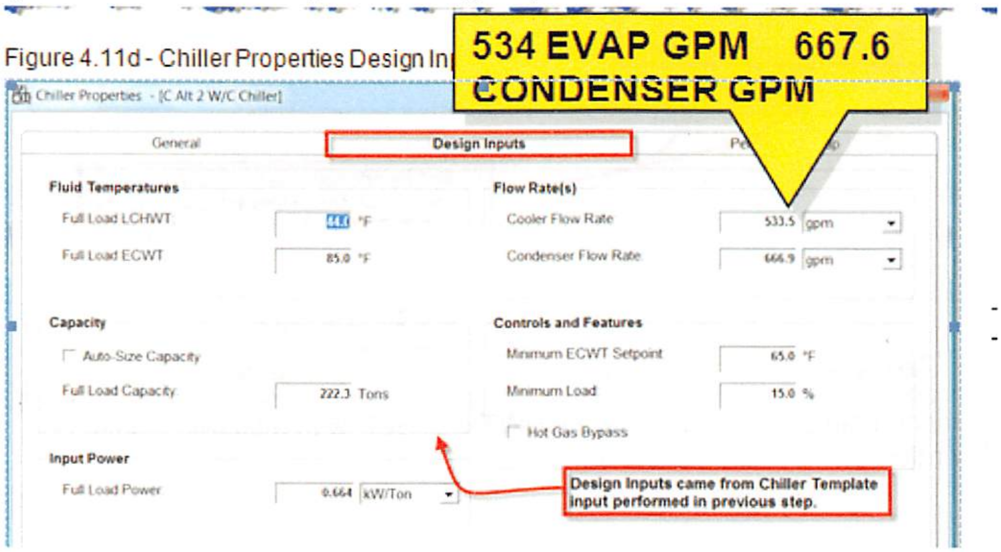
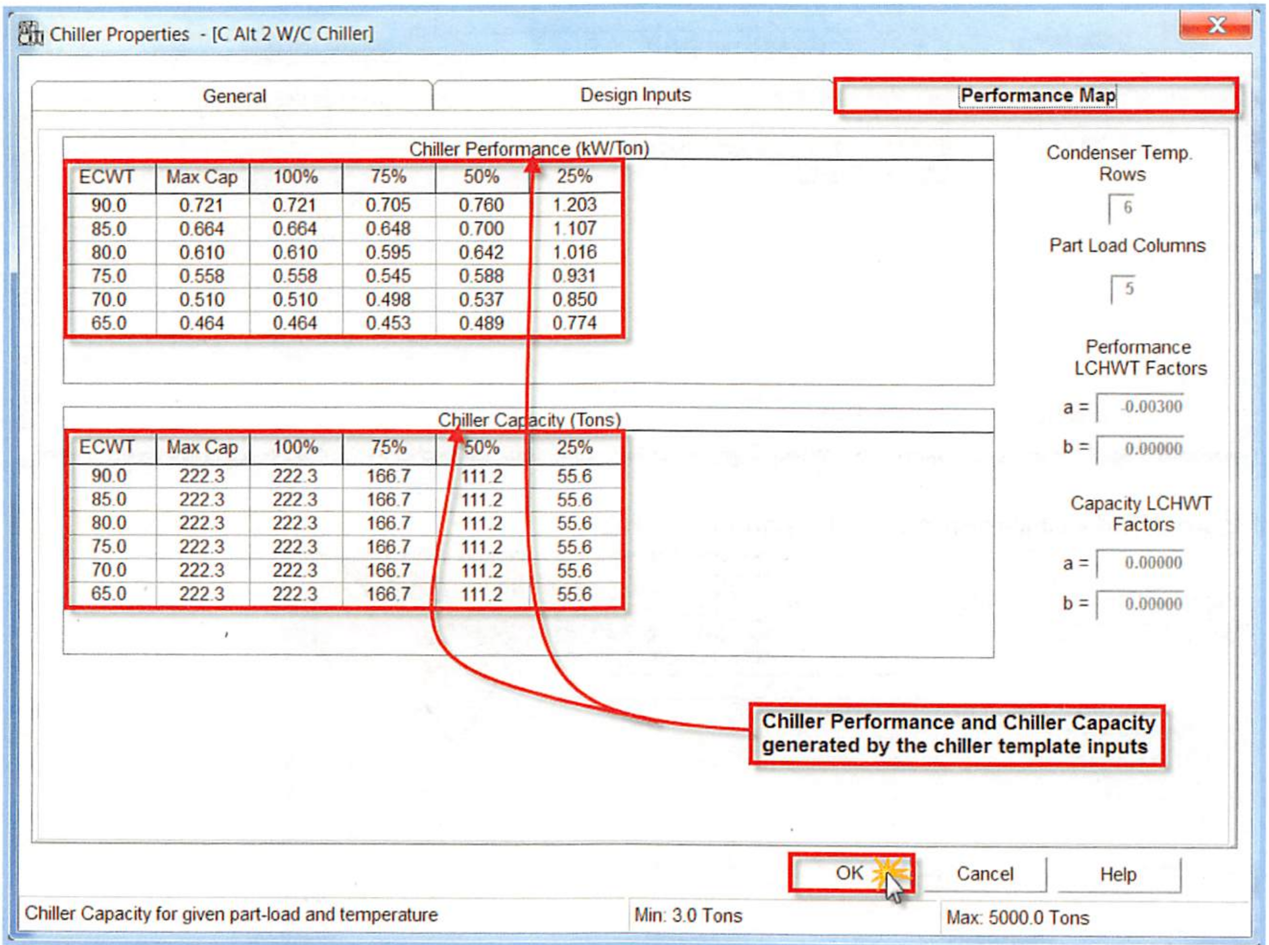


Figure 4.11e – Chiller Properties Performance Map Tab



Chiller Performance (kW/Ton)

ECWT	Max Cap	100%	75%	50%	25%
90.0	0.721	0.721	0.705	0.760	1.203
85.0	0.664	0.664	0.648	0.700	1.107
80.0	0.610	0.610	0.595	0.642	1.016
75.0	0.558	0.558	0.545	0.588	0.931
70.0	0.510	0.510	0.498	0.537	0.850
65.0	0.464	0.464	0.453	0.489	0.774

Chiller Capacity (Tons)

ECWT	Max Cap	100%	75%	50%	25%
90.0	222.3	222.3	166.7	111.2	55.6
85.0	222.3	222.3	166.7	111.2	55.6
80.0	222.3	222.3	166.7	111.2	55.6
75.0	222.3	222.3	166.7	111.2	55.6
70.0	222.3	222.3	166.7	111.2	55.6
65.0	222.3	222.3	166.7	111.2	55.6

bove inputs are IPLV rating points based on 44/56 LCHWT/ECHWT, with adjusted Cooler and Condenser Water flow rates.

Cooling Plant Sizing Summary Comparison Class Discussion

The maximum plant load for the water-cooled design case using air systems C1-C8 is **213.2TONS** . Note that some of these air systems are fan coil units with DOAS (common vent).

For the air-cooled design case using air systems A01-A10, the plant load was **267.6 tons.** Some of these air systems are VAV. Both plants serve identical 59,553 ft² areas.

What contributes to the load difference between the plants? They have the same area, spaces, walls, roof, glass, and people.

We find the answer by comparing the Air System Design Load Summaries for the two plant types. (Not done as part of this workshop).The air-cooled chiller plant requires more ventilation air than the water-cooled chiller plant. But the primary reason for the tonnage difference is the FCU system using DOAS requires less total OA to comply with ASHRAE.

We selected the ASHRAE 62.1-2007 Ventilation sizing for all air systems in both plants. However, each VAV air system serves multiple zones requiring the use of the critical space equation for VAV systems in order to satisfy the critical zones requirements and comply with ASHRAE 62.1-2007. **The difference in the design cases results in a sizeable ventilation air load reduction.**

Entering Cooling Tower Performance Data

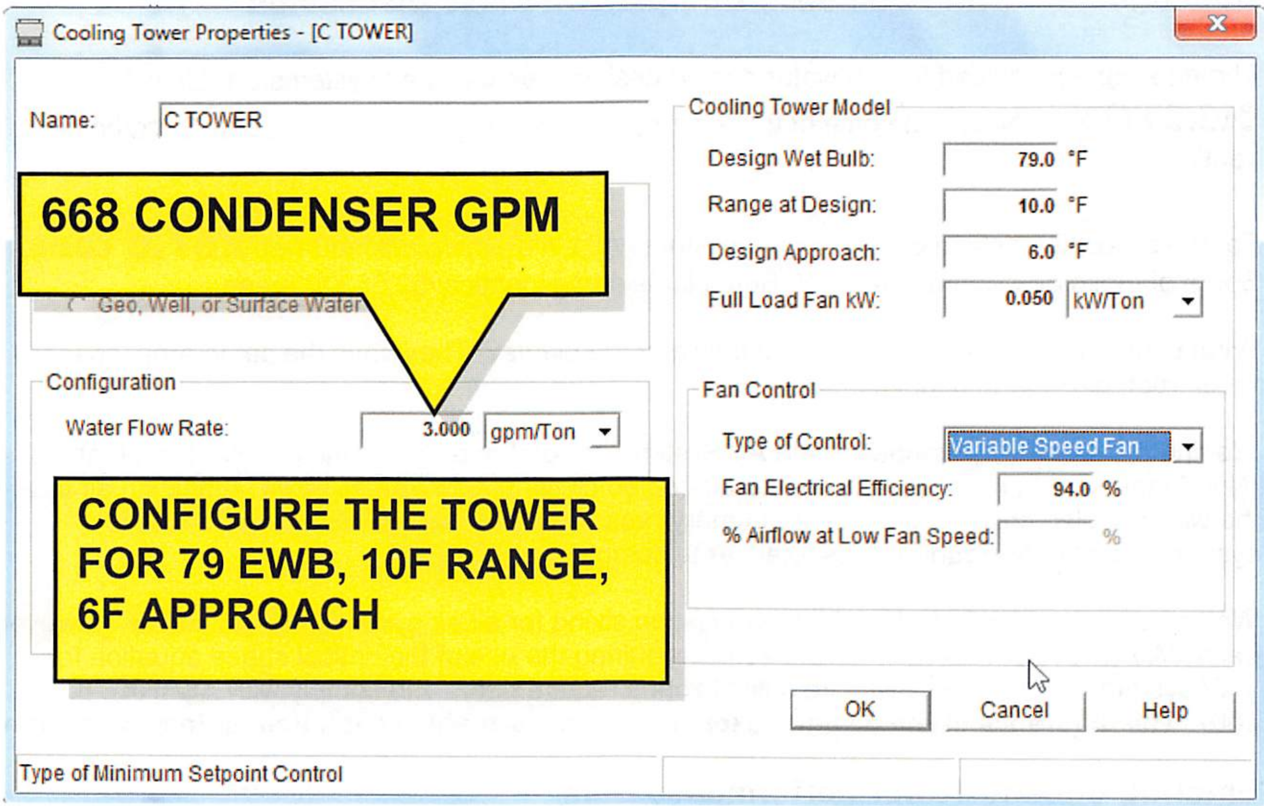
Next, we need to verify the cooling tower performance for our water-cooled chiller. Before we do, there are several important terms definitions related to cooling towers including:

1. **Entering Wet Bulb** temperature is an important parameter in tower selection. For most areas in North America, an entering wet bulb temperature of 78°F is common. **For our exercise we will use 79F wet bulb**
2. **Approach** is the difference between the water leaving the tower and the entering wet bulb temperature of the air. A 6°F approach is what we will use for HVAC systems with a 79°F entering wet bulb and 85°F water leaving the tower. (85°F - 79°F = 6°F)
3. **Range** is the difference in temperature of entering and leaving condenser water. An approximate 6°F range reflects approximately 3 gpm/ton flow rate in the condenser loop.

Check with your local cooling tower representative to confirm the design entering wet bulb and approach values for your area. The tower range must match the chiller condenser ΔT.

1. Create a new cooling tower by opening the Cooling Tower Properties form.
2. Enter the cooling tower data found under the Chiller Properties Design Input Tab in Figure 4.11 D.
3. See details in Figure 4.12.

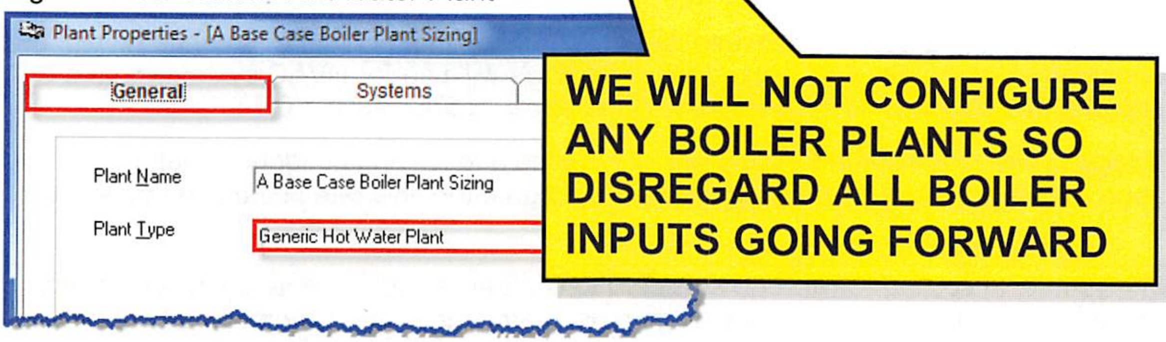
Figure 4.12 - Cooling Tower Properties for C Alt 2 WC Screw Chiller



Entering Boiler Performance Data

We are now ready to size our boiler plants and add boilers to our library. We start by sizing our A Base Case boiler load as detailed in the following Figures 4.13a through 4.13c. Create a new Generic Hot Water Plant and link all "A" design air systems.

Figure 4.13a Generic Hot Water Plant



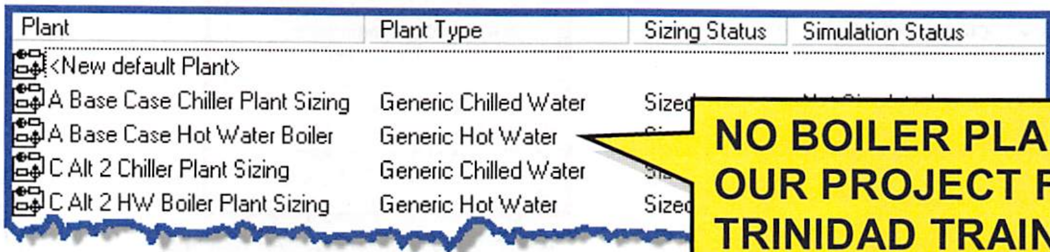
Workshop 5 Inputs

Blank Page

Workshop 5 - Configuring "Final" Chiller and Boiler Plants

We created 2 chiller plants in our previous workshop, a chiller plant for our A Base Case and our C Alt 2 Design, as displayed in Figure 5.1.

Figure 5.1 – Chiller Plants Created in WS4.



NO BOILER PLANTS FOR OUR PROJECT FOR TRINIDAD TRAINING

What is a Plant?

A Plant is the equipment and controls that provide cooling or heating to coils in one or more air systems. Examples include chiller plants, hot water or steam boiler plants and remote source chilled water, hot water or steam plants. This workshop consists of finalizing the two chiller plants in Workshop 4.

The base design case chiller plant consists of two Carrier 30XA 140 A/C (air-cooled) packaged screw chillers. The air systems served by this plant include all "A" designated air systems with chilled water coils. The configuration of the chiller plant is two chillers in sequence. The pumping and piping distribution system is a primary only with variable speed pumping and sized for a 12°△T with 2% piping heat gain factor.

The "C Alt 2" chiller plant serves the "C" designated air systems. This plant consists of one 222.5 ton water-cooled screw chiller and a matching cooling tower. The pumping and piping distribution system is a primary only variable speed system sized for a 12°△T and 2% piping heat gain factor.

DOUBLE CLICK ON "A BASE" PLANT AND CHANGE FROM "GENERIC" TO "CHILLER PLANT".

Figure 5.2a – A Base Case Chiller Plant Data

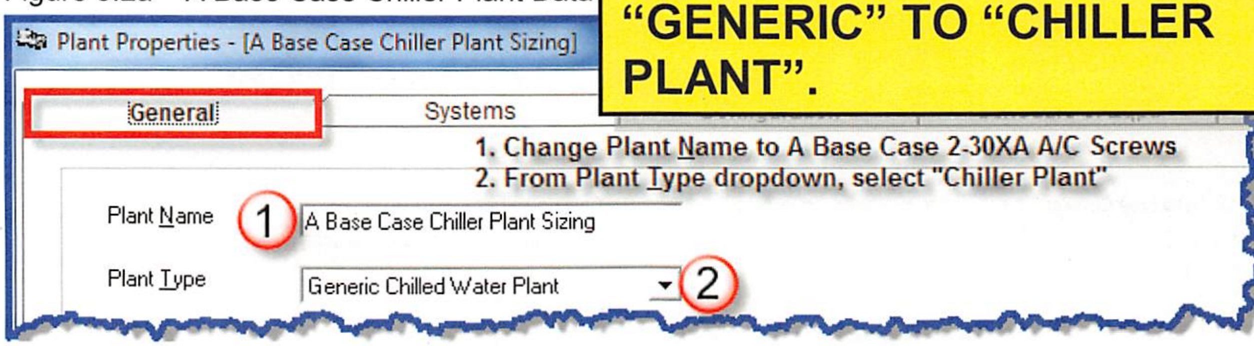


Figure 5.2b – A Base Case Air Systems

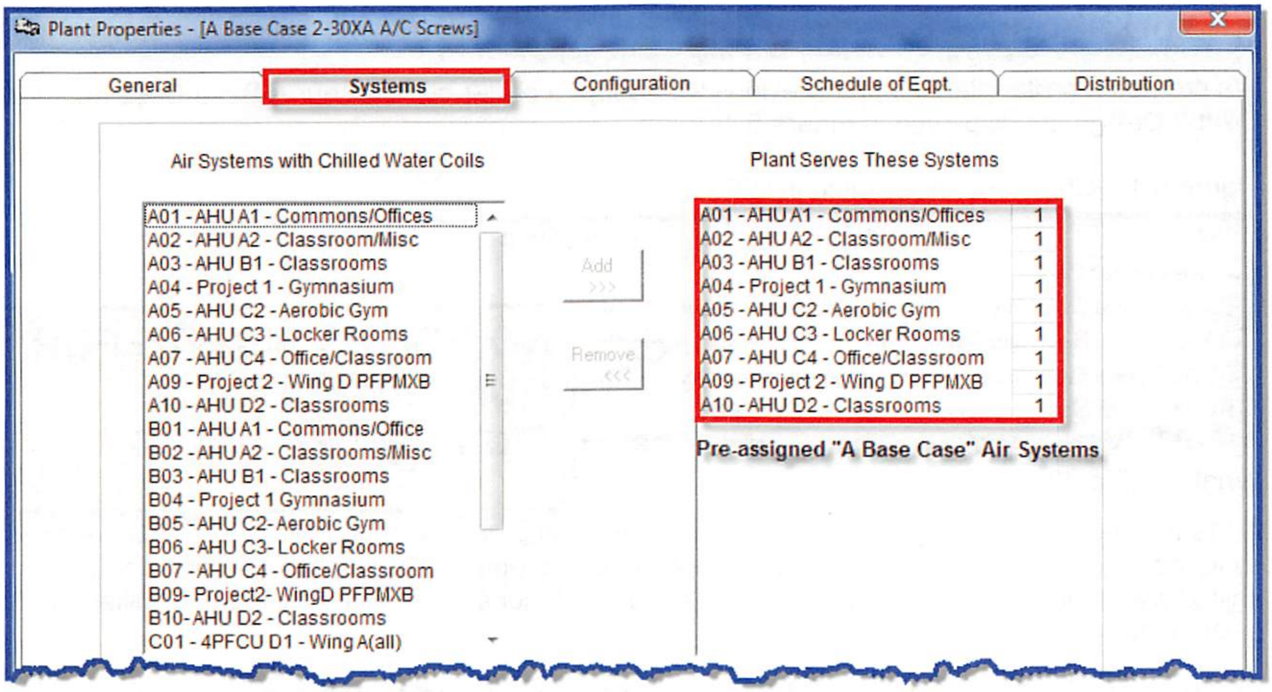


Figure 5.2c – Base Case Plant Configuration

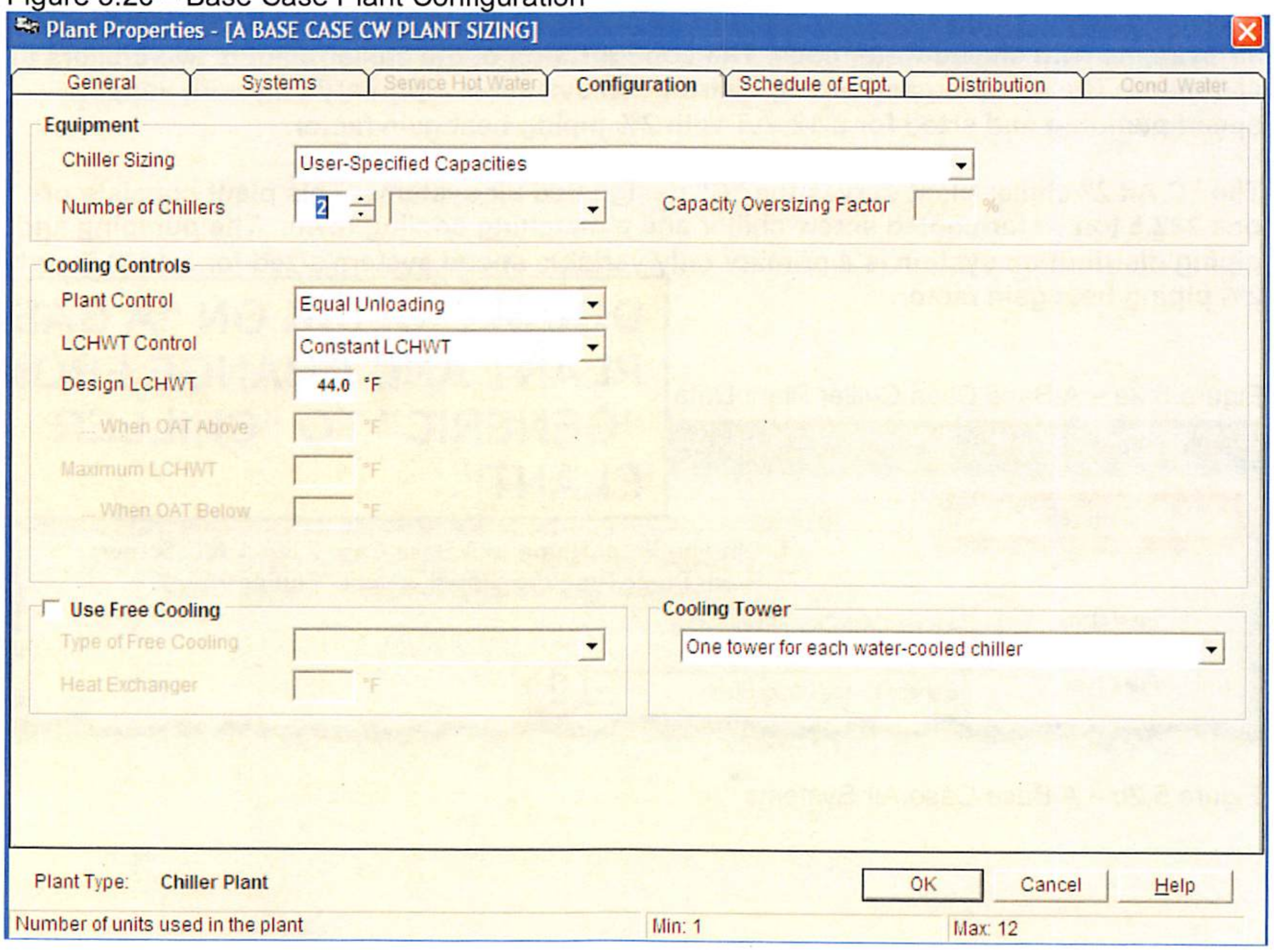


Figure 5.2d – Schedule of Equipment

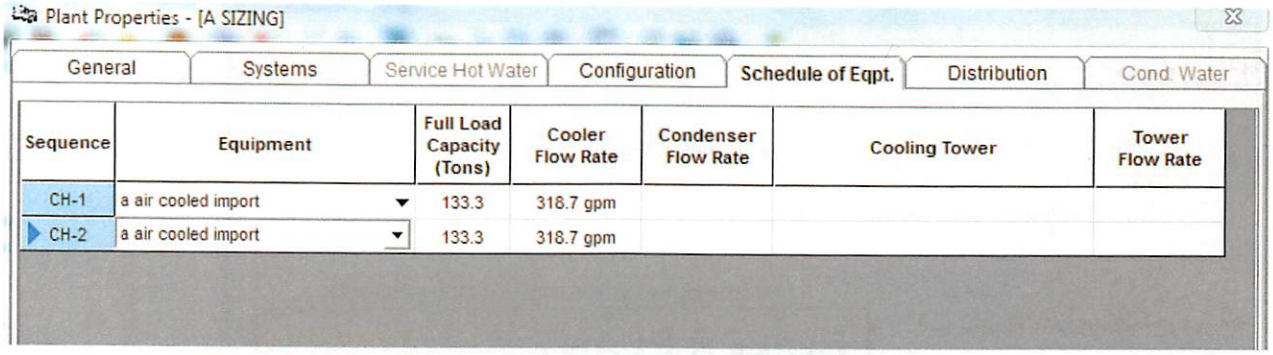


Figure 5.2e – Configure Plant Distribution

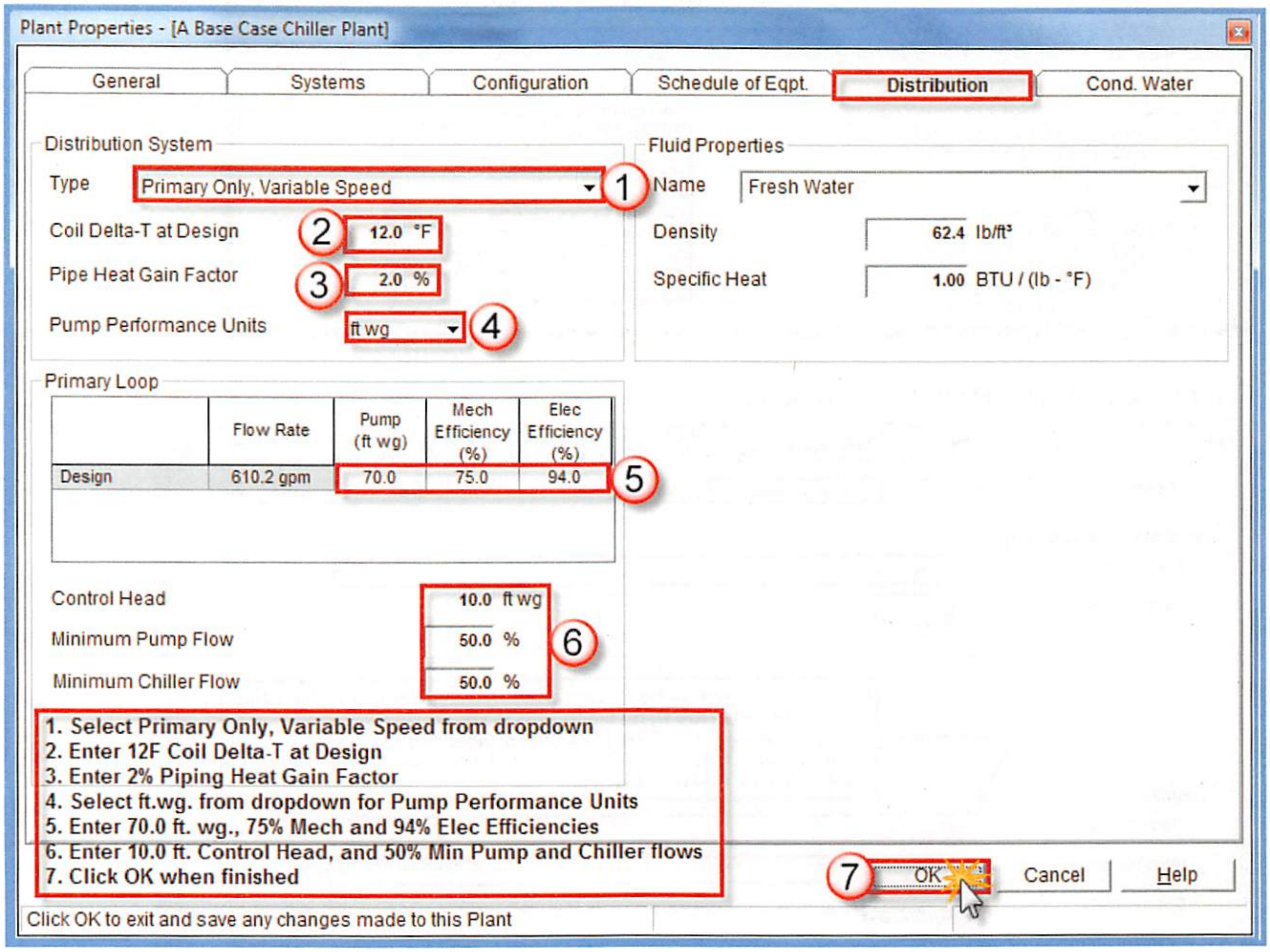
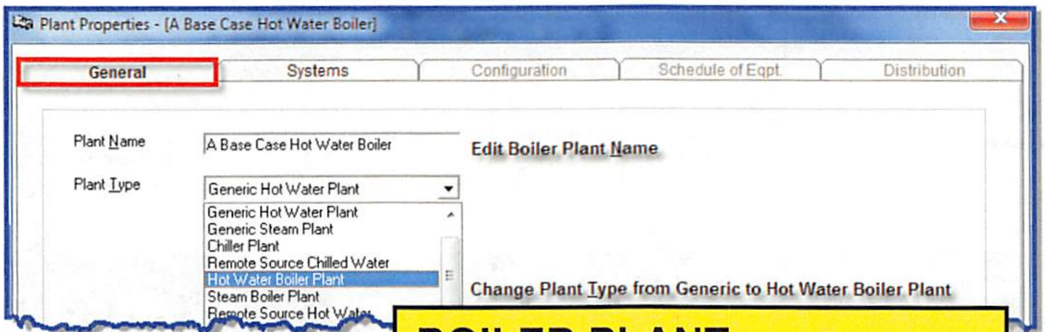


Figure 5.2f – Base Case Boiler Plant Input



BOILER PLANT CONFIGURATION FOR DISCUSSION ONLY

Figure 5.2g – A Base Case Ai

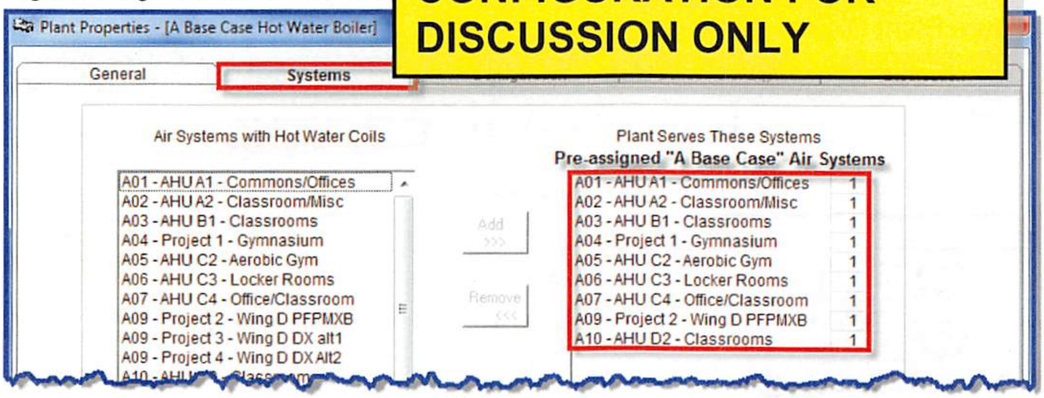


Figure 5.2h – Boiler Plant Configuration

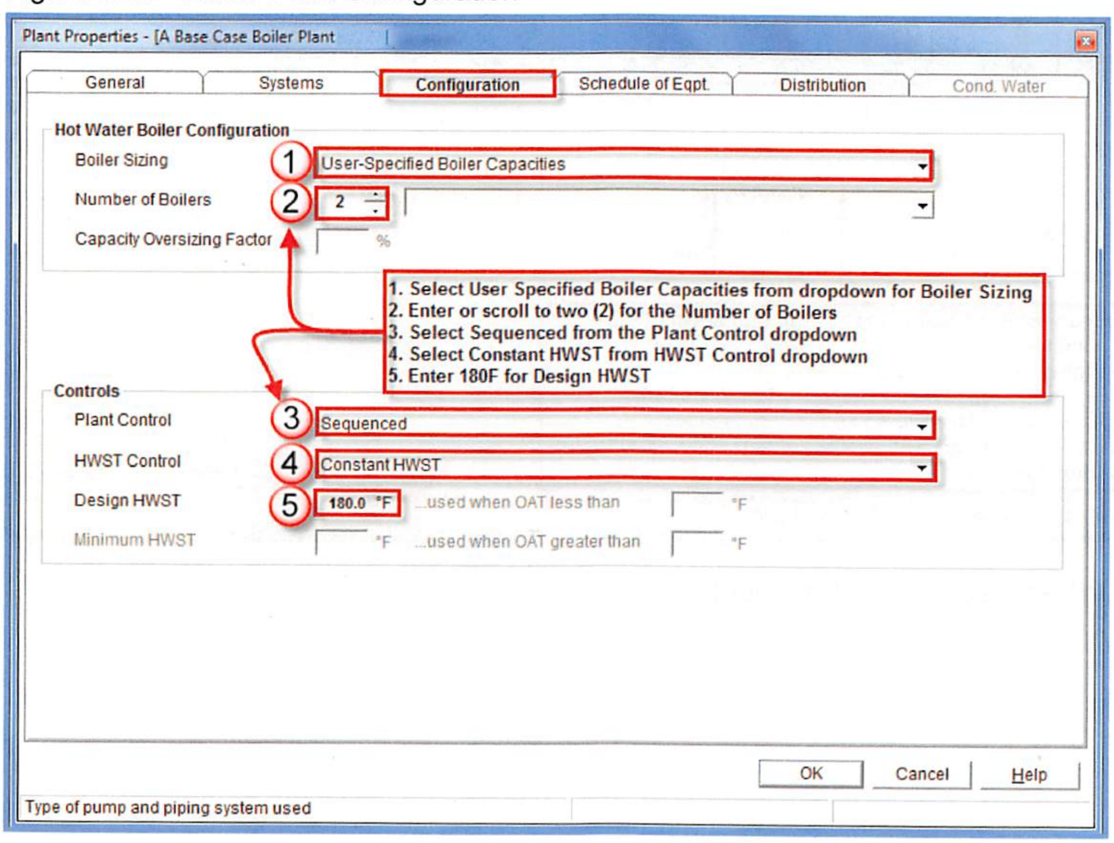


Figure 5.2i – Boiler Plant Schedule of Equipment

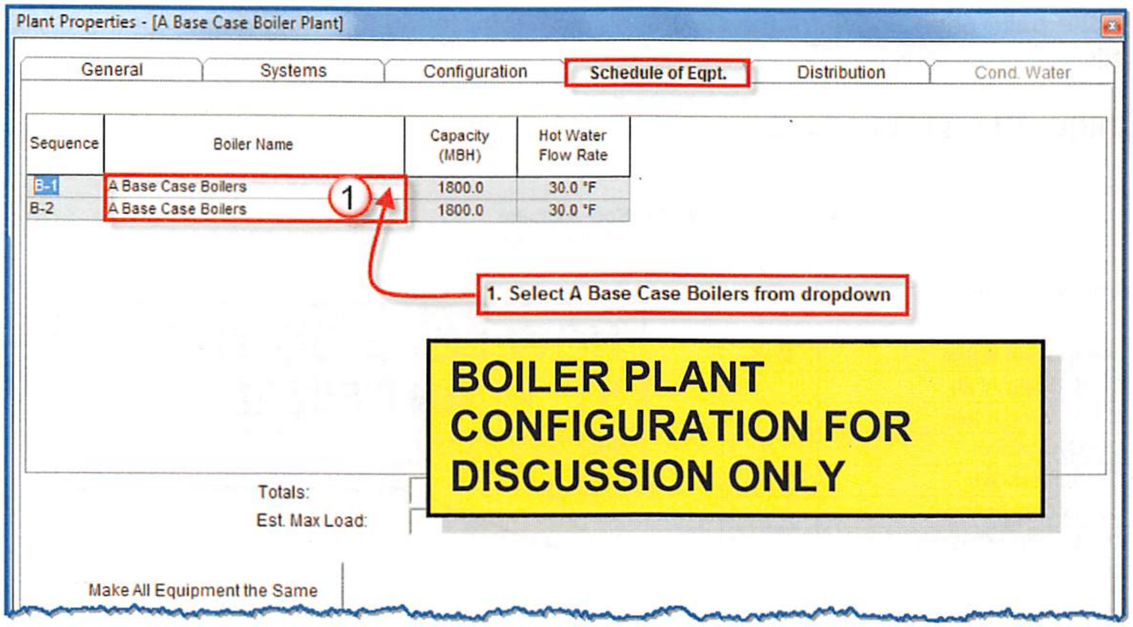
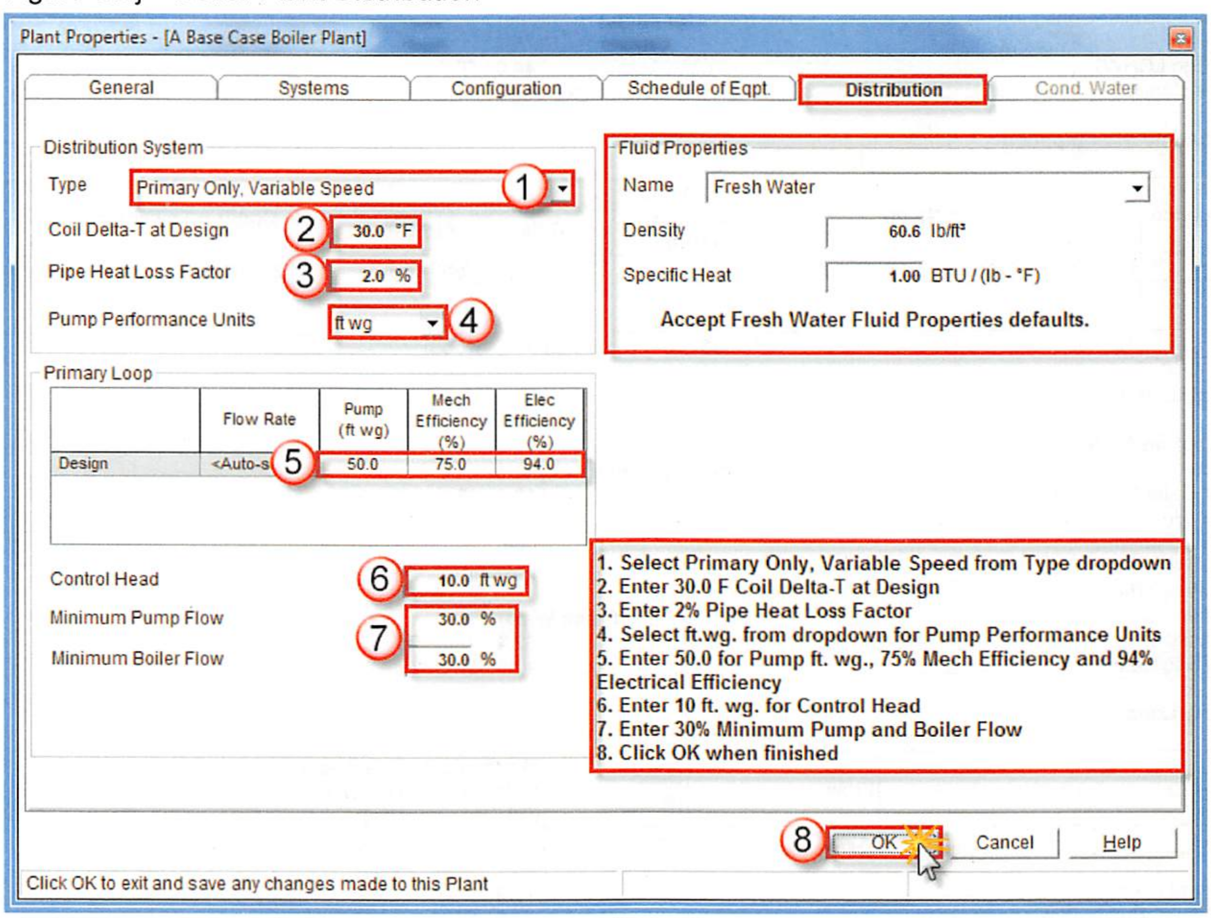


Figure 5.2j – Boiler Plant Distribution



This completes the base case plant inputs please refer to the chiller and boiler plant input reports for C Alt 2 to configure chiller and boiler plants. Use the same procedure for editing the plants described in the base case above for the C Alt 2 plants. Refer to the following pages for the C Alt 2 plant details.

C Alt 2 Chiller Plant Input Data

1. General Details:

Plant Name .... **C Alt 2-(1)30XW WC Screw Chiller**
Plant Type .... **Chiller Plant**

2. Air Systems served by Plant:

Air System Name	Mult.
C01 - 4PFCU D1 - Wing A(all)	1
C02 - 4PFCU D1 - Wing B (all)	1
C03 - AHU C1- Gymnasium	1
C04 - AHU C2- Aerobic Gym	1
C05 - AHU C3 - Locker Rooms	1
C06 - 4PFCU C4 - Office/Classrm	1
C08 - 4PFCU D1 - Wing D (all)	1

NOW LET'S DO THE 'C" PLANT FINAL INPUTS!

3. Configuration

Chiller Sizing .... **User-Specified Chiller Capacities**
Number of Chillers **1**
Cooling Tower Configuration .... **One tower for each W/C chiller**
LCHWT Control .... **Constant LCHWT**
Design LCHWT .... **44.0** °F
Free Cooling .... **Not Used**

4. Schedule of Equipment

Sequence	Chiller Name	Full Load Capacity (Tons)	Cooler Flow Rate	Condenser Flow Rate	Cooling Tower Name	Tower Flow Rate
CH-1	C Alt 2 WC Packaged Screw Chiller	222.5	534	668	C Alt 2 W/C Screw Cooling Tower	900
	Totals:	222.5	534 gpm	668	Totals:	900

5. Distribution

Distribution System

Type .... **Primary Only, Variable Speed**
Coil Delta-T at Design .... **12.0** °F
Pipe Heat Gain Factor .... **2.0** %
Pump Performance .... **ft wg**

Fluid Properties

Name .... **Fresh Water**
Density .... **62.4** lb/ft³
Specific Heat .... **1.00** BTU / (lb - °F)

Primary Loop

	Flow	Head (ft wg)	Mechanical Efficiency (%)	Electrical Efficiency (%)
Design	534	75.0	80	94.0

Control Head .... **10.0** ft wg
Minimum Pump Flow .... **50** %
Minimum Chiller Flow .... **50** %

6. Condenser Water

Condenser Water System

Pump Control .... CONSTANT FLOW
Pump Performance .... **ft wg**

HEAD .... **25.0** ft wg

Condenser Water Loop

Pump for...	Flow	Head (ft wg)	Mechanical Efficiency (%)	Electrical Efficiency (%)
CH-1	638	25	75.0	94.0

C Alt 2 Hot Water Boiler Plant Input Data

1. General Details:

Plant Name .... **C Alt 2 HW Boiler Plant**
Plant Type .... **Hot Water Boiler Plant**

2. Air Systems served by Plant:

Air System Name	Mult.
C01 - 4PFCU D1 - Wing A(all)	1
C02 - 4PFCU D1 - Wing B (all)	1
C03 - AHU C1- Gymnasium	1
C04 - AHU C2- Aerobic Gym	1
C05 - AHU C3 - Locker Rooms	1
C06 - 4PFCU C4 - Office/Classrm	1
C08 - 4PFCU D1 - Wing D (all)	1

3. Configuration

Boiler Sizing .... **User-Specified Boiler Capacities**
Number of Boilers **2**
Plant Control .... **Sequenced**
HWST Control .... **Constant HWST**
Design HWST .... **180.0** °F

4. Schedule of Equipment

Sequence	Boiler Name
B-1	C Alt 2 Boiler 1
B-2	C Alt 2 Boiler 2
	Totals:

WE WILL NOT INCLUDE A BOILER PLANT SO DISREGARD ALL BOILER INPUTS

Est. Max Load .... **2403.5** Tons

5. Distribution

Distribution System

Type .... **Primary Only, Variable Speed**
Coil Delta-T at Design .... **30.0** °F
Pipe Heat Loss Factor .... **2.0** %
Pump Performance .... **ft wg**

Fluid Properties

Name .... **Fresh Water**
Density .... **60.6** lb/ft^3

Specific Heat .... **1.00** BTU / (lb - °F)

Primary Loop

	Flow	Head (ft. wg.)	Mechanical Efficiency (%)	Electrical Efficiency (%)
Design	<auto-sized>	50.0	75.0	94.0

Control Head .... **10.0** ft wg
Minimum Pump Flow .... **30.0** %
Minimum Boiler Flow .... **30.0** %

D Alt3 SZCV/RTU (ROOFTOP UNIT)

Next let's look at how to configure a packaged roof top unit for energy simulation. Our "D" Alternative consists of 36 single zone, constant air volume packaged rooftop units with electric heating. **Open the Air System Properties form for [D31 – RTU D5 – Classroom D104] and review the following details required for an energy.**

Figure 5.3a – Packaged RTU-Configuration System Components –Supply Fan

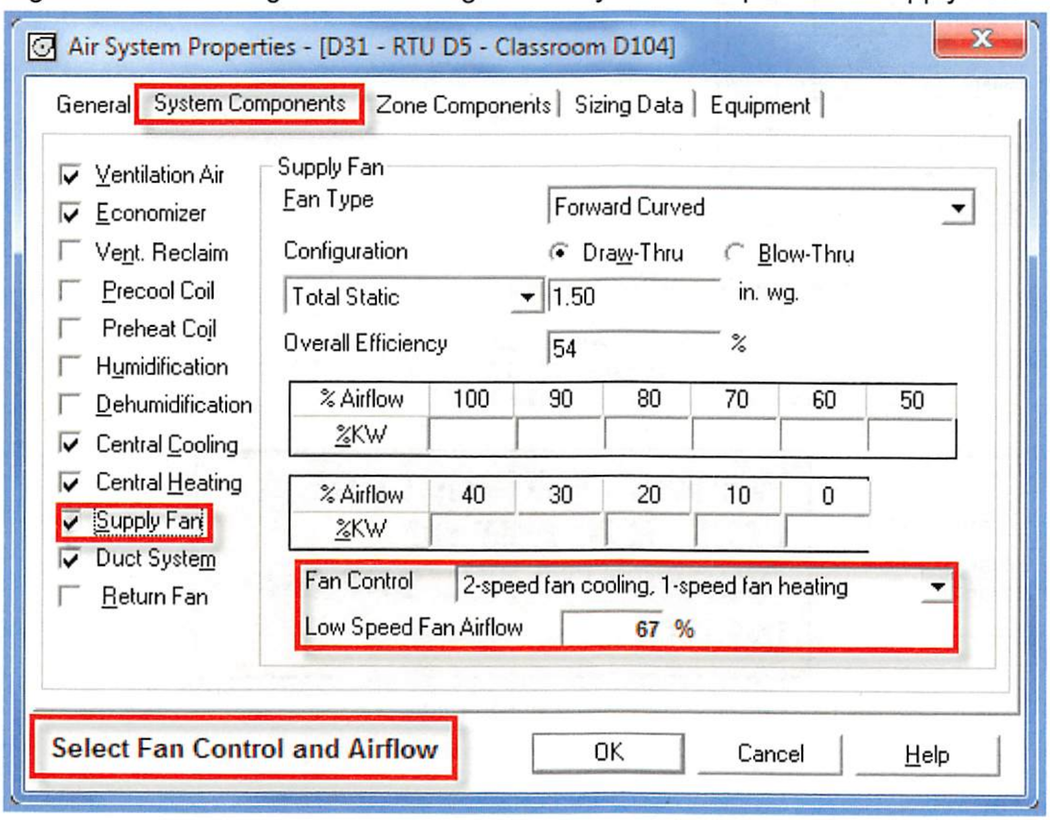
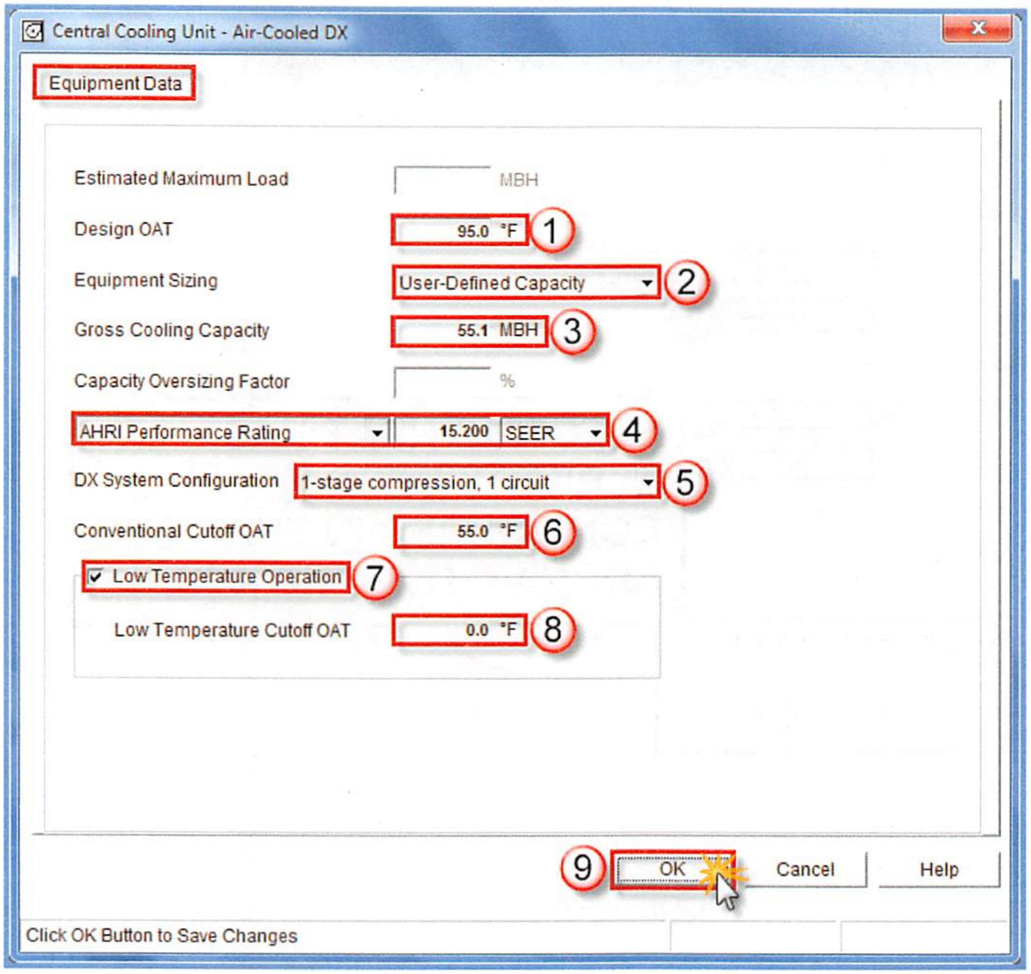


Figure 5.3b – Equipment – Central Cooling Unit

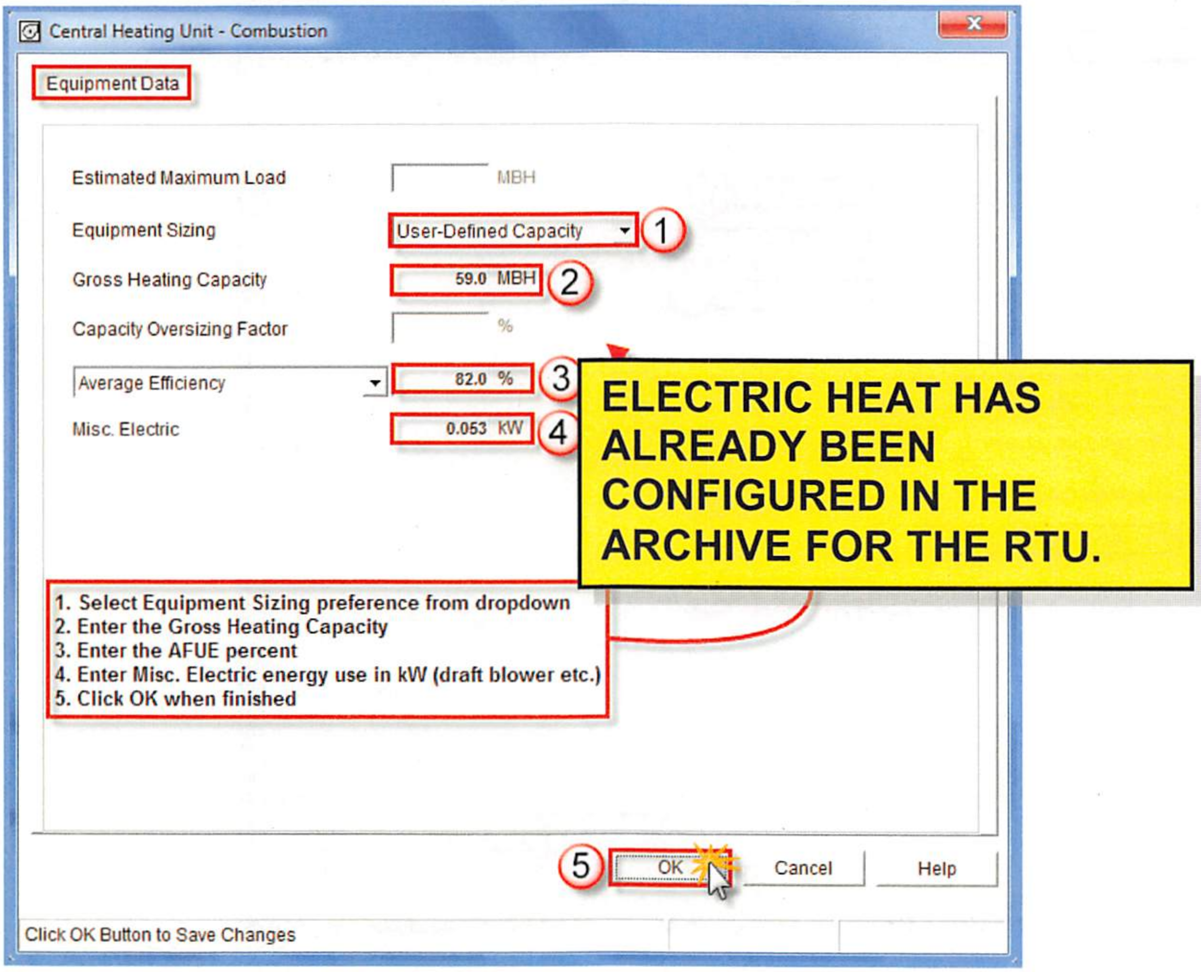


Configure the central cooling unit air cooled DX Equipment as follows:

1. The Design OAT populates to ARI Standard conditions.
2. Equipment capacity defaults to auto-sized, however, we recommend entering actual selected equipment manufacturer's performance data by selecting "User-Defined Capacity from Equipment Sizing dropdown.
3. Enter Gross Cooling Capacity from manufactures performance data
4. Select AHRI Performance Rating from dropdown and enter the SEER or EER efficiency
5. Select DX Configuration from dropdown
6. Enter Conventional Cutoff OAT
7. Leave Low Temperature Operation checkbox checked
8. Enter the Low Ambient Temperature Cutoff Outdoor Temperature
9. Click OK to save

.

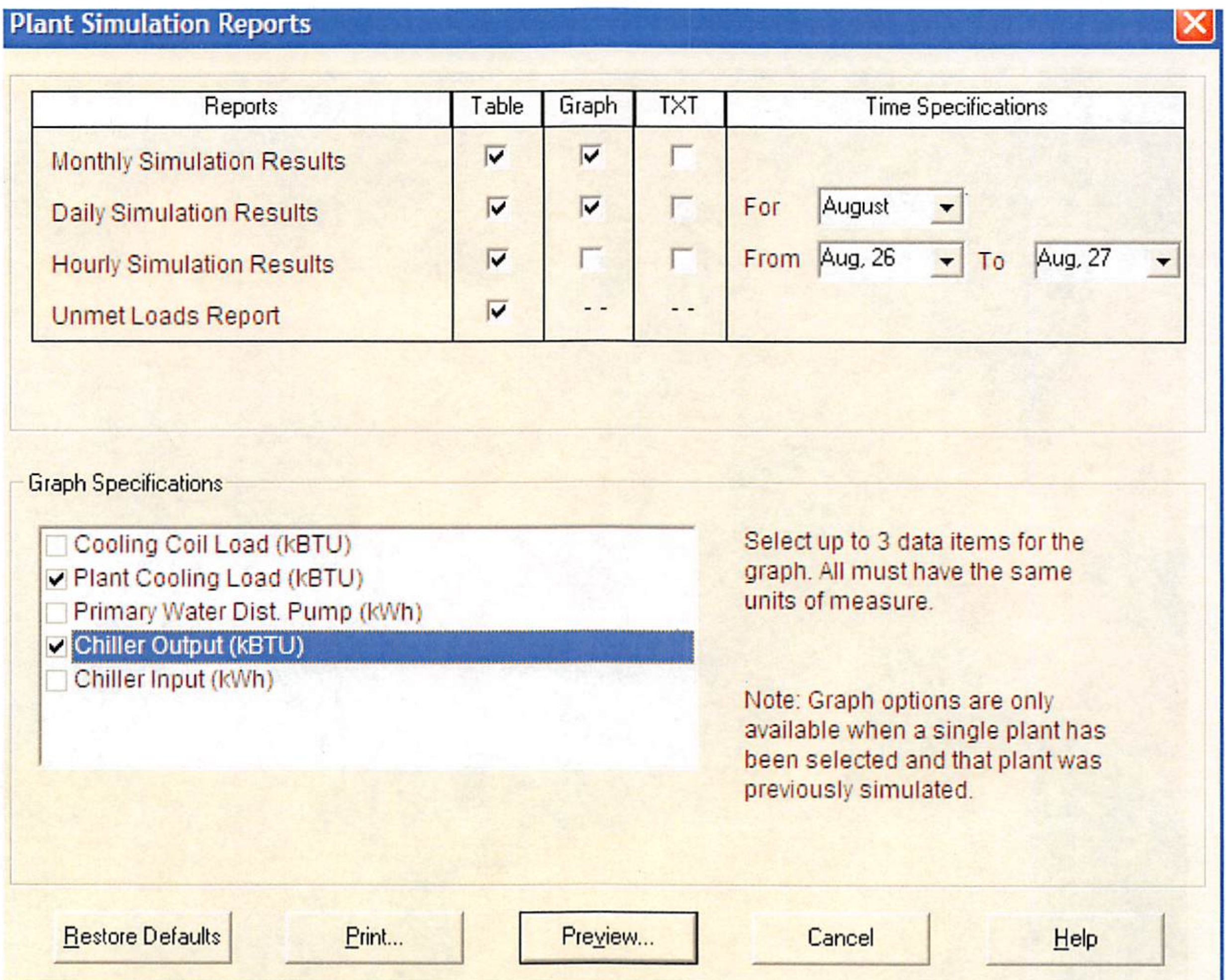
Figure 5.3c Central Heating Unit



After entering the plant and equipment data, we can generate the Simulation Reports for the cooling plants and packaged RTU. Please refer to the following pages for the detailed simulation reports for "A" Base Case Chiller plant, AND Classroom D104 rooftop unit.

Workshop 5 Solutions

RUN THESE REPORTS FOR THE A BASE AIR COOLED CHILLER PLANT



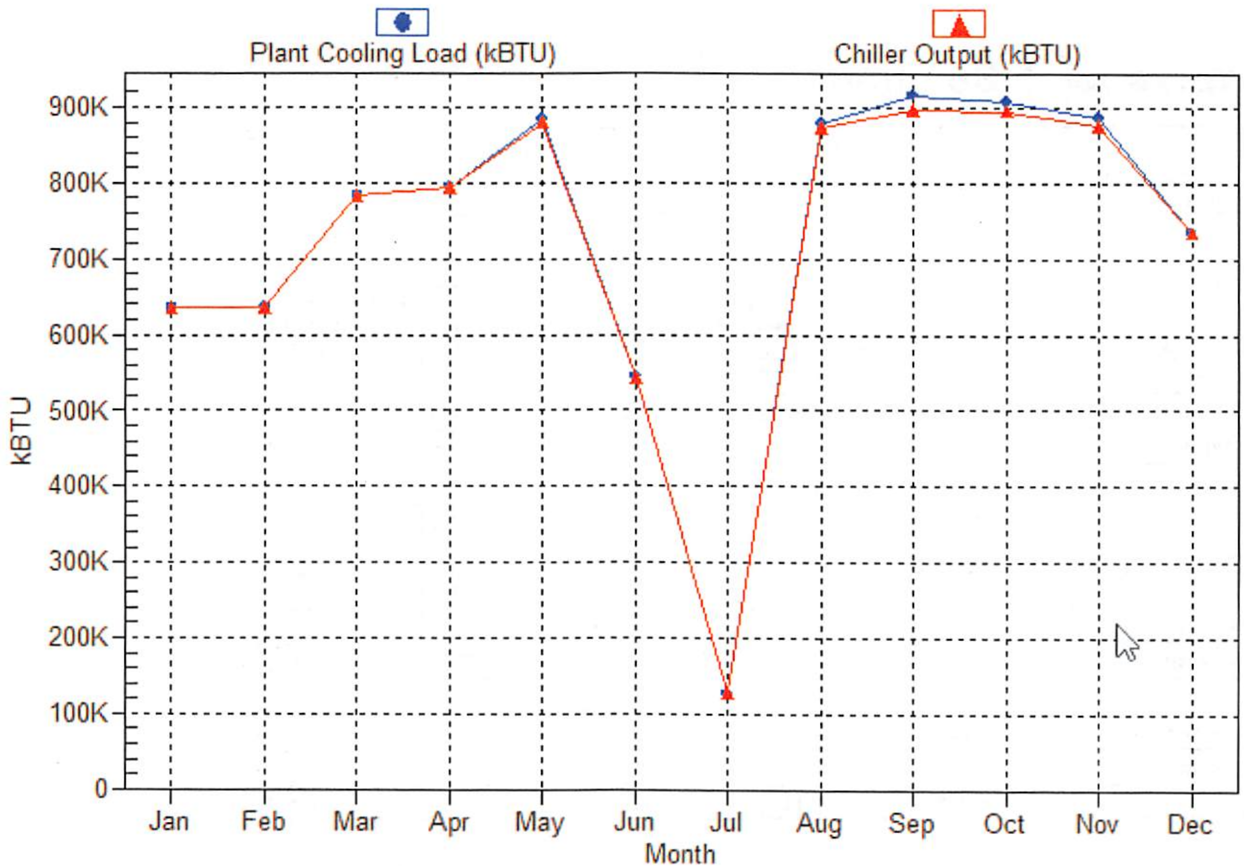
Workshop 5 Solutions

Monthly Simulation Results for A SIZING

TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru
carrier

Plant Simulation Results (Table 1) :

Month	Cooling Coil Load (kBTU)	Plant Cooling Load (kBTU)	Chiller Output (kBTU)	Chiller Input (kWh)	Primary Water Dist. Pump (kWh)
January	616710	635335	635335	49242	2492
February	618105	636255	636255	50354	2278
March	761172	783274	783274	63010	2650
April	773003	795584	794258	64747	2696
May	858546	883708	880080	71862	2965
June	526790	544176	542441	44039	2631
July	119591	127550	127550	11262	2307
August	854071	879382	874202	70962	3035
September	890346	916702	897665	73721	3110
October	882267	908352	895849	72316	3098
November	860852	886092	876320	69179	2956
December	713851	734695	734695	56492	2566
Total	**8475301**	**8731105**	**8677925**	**697186**	**32784**



Plant Cooling Load (kBTU)
Chiller Output (kBTU)
kBTU
900K
800K
700K
600K
500K
400K
300K
200K
100K
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Daily Plant Simulation Results for August (Table 1) :

Daily Simulation Results for A SIZING

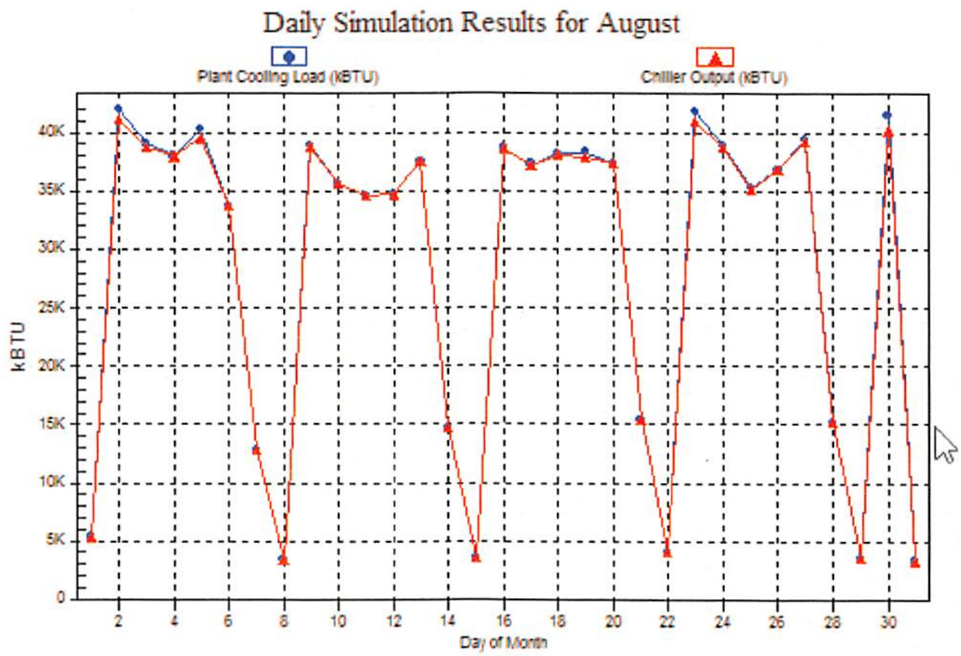
TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru
carrier

07/25/2017
08:26PM

Daily Plant Simulation Results for August (Table 1) :

Day	Cooling Coil Load (kBTU)	Plant Cooling Load (kBTU)	Chiller Output (kBTU)	Chiller Input (kWh)	Primary Water Dist. Pump (kWh)
1	5074	5355	5355	465	74
2	40868	42047	41096	3298	125
3	37930	39007	38777	3174	113
4	36946	37985	37985	3075	107
5	39203	40326	39526	3184	119
6	32900	33806	33806	2588	92
7	12382	12810	12810	1042	74
8	3087	3328	3328	310	74
9	37777	38851	38818	3145	112
10	34656	35618	35618	2671	98
11	33702	34633	34633	2770	95
12	33777	34715	34715	2805	96
13	36495	37523	37523	3039	107
14	14235	14699	14699	1222	74
15	3382	3630	3630	346	74
16	37586	38648	38648	3143	110
17	36253	37276	37174	2944	107
18	37130	38180	38128	3165	110
19	37236	38300	37897	3045	113
20	36377	37407	37407	3082	108
21	14888	15365	15365	1279	74
22	3766	4021	4021	395	74
23	40715	41888	40938	3411	124
24	37834	38907	38795	3203	112
25	34356	35326	35177	2788	103
26	35795	36798	36798	2971	103
27	38313	39399	39277	3253	113
28	14716	15190	15190	1232	74
29	3309	3555	3555	332	74
30	40313	41478	40202	3247	125
31	3069	3310	3310	338	74
Total	854071	879382	874202	70962	3035

Daily Simulation Results for A SIZING	
TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru	07/25/2017
carrier	08:26PM



Hourly Simulation Results for A SIZING

TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru
carrier

07/25/2017
08:26PM

Table 1.1 Hourly Plant Simulation Results for Thursday, August 26

Hour	Cooling Coil Load (MBH)	Plant Cooling Load (MBH)	Chiller Output (MBH)	Chiller Input (kW)	Primary Water Dist. Pump (kW)
0000	95.5	104.9	104.9	8.7	3.1
0100	93.6	103.0	103.0	8.6	3.1
0200	91.4	100.7	100.7	8.4	3.1
0300	91.6	100.9	100.9	8.4	3.1
0400	91.5	100.8	100.8	8.2	3.1
0500	91.6	100.9	100.9	8.4	3.1
0600	1739.0	1781.3	1781.3	133.0	3.1
0700	2494.5	2558.0	2558.0	202.5	4.7
0800	2907.2	2985.2	2985.2	233.9	6.5
0900	2887.1	2964.4	2964.4	233.8	6.4
1000	2844.4	2920.1	2920.1	232.1	6.2
1100	3039.1	3122.1	3122.1	262.0	7.2
1200	2659.8	2728.9	2728.9	237.9	5.3
1300	2977.6	3058.3	3058.3	259.4	6.9
1400	2834.5	2909.8	2909.8	242.9	6.1
1500	2683.8	2753.7	2753.7	223.5	5.4
1600	2502.7	2566.4	2566.4	206.5	4.7
1700	2140.7	2193.0	2193.0	169.9	3.6
1800	826.7	850.7	850.7	65.1	3.1
1900	835.1	859.3	859.3	66.2	3.1
2000	841.9	866.3	866.3	66.4	3.1
2100	824.4	848.4	848.4	64.9	3.1
2200	100.6	110.1	110.1	9.9	3.1
2300	101.0	110.5	110.5	9.8	3.1
Total	35795.2	36797.9	36797.9	2970.6	103.3

Hourly Simulation Results for A SIZING

TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru
carrier

07/25/2017
08:26PM

Table 2.1 Hourly Plant Simulation Results for Friday, August 27

Hour	Cooling Coil Load (MBH)	Plant Cooling Load (MBH)	Chiller Output (MBH)	Chiller Input (kW)	Primary Water Dist. Pump (kW)
0000	100.5	110.0	110.0	9.7	3.1
0100	100.4	109.9	109.9	9.5	3.1
0200	102.0	111.5	111.5	9.9	3.1
0300	103.1	112.6	112.6	10.2	3.1
0400	105.3	114.9	114.9	10.5	3.1
0500	107.4	117.1	117.1	10.9	3.1
0600	2312.2	2369.8	2369.8	181.8	4.1
0700	2471.4	2534.1	2534.1	197.7	4.6
0800	2961.5	3041.6	3041.6	240.8	6.8
0900	3011.7	3093.7	3093.7	251.2	7.0
1000	3074.5	3158.9	3158.9	262.8	7.4
1100	3127.8	3214.3	3199.2	272.5	7.7
1200	2704.8	2775.5	2775.5	241.6	5.5
1300	3099.3	3184.7	3184.7	271.2	7.5
1400	3169.6	3257.8	3199.2	279.2	8.0
1500	3159.5	3247.3	3199.2	279.2	7.9
1600	2693.6	2763.9	2763.9	227.5	5.5
1700	2216.7	2271.4	2271.4	183.1	3.8
1800	924.2	950.2	950.2	77.1	3.1
1900	875.8	900.8	900.8	71.9	3.1
2000	871.0	895.9	895.9	70.2	3.1
2100	828.0	852.1	852.1	65.2	3.1
2200	95.1	104.5	104.5	9.5	3.1
2300	97.2	106.6	106.6	9.5	3.1
Total	38312.6	39399.1	39277.4	3252.6	113.0

1. Unmet Load Statistics - Central Cooling Unit - Air-Cooled DX

Note: Data shown in this report is for diagnostic purposes only. Values represent total unmet hours for each cooling and/or heating unit. No deductions are made when unmet hours for one unit coincide with those in another unit.

1. Unmet Load Statistics - Central Cooling Unit - Air-Cooled DX

Month	Equipment Capacity is Sufficient (hrs)	Capacity Insufficient by 0%-5% (hrs)	Capacity Insufficient by 5%-10% (hrs)	Capacity Insufficient by >10% (hrs)	Total Hours with Unmet Loads	Total Hours with Equipment Loads
January	296	0	0	0	0	296
February	316	0	0	0	0	316
March	376	0	0	0	0	376
April	417	4	0	0	4	421
May	440	4	1	0	5	445
June	422	0	0	0	0	422
July	541	0	0	0	0	541
August	401	16	2	0	18	419
September	361	18	23	4	45	406
October	384	19	7	0	26	410
November	328	3	1	3	7	335
December	328	0	0	0	0	328
Total	**4610**	**64**	**34**	**7**	**105**	**4715**

1. Zone Temperature Statistics

Zone Temperature Report for D03 - RTU A3 - Principal/Conf

Project Name: TRINIDAD ENERGY ARCHIVE 2 UNSOLVED 2017 wk thru 07/25/2017
Prepared by: carrier 08:42PM

1. Zone Temperature Statistics

	Occ	Occ	Occ	Occ	Occ	Occ	Occ	Occ	Occ	Unocc	Unocc	Unocc	Unocc
Zone Name	Max Zone Temp (°F)	Hours More Than 5.0 °F Above Throt. Range	Hours 1.0 to 5.0 °F Above Throt. Range	Cooling Setpoint plus Throt. Range (°F)	Hours Within Throt. Range or Dead-band	Heating Setpoint minus Throt. Range (°F)	Hours 1.0 to 5.0 °F Below Throt. Range	Hours More Than 5.0 °F Below Throt. Range	Min Zone Temp (°F)	Max Zone Temp (°F)	Cooling Setpoint plus Throt. Range (°F)	Heating Setpoint minus Throt. Range (°F)	Min Zone Temp (°F)
A104-Asst. Prin.	74.4	0	0	74.0	2724	68.0	0	0	72.2	82.5	84.0	63.0	76.0

Note: For any occupied hours in which cooling is unavailable or scheduled off, zone temperature out of range statistics are not reported.
Note: For any occupied hours in which heating is unavailable or scheduled off, zone temperature out of range statistics are not reported.

Note: For any occupied hours in which cooling is unavailable or scheduled off, zone temperature out of range statistics are not reported.
Note: For any occupied hours in which heating is unavailable or scheduled off, zone temperature out of range statistics are not reported.

Workshop 6 Inputs

Blank Page

Blank Page

Workshop 6 Defining and Simulating Buildings

Defining Buildings in HAP

The first step in this workshop is to retrieve Trinidad Energy Archive 3 Unsolved from the Unsolved Loads and Energy folder on your desktop. Before we start working with this archive, let us discuss how HAP uses the term "building".

A building in HAP is the "container" for all HVAC and non-HVAC systems for one design scenario. Performing an energy analysis calculates annual energy costs for the building's energy consuming systems. System design load analysis in HAP, requires us to create elements, spaces, zones, air systems, and plants like in the previous workshops, while a "building" is only required for performing an energy simulation.

Taken literally, a building represents one structure. However, in HAP the definition of a building is flexible. It can also represent a group of structures. For example, a "building" could represent a campus in which all the structures are served by central steam and chilled water plant equipment. Keep in mind, a design case can contain part of an actual building, a complete building, or many buildings.

When using the Equipment Wizard HAP not only creates the Air Systems and Plants but also a Building. The Wizard created Building includes the plants, air systems, spaces and all items linked to the spaces like schedules, construction items etc.

One exercise included in this workshop is defining the Energy Charges by creating a Fuel Rate and Electric Rate. There are several ways to create these energy rates including the Utility Rate Wizard, importing previously created rates, use the USA state EIA average rates or user defining the rates. For our workshop we create a complex electric rate that includes seasonal scheduling, time-of-day utility rate schedules and demand clause. Create the Natural Gas utility rate as a simple rate structure. Use the following values for creating the electric and fuel utility rates.

WE WILL DO A PRACTICE "DETAILED" ELECTRIC AND FUEL RATE...USING THE UTILITY RATE WIZARD... SEE THE HANDOUT!

Electric Rate

Rate Name ....

Rate Type ....

Electric Rate Details

Electric Rate Setup

Rate Name ....

Customer Charge ....

Seasonal Pricing ....

Time of Day Pricing ....

Energy Charge

Type .... **Flat Prices**

Demand Charge

Type .... **Flat Prices**

Emission Factors

CO2e Emissions .... **1.575** lb/kWh

Blank Page

Electric Rate Schedules

Seasonal Pricing

	Summer	Winter
Start	May	Oct
End	Sept	April

Time of Day Pricing

	Summer		Winter	
	Peak Start	Off Peak Start	Peak Start	Off Peak Start
Weekdays	9 AM	9 PM	9 AM	9 PM
Saturday	None	All	None	All
Sunday/Hol	None	All	None	All

WE WILL CONFIGURE THIS EXAMPLE ELECTRIC RATE WITH THE UTILITY RATE WIZARD...SEE THE HANDOUT FOR THE INFO TO CONFIGURE!

Electric Energy and Demand Charges

Electric Energy Charge

Season	Period	Block Size (kWh)	Price ($/kWh)
Summer	Peak	All	0.08000
Summer	Off-Peak	All	0.06500
Winter	Peak	All	0.07000
Winter	Off-Peak	All	0.05500

Electric Demand Charge

Season	Period	Block Size (kW)	Price ($/kW)
Summer	Peak	All	12.00000
Summer	Off-Peak	All	10.00000
Winter	Peak	All	9.00000
Winter	Off-Peak	All	6.00000

Ratchet Clause

Ratchet Clause .... **Used**
Peak Month Start .... **May**
Peak Month End .... **Sept**
Ratchet Applies Start .... **Oct**
Ratchet Applies End .... **May**
Multiplier .... **80** %

Minimum Demand

Minimum Demand .... **25** kW

Fuel Rates

Natural Gas

Rate Name .... **Gas Rate**
Units of Measure .... **MCF**
Conversion Factor .... **1000.00000** kBTU/MCF
Fuel Price .... **12.28000** $/MCF
CO2e Emissions .... **122.000** lb/MCF

Refer to Figures 6.1a through 6.1c for details.

Figure 6.1a – **Utility Rate Wizard** Input Form Screen 1

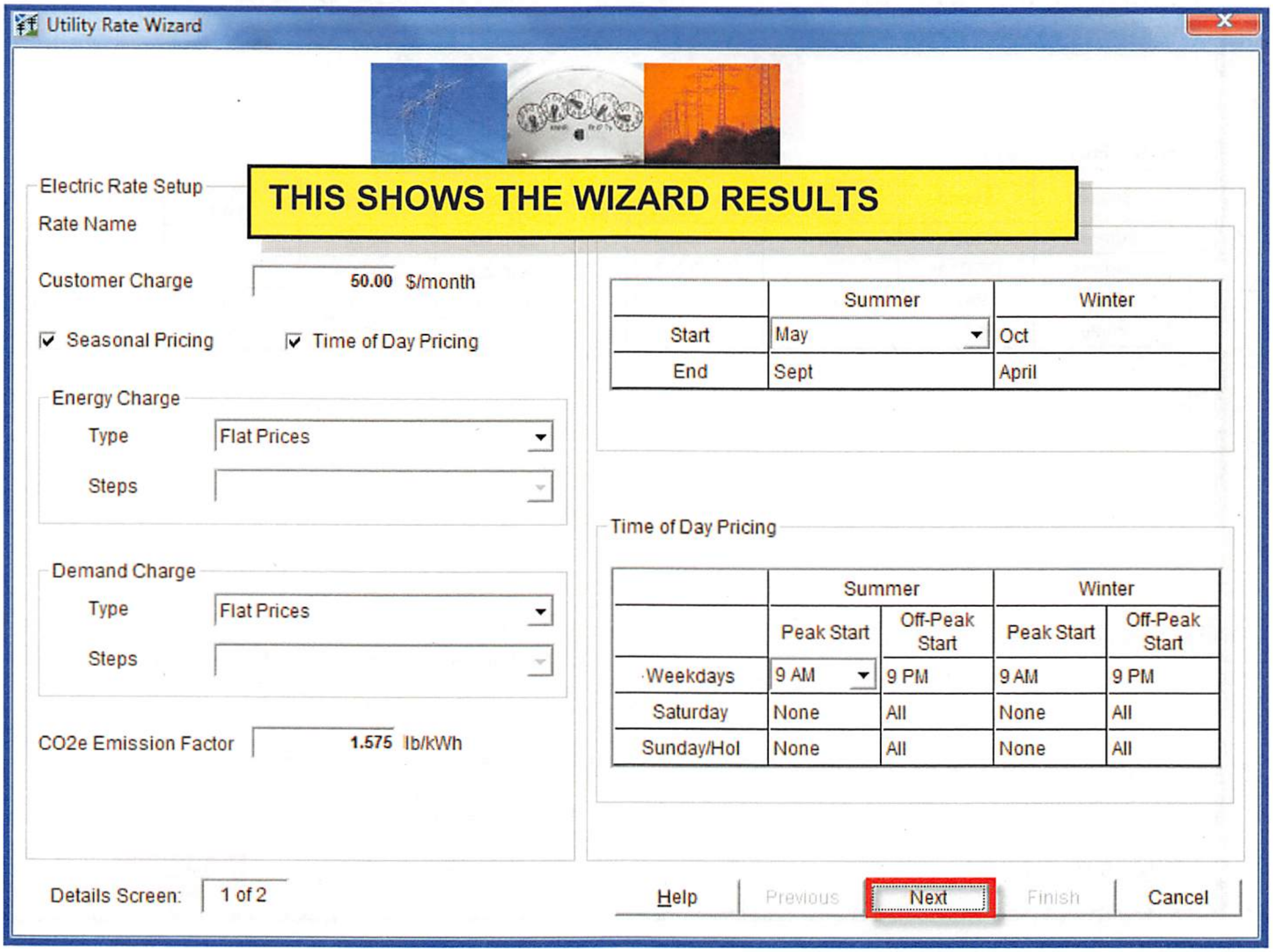
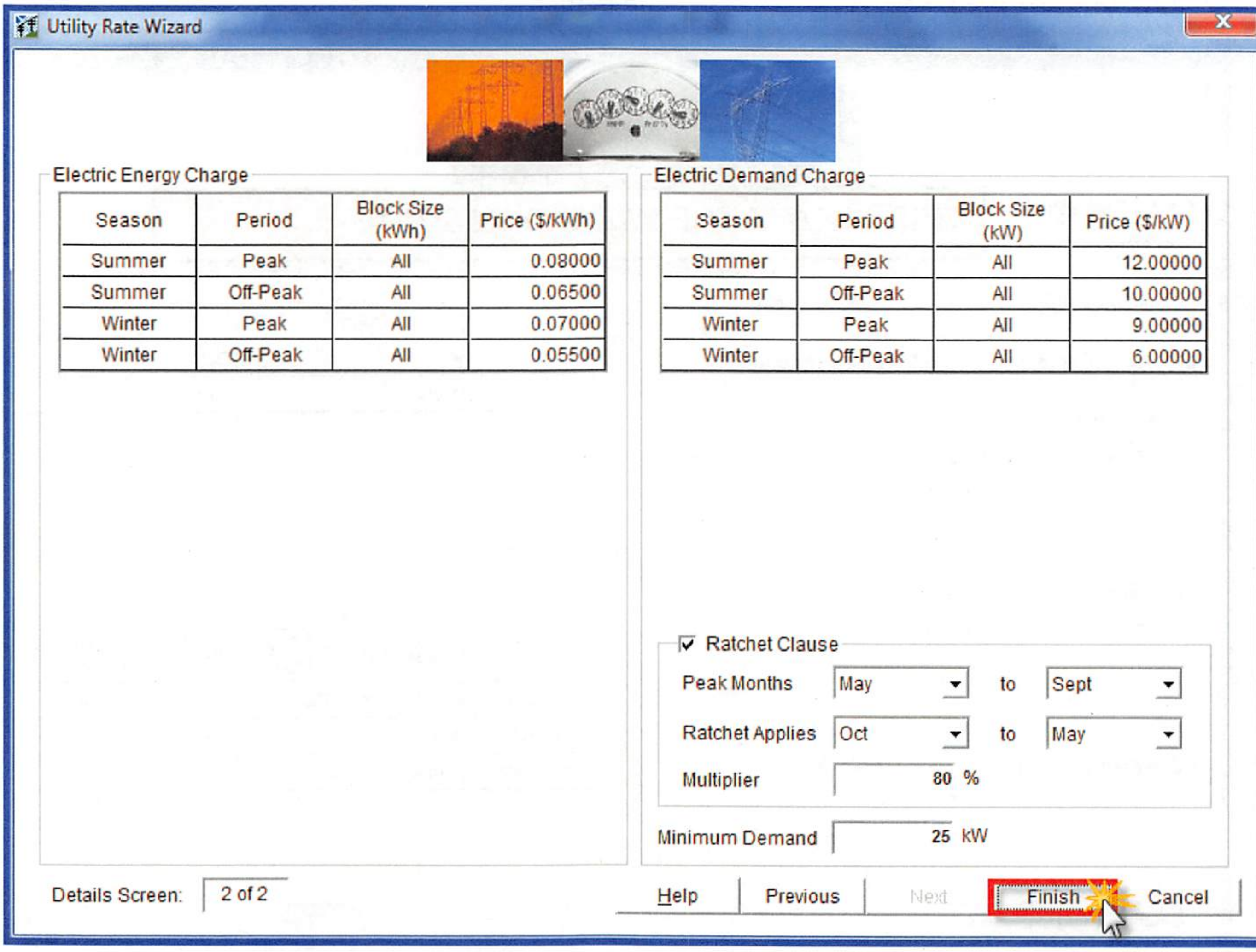


Figure 6.1b - Utility Rate Wizard Input Form Screen 2



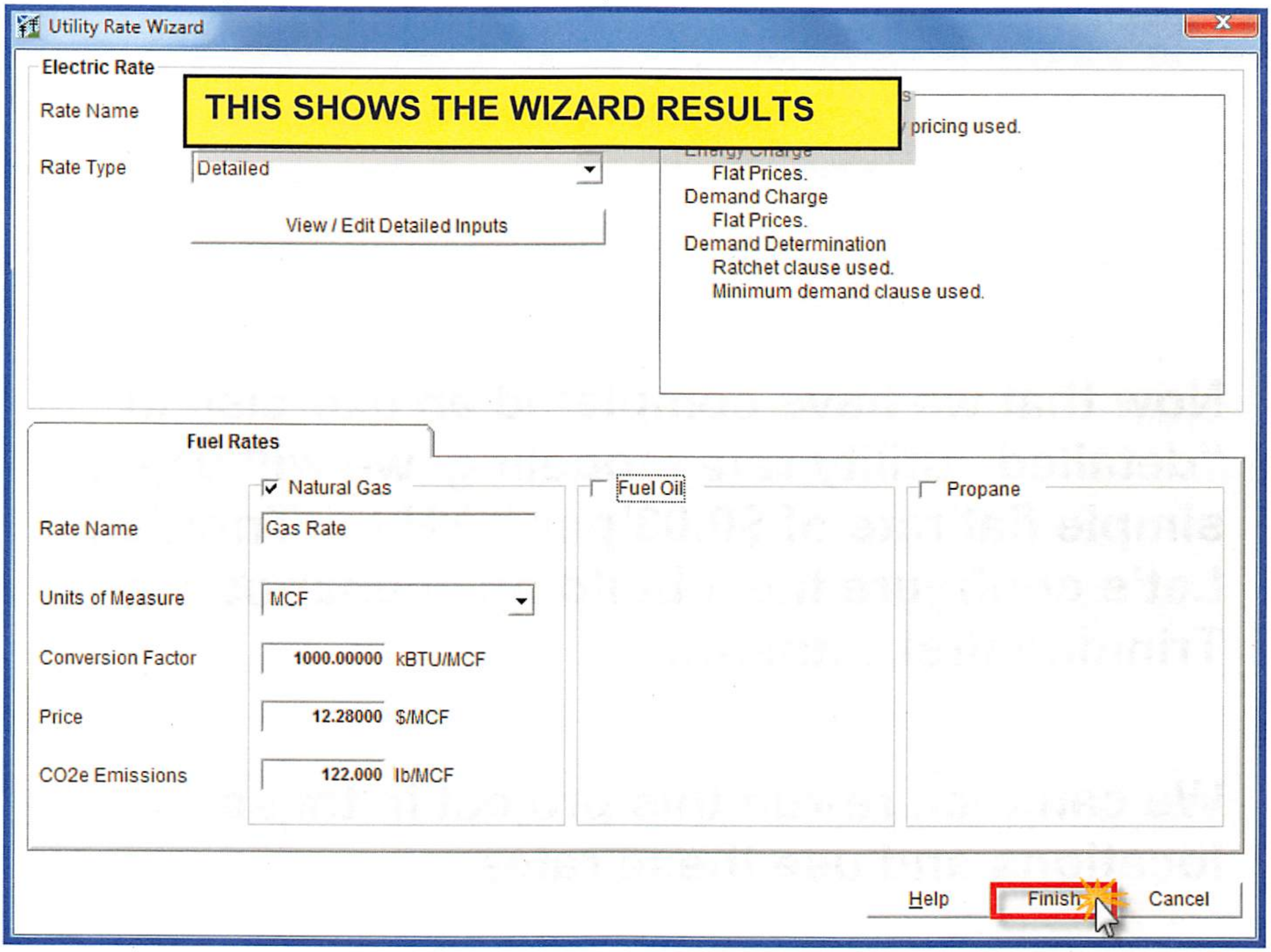
Electric Energy Charge

Season	Period	Block Size (kWh)	Price ($/kWh)
Summer	Peak	All	0.08000
Summer	Off-Peak	All	0.06500
Winter	Peak	All	0.07000
Winter	Off-Peak	All	0.05500

Electric Demand Charge

Season	Period	Block Size (kW)	Price ($/kW)
Summer	Peak	All	12.00000
Summer	Off-Peak	All	10.00000
Winter	Peak	All	9.00000
Winter	Off-Peak	All	6.00000

Figure 6.1c – Utility Rate Wizard Natural Gas Utility Rate



Now that we have completed an exercise in "detailed" utility rate modeling, we will use a simple flat rate of $0.03 per kWH for Trinidad. Let's configure the 4 building scenarios for Trinidad first....then...

We can then re-run this project in these locations and use these rates:

1. **Curacao:**
   Electricity Cost $ 0.30 cent / kWh
   All Electric

2. **Barbados:**
   Electricity Cost $ 0.35 cent / kWh
   Fuel: Natural Gas

Our next exercise in this workshop consists of creating the "Buildings" for this project. As discussed in a previous paragraph, each "Building" represents a design alternative for comparison of energy consumption etc. Our project includes the following four (4) designs:

I. Building Name:	**A Base VAV-PFPMXB- 62.1-2007**
Cooling Plant:	(2) 30 XA Air- Cooled Chillers
Heating:	Electric
Air Systems:	A01-A10
Air System Types:	VAV PFPMXB, SZCV
Ventilation Control:	Constant
Ventilation Sizing:	ASHRAE 62.1-2007

II. Building Name:	**B Alt1 VAV-PFPMXB- DCV**
Cooling Plant:	(2) 30 XA Air- Cooled Chillers
Heating Plant:	Electric
Air Systems:	B01-B10
Air System Types:	VAV PFPMXB, SZCV
Ventilation Control:	*Demand Controlled Ventilation*
Ventilation Sizing:	ASHRAE 62.1-2007

III. Building Name:	**C Alt2-4PFCU- DOAS– 62.1-2007**
Cooling Plant:	(1) 23 XRV Water-Cooled Screw Chiller
Heating Plant:	Electric
Air Systems:	C1-C8
Air System Types:	4- Pipe Fan Coil Units, SZCV
Ventilation Control:	Constant (dedicated ventilation for 4PFCU
Ventilation Sizing:	ASHRAE 62.1-2007

IV. Building Name:	**D Alt3 SZCV/RTU- 62.1-2007**
Cooling Plant:	None (Integral to RTU- Air Cooled DX)
Heating Plant:	None (Integral to RTU –Electric Resistance
Air Systems:	D01-D36
Air System Types:	SZCV RTU
Ventilation Control:	Constant
Ventilation Sizing:	ASHRAE 62.1-2007

Notice the "B Alt-1" scenario is a duplicate of the "A" Base Case except the associated air systems use demand control ventilation to size ventilation loads. Using DCV is an energy saving strategy that reduces ventilation air requirements resulting from diverse building occupancy. The "C Alt-2" design scenario uses a water cooled screw chiller to supply chilled water to 2-pipe fan coil units and single zone air handlers. The fan coil systems utilize a common (dedicated) ventilation air system resulting in a lower peak total ventilation airflow compared to the A and B scenarios.

The "D-Alt 3" scenario uses multiple packaged single zone constant volume RTU units. The rooftop units are self-contained DX cooling with electric heating and are not connected to a chilled water or hot water plant.

In order to save time, the schedules and profiles applicable to the miscellaneous energy items are completed as part of archive # 3.

Figure 6.2 – Enter Building Data

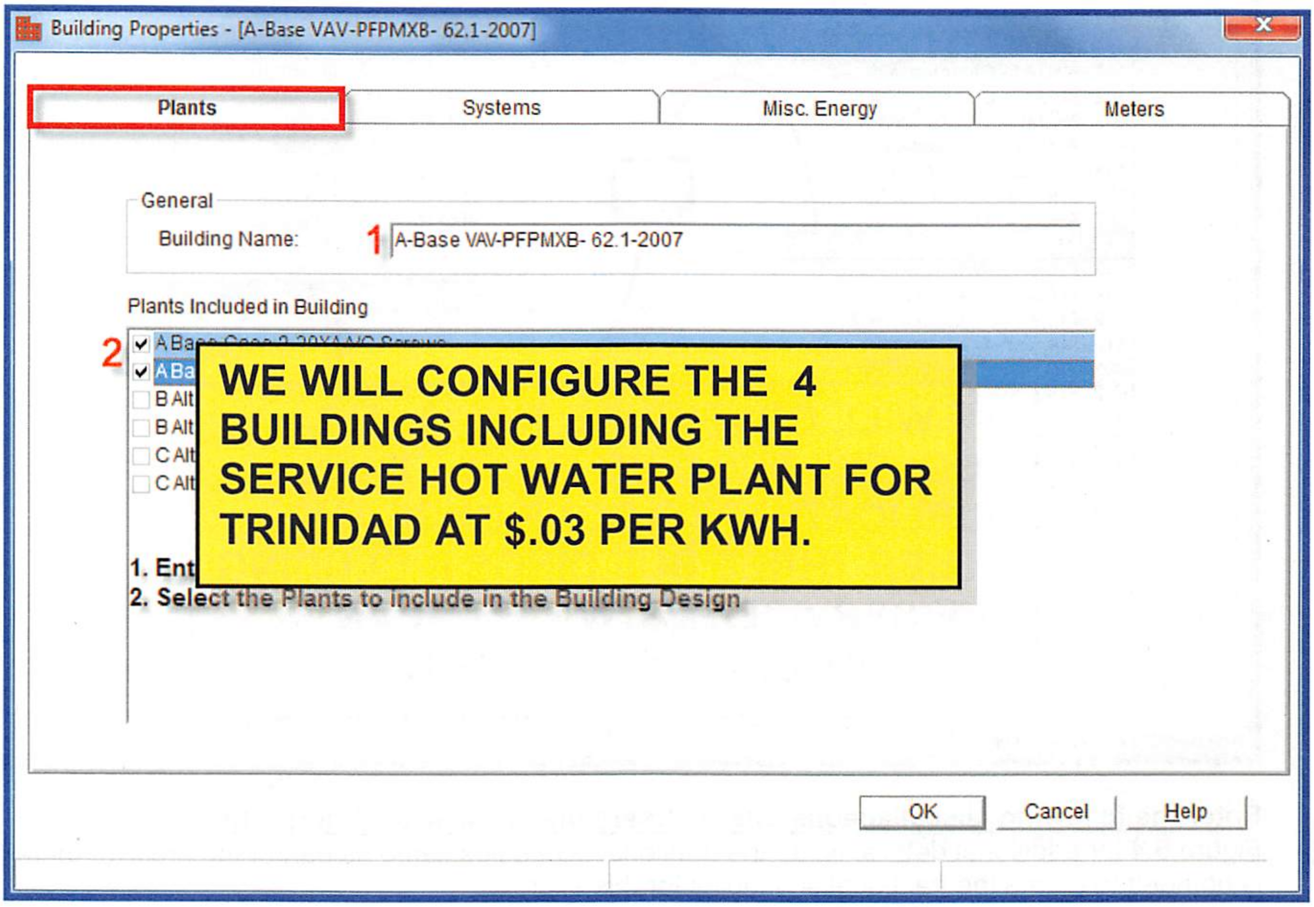
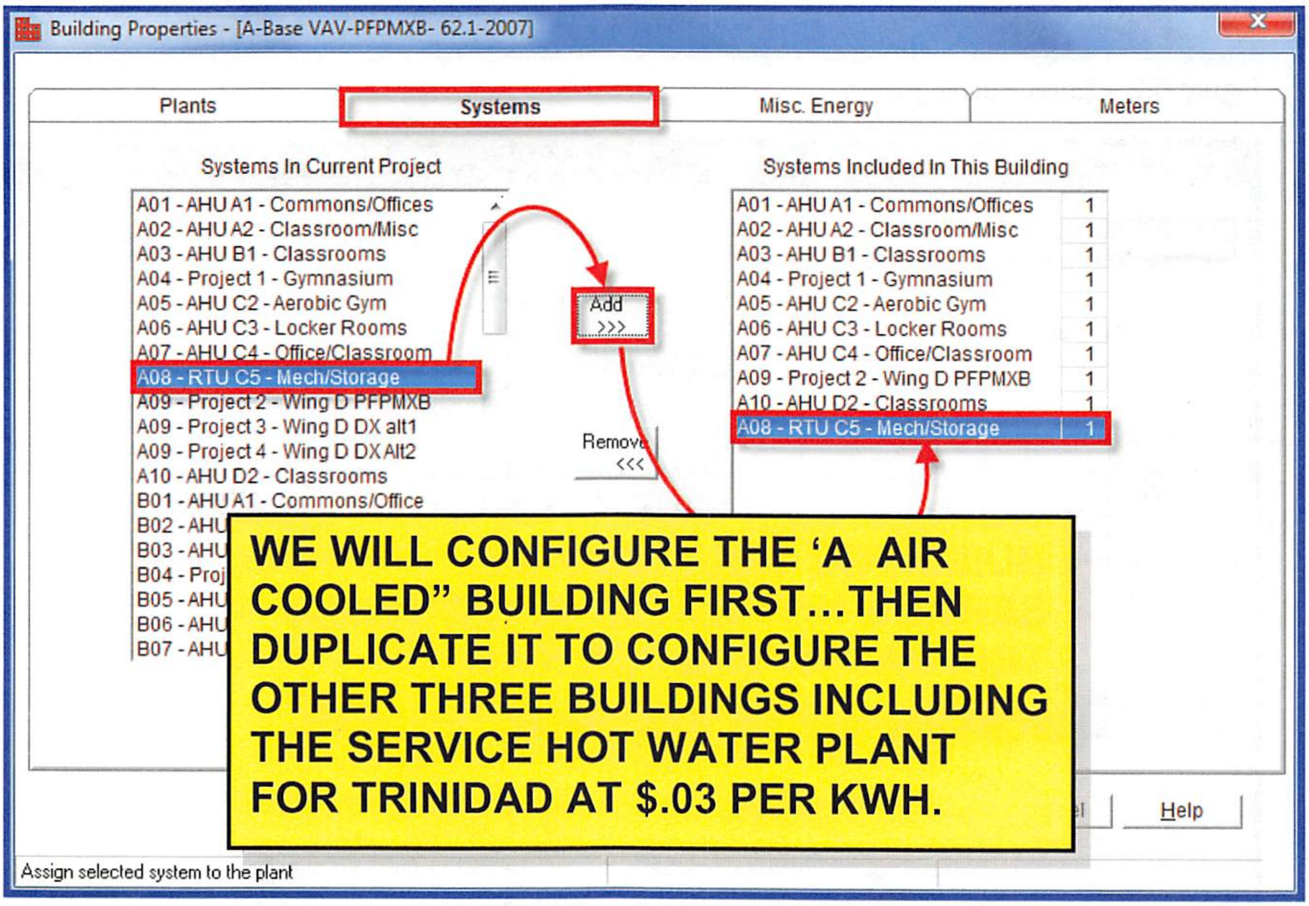


Figure 6.3 – Assign Air Systems to Building Design



Enter the following Miscellaneous Energy Users under the Misc. Energy Tab. Refer to Figure 6.4 for additional details. Note: the fractional schedules came as part of the archive, there is no need to create the fractional schedules for this exercise

Name	Energy Type	Peak Use	Schedule
Exterior Lighting	Electric	5.0kW	Parking Lot Lights
Aerobic Pool Heater	Electric	200 KW	Aerobic Pool Heater
Pool Circ. Pumps	Electric	2.5 kW	Aerobic Pool Heater

Figure 6.4 – Misc. Energy Tab Input Details

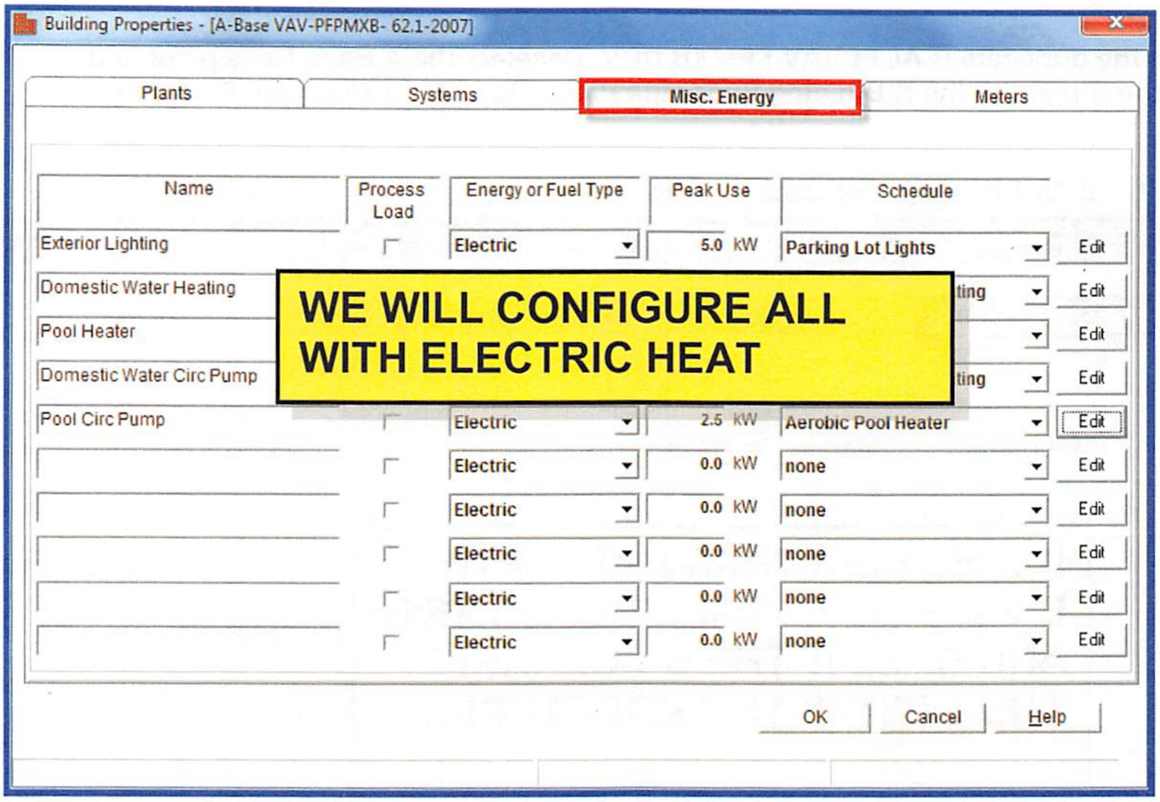
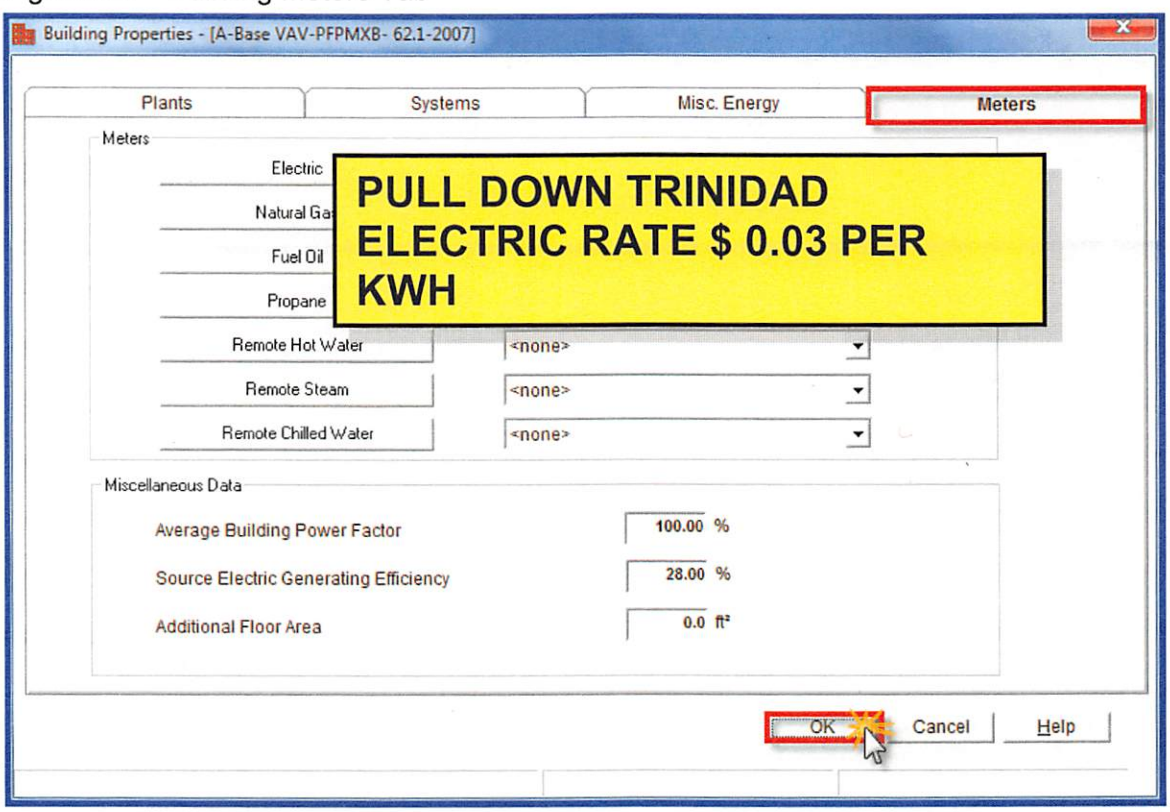


Figure 6.5 – Building Meters Tab



<u>Highlight the "A Base Case Building" after saving it and then right mouse click and choose Duplicate.</u>

Rename the duplicate B ALT1 VAV FPMXB DCV. Deselect the A Base Case plant and assign the B plant to the B Building under the Plants Tab. Refer to Figure 6.6 for details.

Figure 6.6 – B Alt 1 Building Properties - Plants

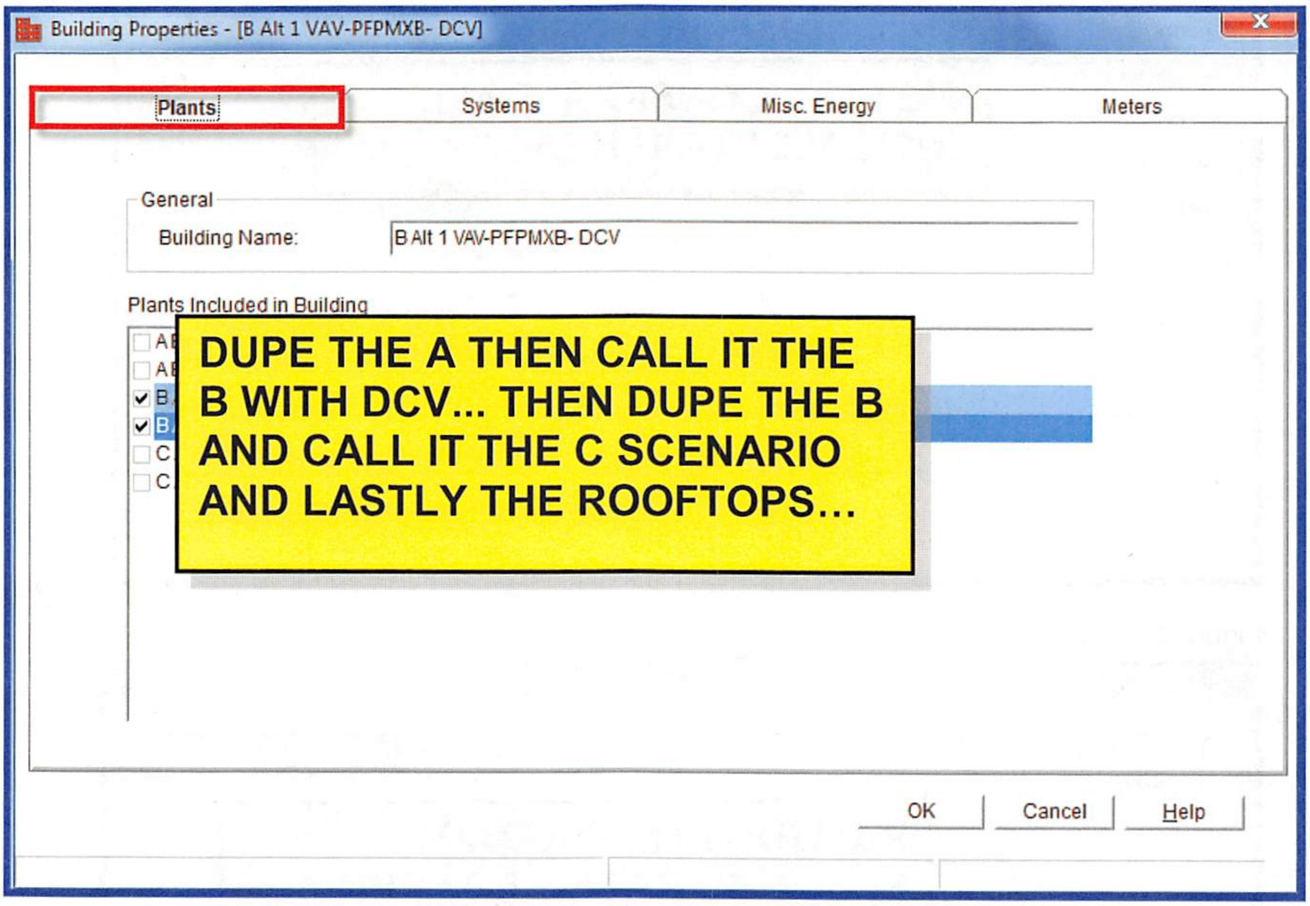
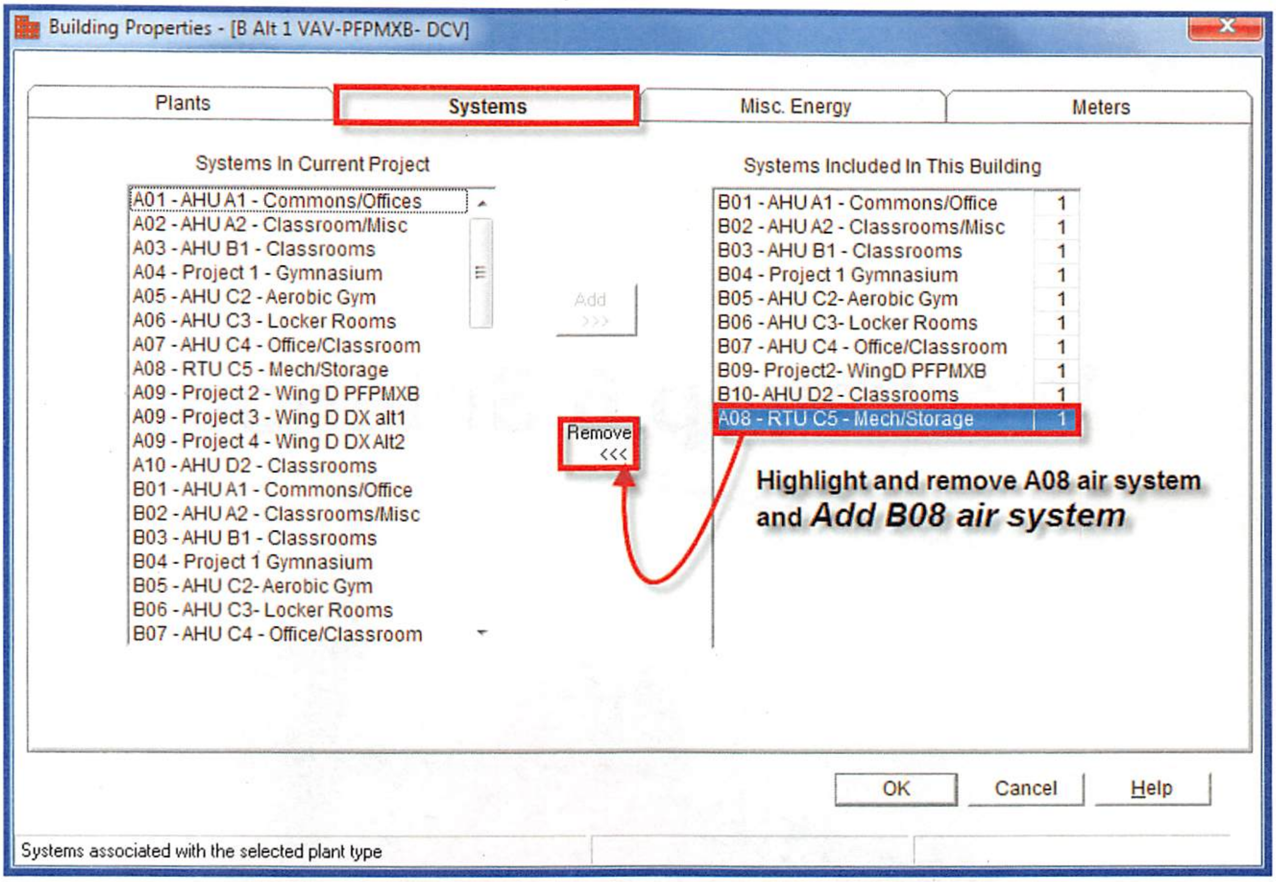
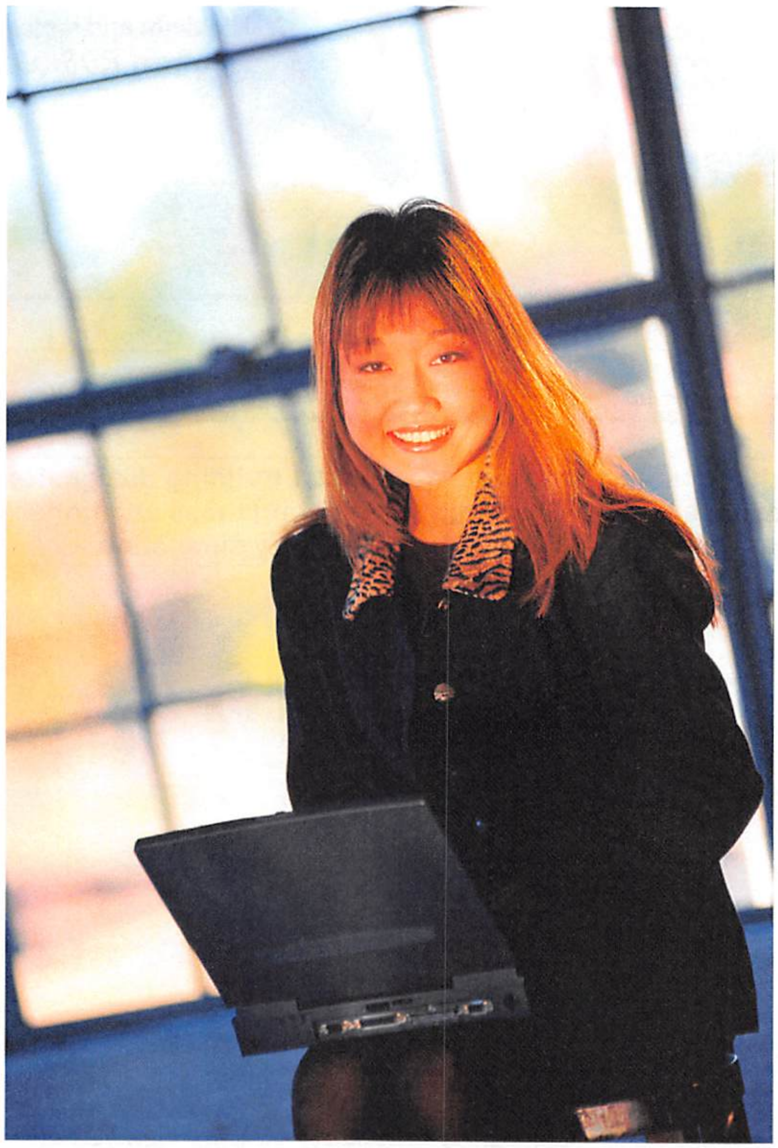


Figure 6.7 – B Alt 1 Building Properties – Systems



These are the only required changes for the B Alt 1 Building design. Repeat the process for the C Alt 2 design and D Alt 3 Design. After saving these additional buildings, highlight all four design case buildings and perform the energy simulation.

Workshop 6 Solutions



Blank Page

Simulation Results

Table 1. Annual Costs

Component	A AC CHILLERS ($)	B AC CHILLERS DCV ($)	C WC CHILLER ($)	D RTUS ($)
Air System Fans	7,228	7,228	4,717	6,898
Cooling	21,650	17,824	12,387	17,679
Heating	2,346	2,346	1,247	1,247
Pumps	985	901	1,479	2
Heat Rejection Fans	0	0	1,823	0
HVAC Sub-Total	**32,209**	**28,299**	**21,653**	**25,825**
Lights	7,311	7,311	7,311	7,311
Electric Equipment	3,568	3,568	3,569	3,569
Misc. Electric	10,070	10,070	10,070	10,070
Misc. Fuel Use	0	0	0	0
Non-HVAC Sub-Total	**20,949**	**20,949**	**20,949**	**20,950**
Grand Total	**53,159**	**49,248**	**42,603**	**46,775**

Table 2. Annual Cost per Unit Floor Area

Component	A AC CHILLERS ($/ft²)	B AC CHILLERS DCV ($/ft²)	C WC CHILLER ($/ft²)	D RTUS ($/ft²)
Air System Fans	0.105	0.105	0.068	0.100
Cooling	0.314	0.258	0.179	0.256
Heating	0.034	0.034	0.018	0.018
Pumps	0.014	0.013	0.021	0.000
Heat Rejection Fans	0.000	0.000	0.026	0.000
HVAC Sub-Total	**0.467**	**0.410**	**0.314**	**0.374**
Lights	0.106	0.106	0.106	0.106
Electric Equipment	0.052	0.052	0.052	0.052
Misc. Electric	0.146	0.146	0.146	0.146
Misc. Fuel Use	0.000	0.000	0.000	0.000
Non-HVAC Sub-Total	**0.303**	**0.303**	**0.303**	**0.303**
Grand Total	**0.770**	**0.713**	**0.617**	**0.677**
Gross Floor Area (ft²)	69057.0	69057.0	69057.0	69057.0
Conditioned Floor Area (ft²)	69057.0	69057.0	69057.0	69057.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 3. Component Cost as a Percentage of Total Cost

Component	A AC CHILLERS (%)	B AC CHILLERS DCV (%)	C WC CHILLER (%)	D RTUS (%)
Air System Fans	13.6	14.7	11.1	14.7
Cooling	40.7	36.2	29.1	37.8
Heating	4.4	4.8	2.9	2.7
Pumps	1.9	1.8	3.5	0.0
Heat Rejection Fans	0.0	0.0	4.3	0.0
HVAC Sub-Total	**60.6**	**57.5**	**50.8**	**55.2**
Lights	13.8	14.8	17.2	15.6
Electric Equipment	6.7	7.2	8.4	7.6
Misc. Electric	18.9	20.4	23.6	21.5
Misc. Fuel Use	0.0	0.0	0.0	0.0
Non-HVAC Sub-Total	**39.4**	**42.5**	**49.2**	**44.8**
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**

Annual Emissions Summary

Table 1. Annual Costs

Component	A AC CHILLERS ($)	B AC CHILLERS DCV ($)	C WC CHILLER ($)	D RTUS ($)
HVAC Components				
Electric	32,210	28,299	21,652	25,826
Natural Gas	0	0	0	0
Fuel Oil	0	0	0	0
Propane	0	0	0	0
Remote HW	0	0	0	0
Remote Steam	0	0	0	0
Remote CW	0	0	0	0
HVAC Sub-Total	**32,210**	**28,299**	**21,652**	**25,826**
Non-HVAC Components				
Electric	20,950	20,950	20,949	20,948
Natural Gas	0	0	0	0
Fuel Oil	0	0	0	0
Propane	0	0	0	0
Remote HW	0	0	0	0
Remote Steam	0	0	0	0
Non-HVAC Sub-Total	**20,950**	**20,950**	**20,949**	**20,948**
Grand Total	**53,160**	**49,250**	**42,602**	**46,774**

Table 2. Annual Energy Consumption

Component	A AC CHILLERS	B AC CHILLERS DCV	C WC CHILLER	D RTUS
HVAC Components				
Electric (kWh)	1,073,650	943,315	721,746	860,852
Natural Gas (na)	0	0	0	0
Fuel Oil (na)	0	0	0	0
Propane (na)	0	0	0	0
Remote HW (na)	0	0	0	0
Remote Steam (na)	0	0	0	0
Remote CW (na)	0	0	0	0
Non-HVAC Components				
Electric (kWh)	698,341	698,341	698,315	698,281
Natural Gas (na)	0	0	0	0
Fuel Oil (na)	0	0	0	0
Propane (na)	0	0	0	0
Remote HW (na)	0	0	0	0
Remote Steam (na)	0	0	0	0
Totals				
Electric (kWh)	1,771,992	1,641,656	1,420,061	1,559,133
Natural Gas (na)	0	0	0	0
Fuel Oil (na)	0	0	0	0
Propane (na)	0	0	0	0
Remote HW (na)	0	0	0	0
Remote Steam (na)	0	0	0	0
Remote CW (na)	0	0	0	0

Table 3. Annual Emissions

Component	A AC CHILLERS	B AC CHILLERS DCV	C WC CHILLER	D RTUS
CO2 Equivalent (lb)	2,799,692	2,593,757	2,243,730	2,463,447

Table 4. Annual Cost per Unit Floor Area

Component	A AC CHILLERS ($/ft²)	B AC CHILLERS DCV ($/ft²)	C WC CHILLER ($/ft²)	D RTUS ($/ft²)
HVAC Components				
Electric	0.466	0.410	0.314	0.374
Natural Gas	0.000	0.000	0.000	0.000
Fuel Oil	0.000	0.000	0.000	0.000
Propane	0.000	0.000	0.000	0.000
Remote HW	0.000	0.000	0.000	0.000
Remote Steam	0.000	0.000	0.000	0.000
Remote CW	0.000	0.000	0.000	0.000
HVAC Sub-Total	**0.466**	**0.410**	**0.314**	**0.374**
Non-HVAC Components				
Electric	0.303	0.303	0.303	0.303
Natural Gas	0.000	0.000	0.000	0.000
Fuel Oil	0.000	0.000	0.000	0.000
Propane	0.000	0.000	0.000	0.000
Remote HW	0.000	0.000	0.000	0.000
Remote Steam	0.000	0.000	0.000	0.000
Non-HVAC Sub-Total	**0.303**	**0.303**	**0.303**	**0.303**
Grand Total	**0.770**	**0.713**	**0.617**	**0.677**
Gross Floor Area (ft²)	69057.0	69057.0	69057.0	69057.0
Conditioned Floor Area (ft²)	69057.0	69057.0	69057.0	69057.0

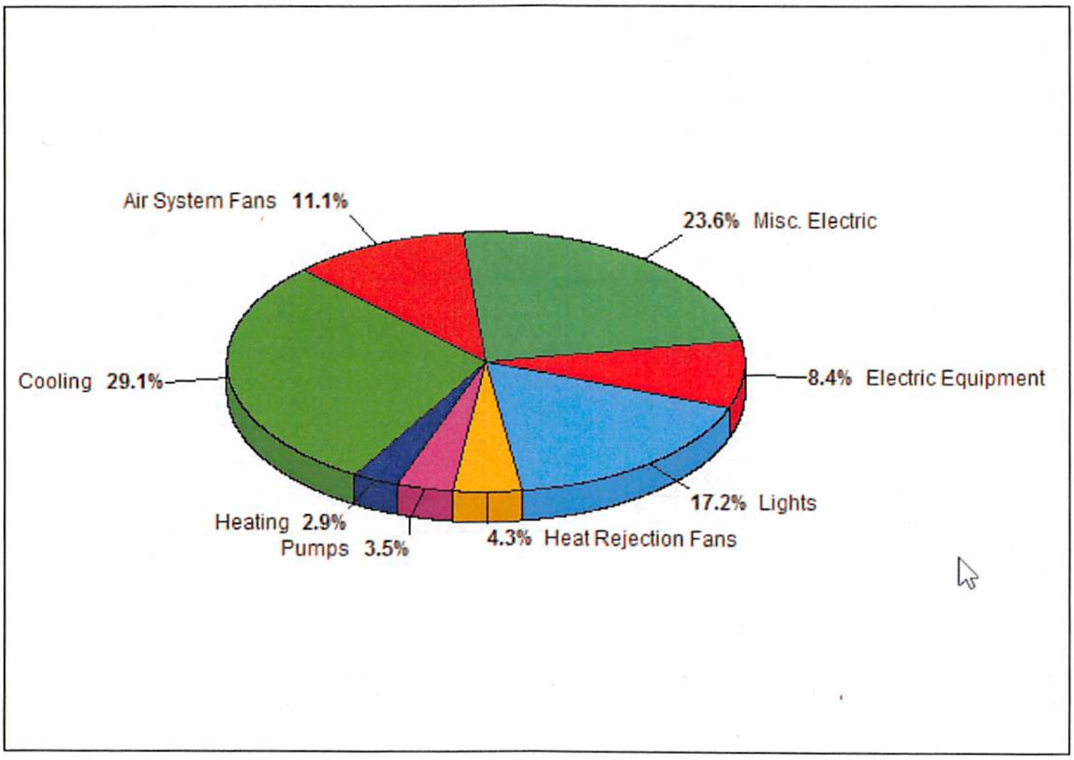
Note: Values in this table are calculated using the Gross Floor Area.

Table 5. Component Cost as a Percentage of Total Cost

Component	A AC CHILLERS (%)	B AC CHILLERS DCV (%)	C WC CHILLER (%)	D RTUS (%)
HVAC Components				
Electric	60.6	57.5	50.8	55.2
Natural Gas	0.0	0.0	0.0	0.0
Fuel Oil	0.0	0.0	0.0	0.0
Propane	0.0	0.0	0.0	0.0
Remote HW	0.0	0.0	0.0	0.0
Remote Steam	0.0	0.0	0.0	0.0
Remote CW	0.0	0.0	0.0	0.0
HVAC Sub-Total	**60.6**	**57.5**	**50.8**	**55.2**
Non-HVAC Components				
Electric	39.4	42.5	49.2	44.8
Natural Gas	0.0	0.0	0.0	0.0
Fuel Oil	0.0	0.0	0.0	0.0
Propane	0.0	0.0	0.0	0.0
Remote HW	0.0	0.0	0.0	0.0
Remote Steam	0.0	0.0	0.0	0.0
Non-HVAC Sub-Total	**39.4**	**42.5**	**49.2**	**44.8**
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**

Annual Component Cost for C Alt 2

Annual Component Costs - C WC CHILLER	
TRINIDAD ENERGY ARCHIVE 3 UNSOLVED 2017 WK THRU	07/29/2017
carrier	07:54AM



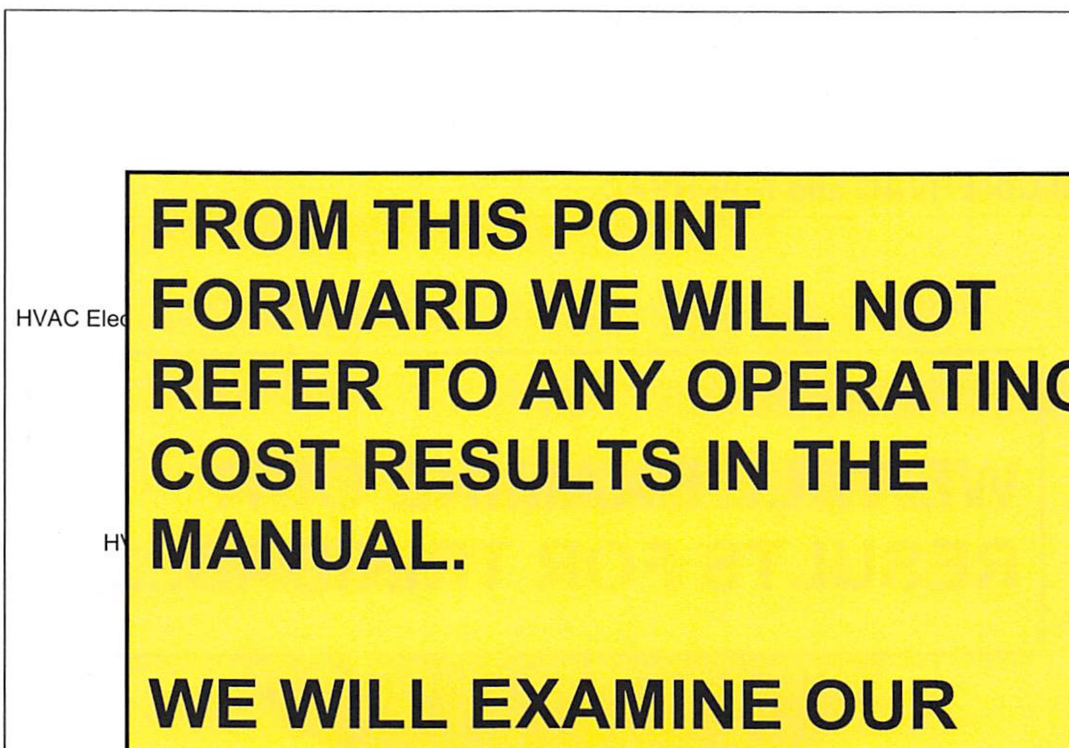
1. Annual Costs

1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	4,717	0.068	11.1
Cooling	12,387	0.179	29.1
Heating	1,247	0.018	2.9
Pumps	1,479	0.021	3.5
Heat Rejection Fans	1,823	0.026	4.3
HVAC Sub-Total	**21,653**	**0.314**	**50.8**
Lights	7,311	0.106	17.2
Electric Equipment	3,569	0.052	8.4
Misc. Electric	10,070	0.146	23.6
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**20,949**	**0.303**	**49.2**
Grand Total	**42,603**	**0.617**	**100.0**

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

Gross Floor Area .... **69057.0** ft²
Conditioned Floor Area .... **69057.0** ft²



FROM THIS POINT FORWARD WE WILL NOT REFER TO ANY OPERATING COST RESULTS IN THE MANUAL.

WE WILL EXAMINE OUR RESULTS FOR TRINIDAD....

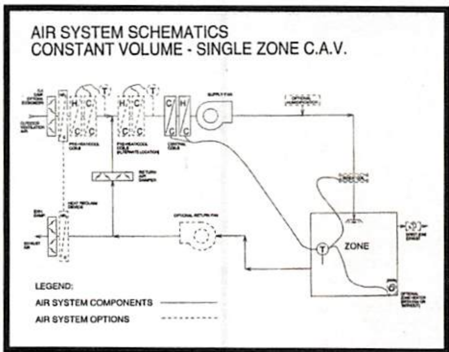
Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	56,374	0.816	31.8
Natural Gas	33,262	0.482	18.8
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**89,636**	**1.298**	**50.6**
Non-HVAC Components			
Electric	61,823	0.895	34.9
Natural Gas	25,725	0.373	14.5
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	**87,548**	**1.268**	**49.4**
Grand Total	**177,184**	**2.566**	**100.0**

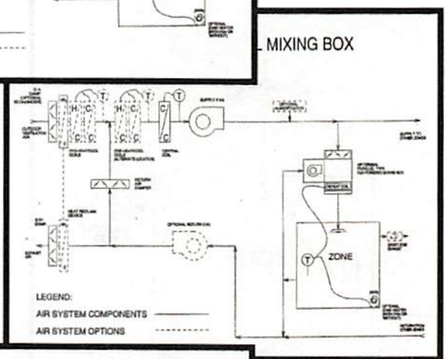
Note: Cost per unit floor area is based on the gross building floor area.

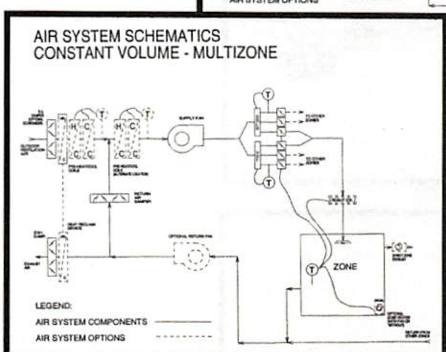
Gross Floor Area .... **69057.0** ft²
Conditioned Floor Area .... **69057.0** ft²

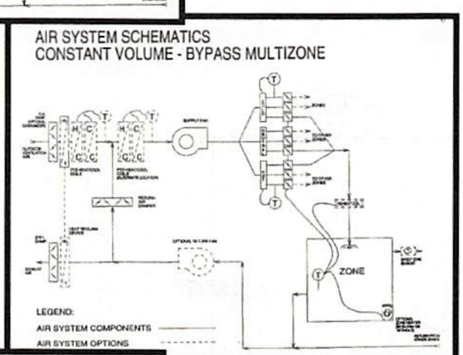
Annual Cost HVAC and Non-HVAC

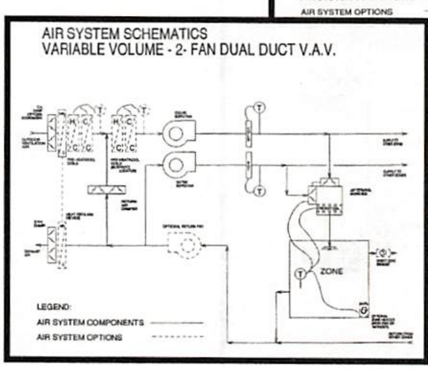
Appendix "A" Air System Schematics





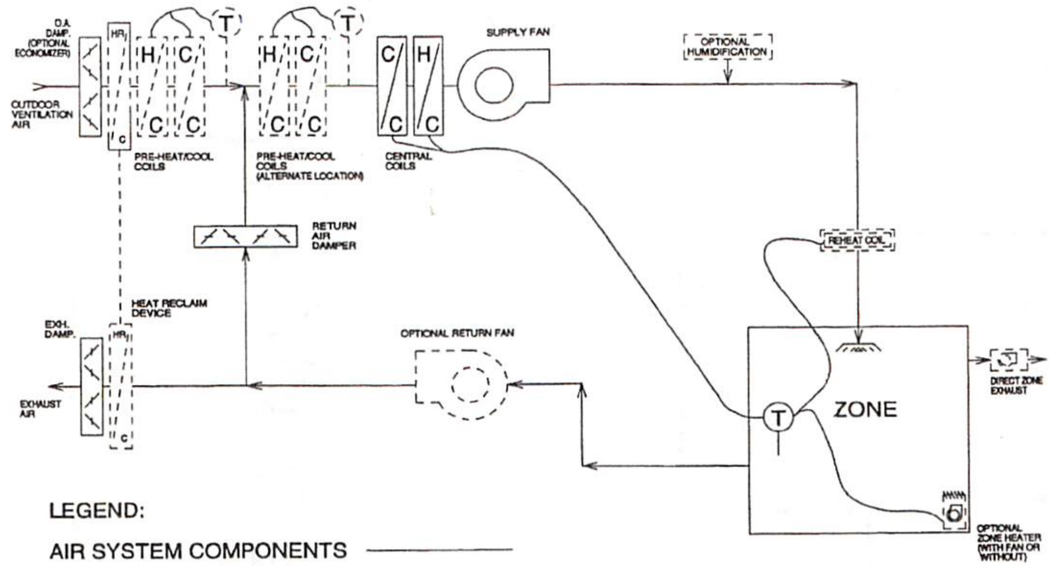






Air System Schematics

AIR SYSTEM SCHEMATICS
CONSTANT VOLUME - SINGLE ZONE C.A.V.

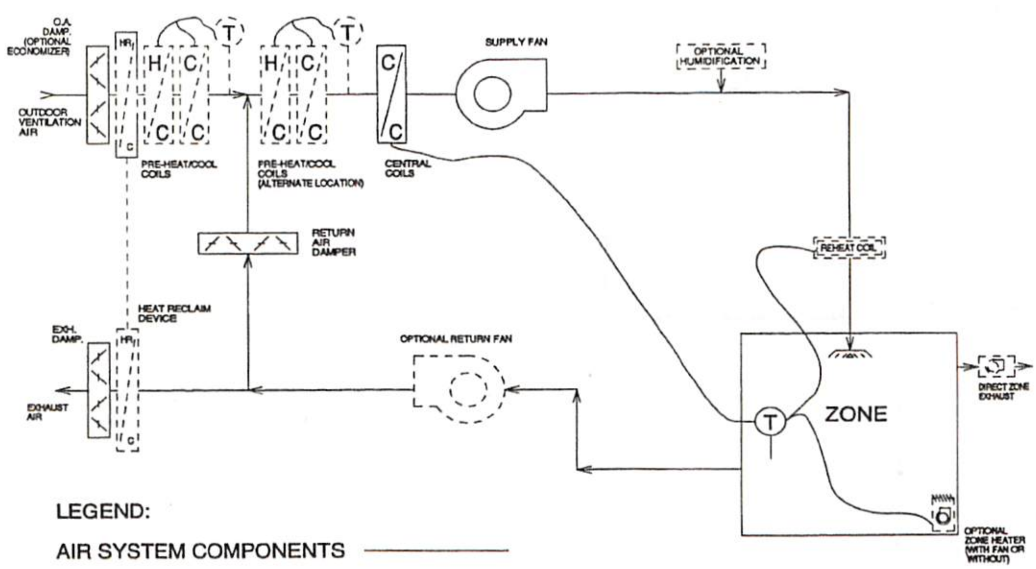


LEGEND:

AIR SYSTEM COMPONENTS ————————

AIR SYSTEM OPTIONS - - - - - - - - - -

AIR SYSTEM SCHEMATICS
CONSTANT VOLUME - C.A.V. REHEAT

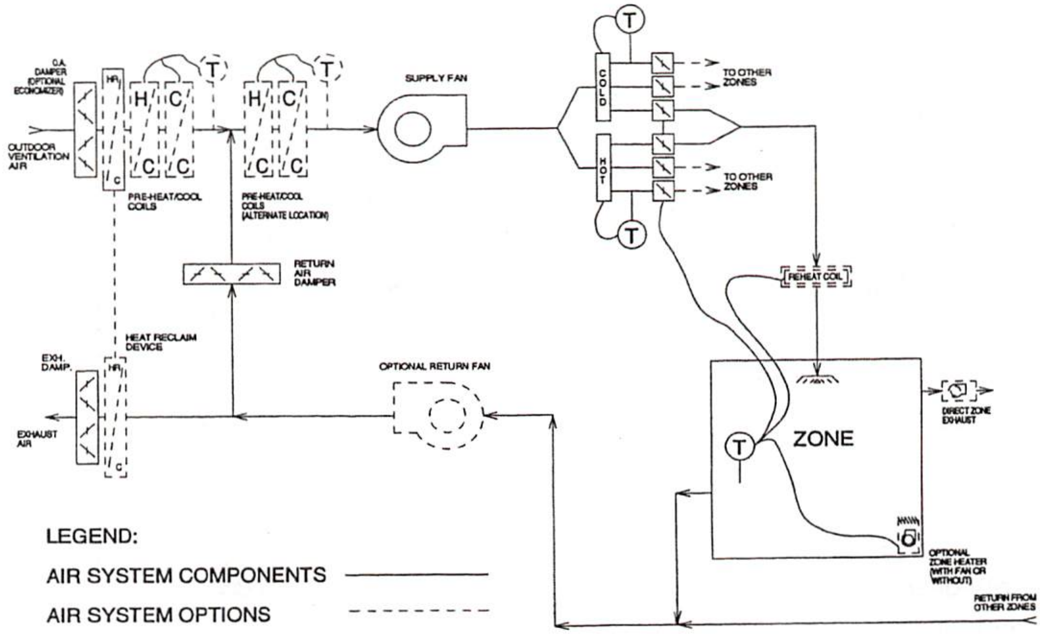


LEGEND:

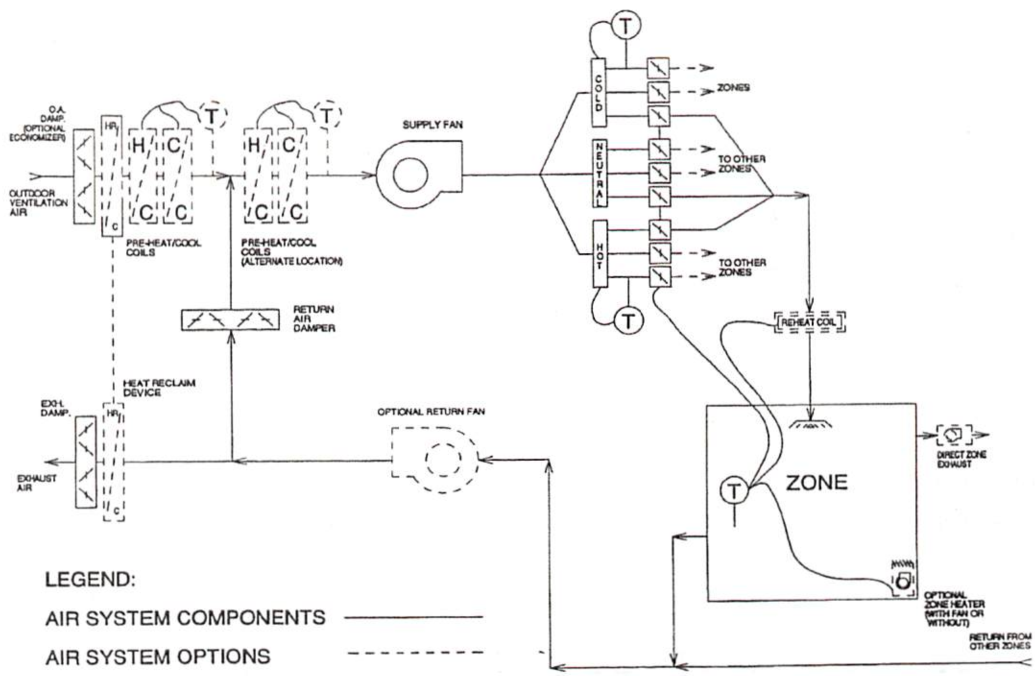
AIR SYSTEM COMPONENTS ————————

AIR SYSTEM OPTIONS - - - - - - - - - -

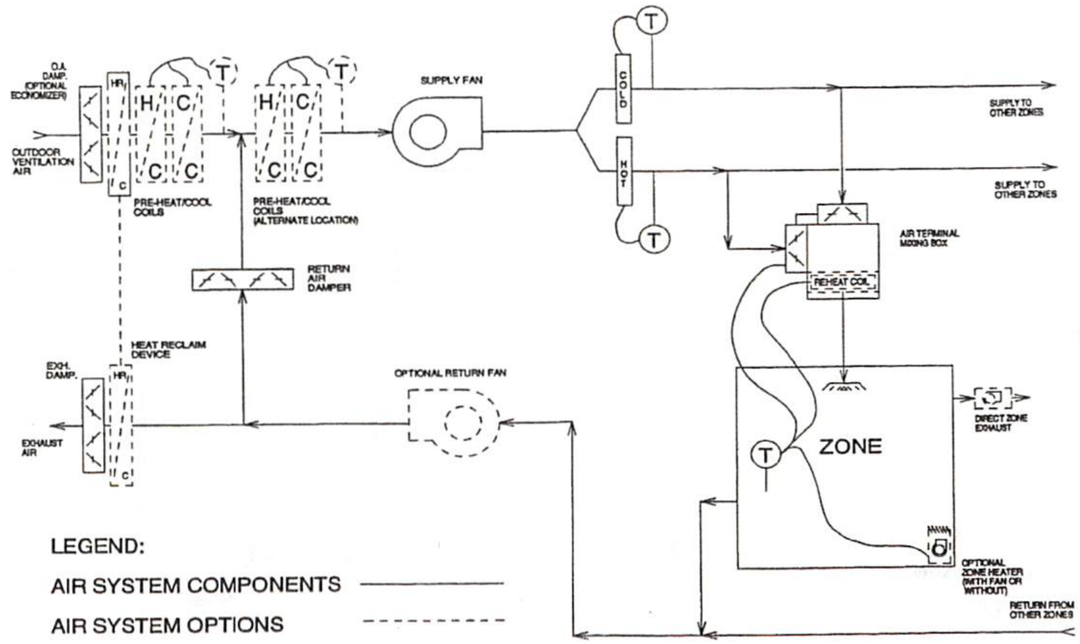
AIR SYSTEM SCHEMATICS
CONSTANT VOLUME - MULTIZONE

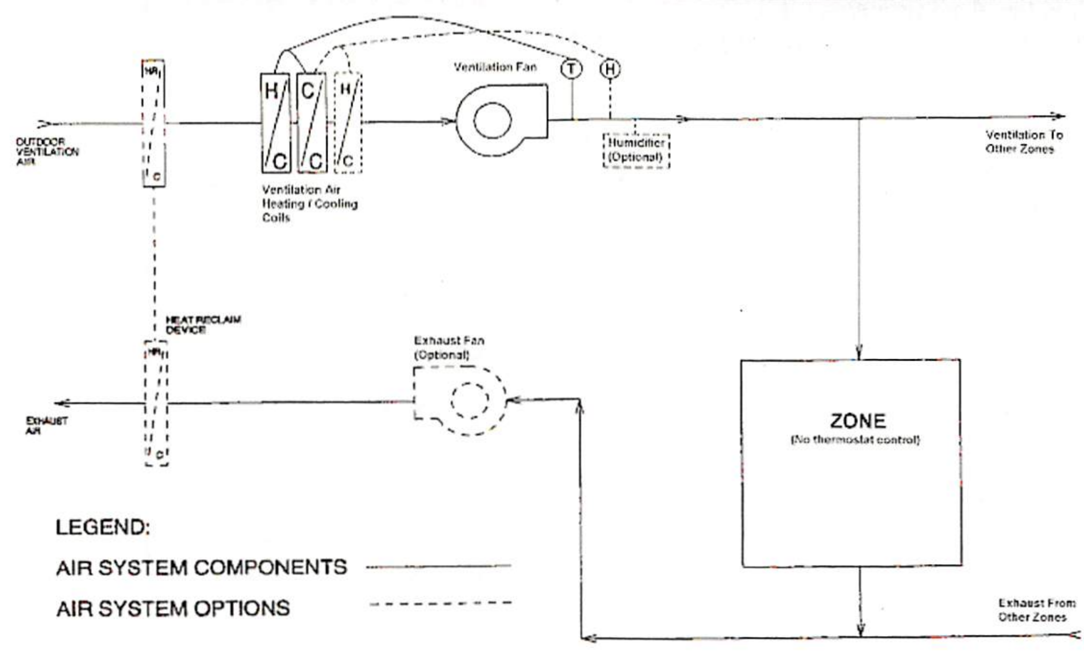


AIR SYSTEM SCHEMATICS
CONSTANT VOLUME - BYPASS MULTIZONE



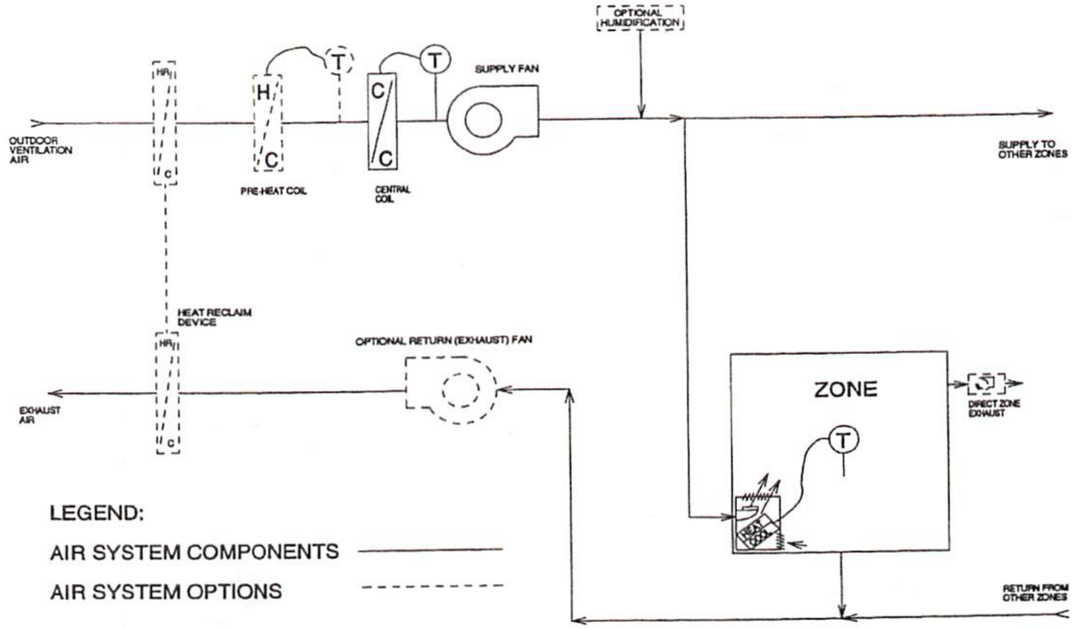
AIR SYSTEM SCHEMATICS
CONSTANT VOLUME - DUAL DUCT C.A.V.



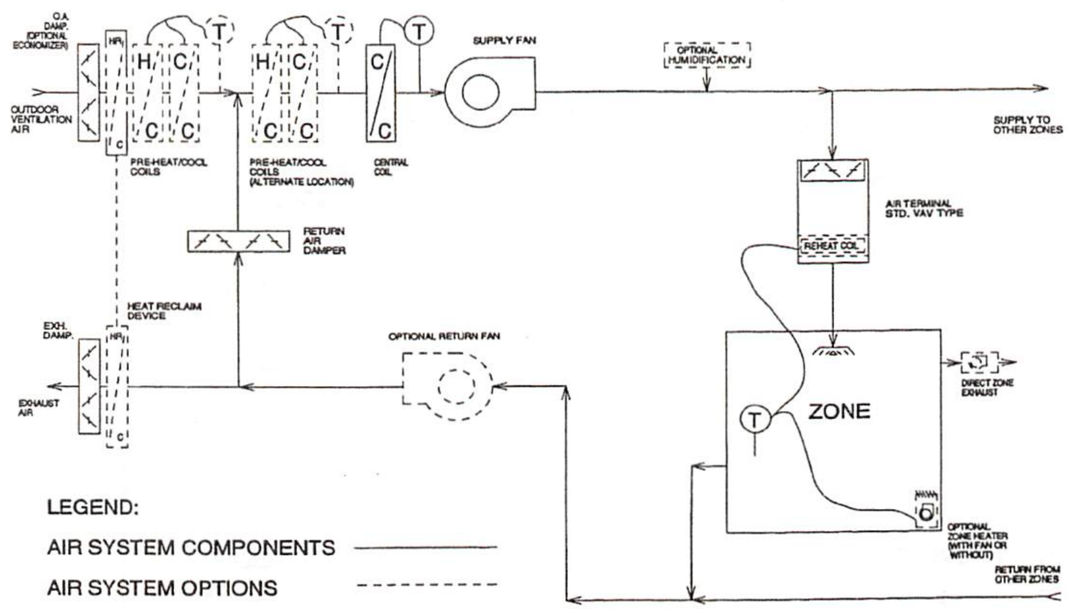


CAV Tempering Ventilation System Schematic

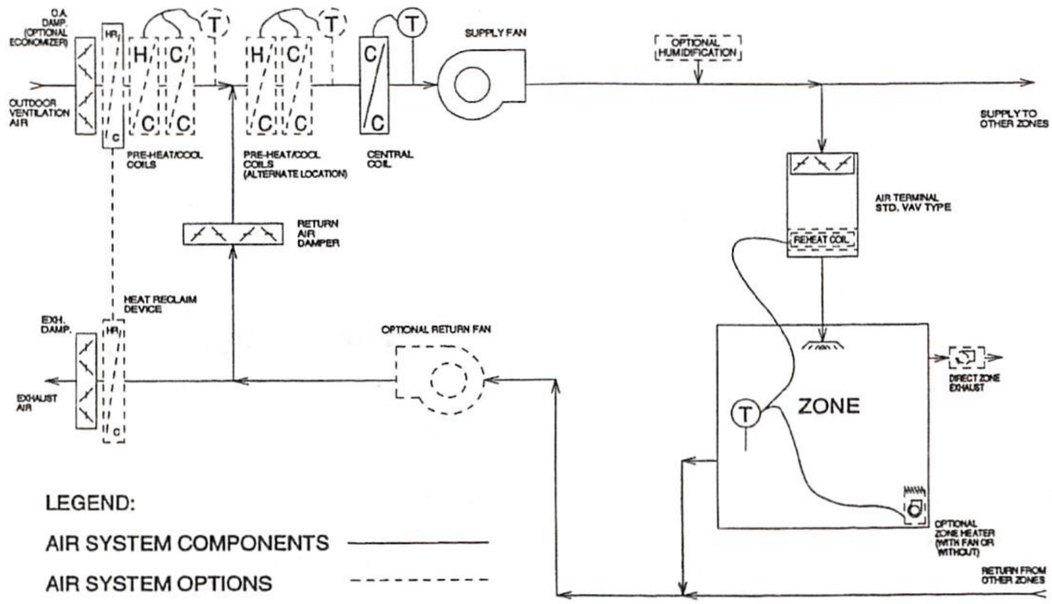
AIR SYSTEM SCHEMATICS
CONSTANT VOLUME - 4 - PIPE INDUCTION



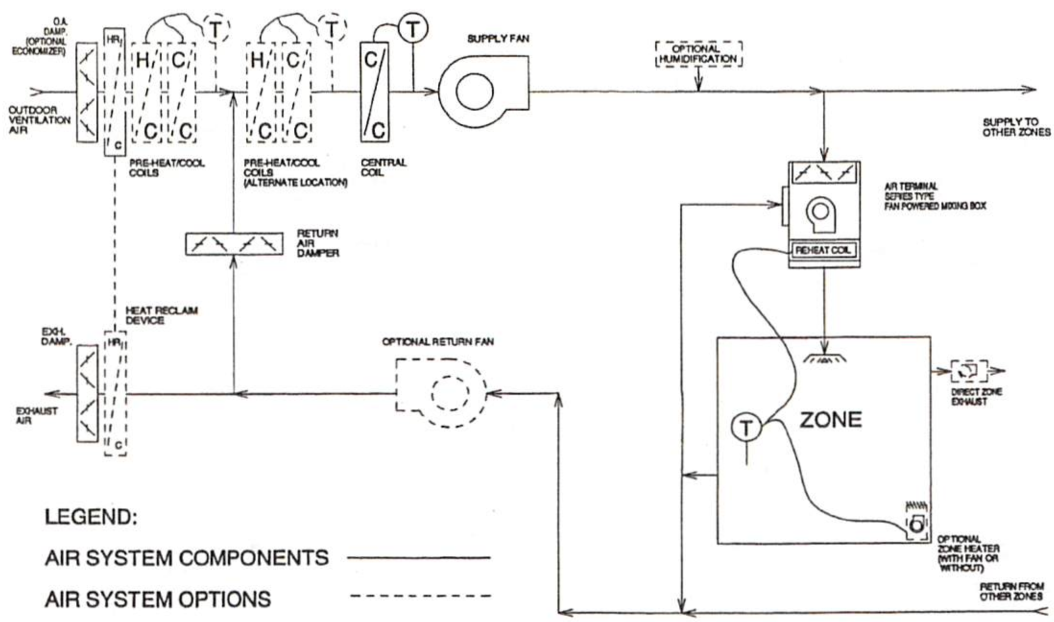
AIR SYSTEM SCHEMATICS
VARIABLE VOLUME - VAV



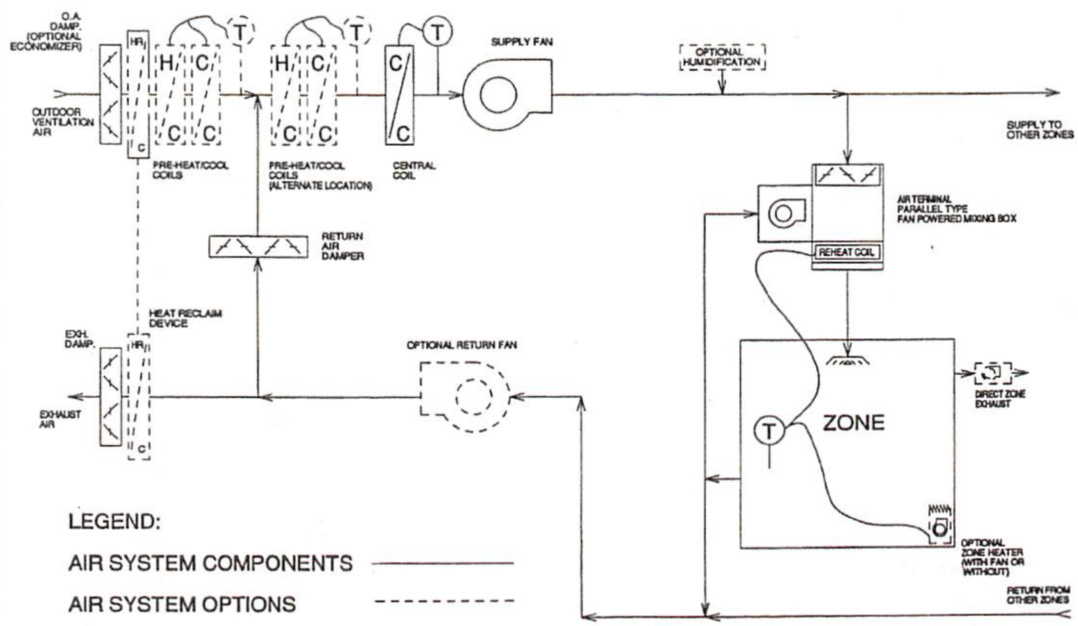
AIR SYSTEM SCHEMATICS
VARIABLE VOLUME - V.A.V. REHEAT



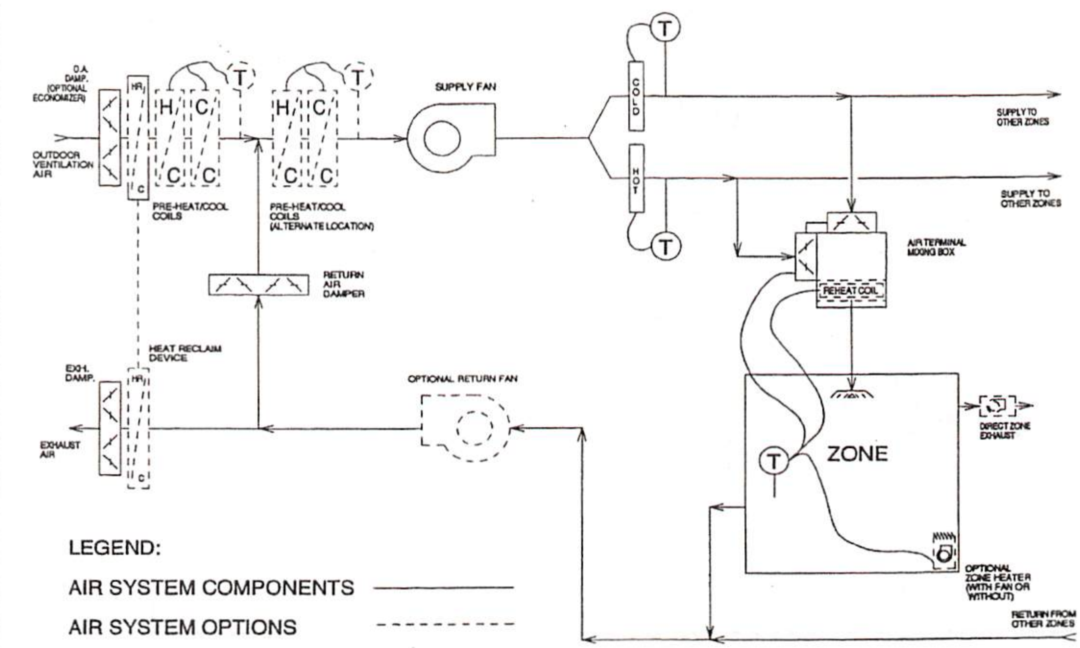
AIR SYSTEM SCHEMATICS
VARIABLE VOLUME - SERIES MIXING BOX



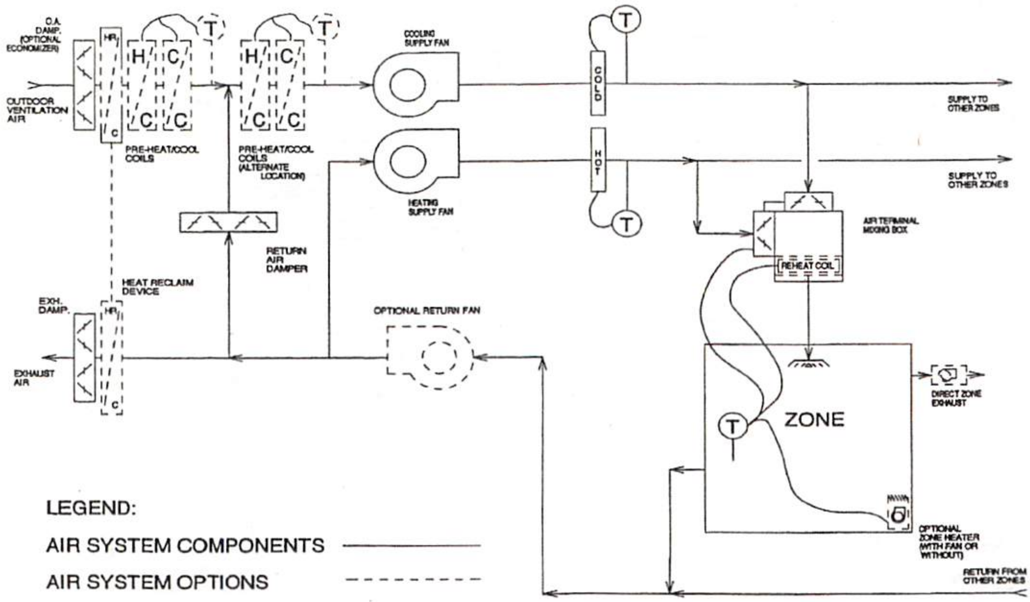
AIR SYSTEM SCHEMATICS
VARIABLE VOLUME - PARALLEL MIXING BOX



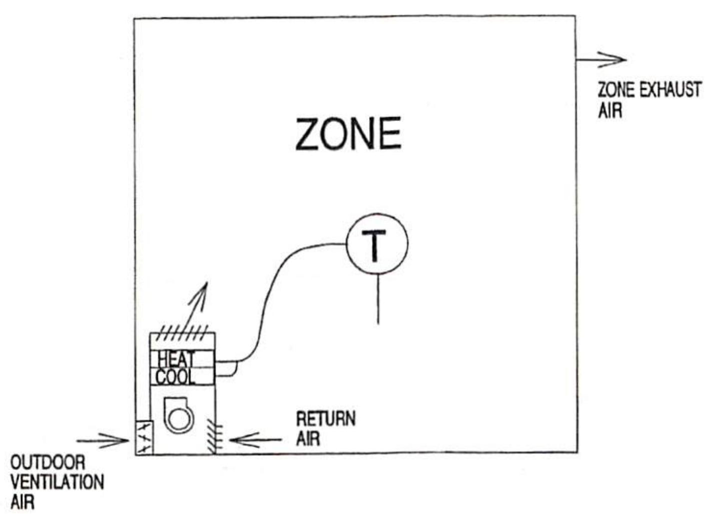
AIR SYSTEM SCHEMATICS
VARIABLE VOLUME - DUAL DUCT V.A.V.



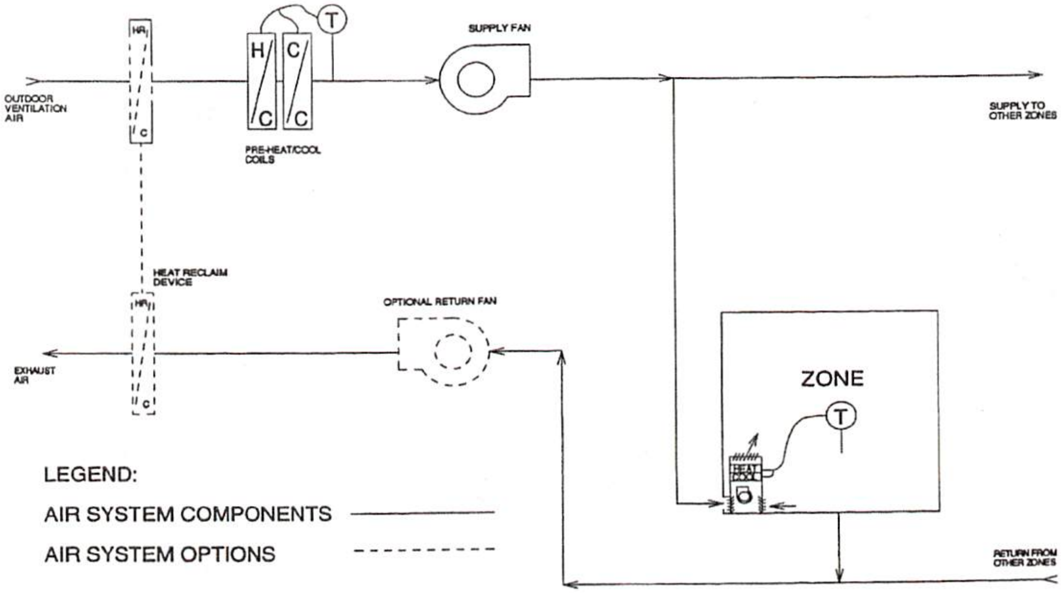
AIR SYSTEM SCHEMATICS
VARIABLE VOLUME - 2- FAN DUAL DUCT V.A.V.



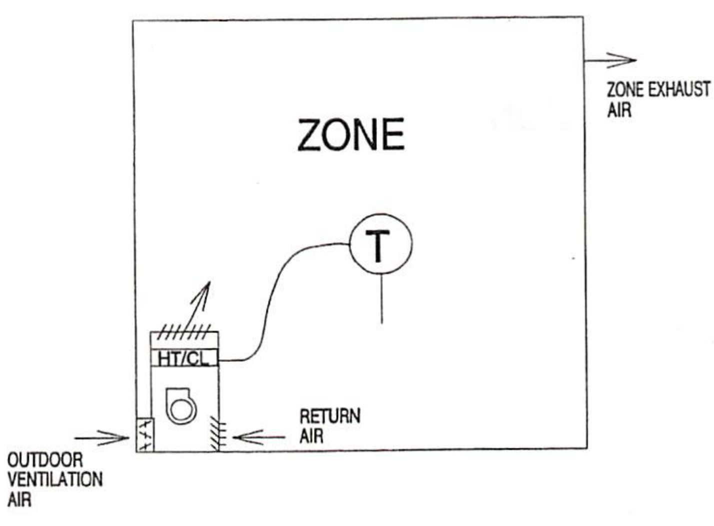
AIR SYSTEM SCHEMATICS
PTAC TERMINALS WITH DIRECT VENTILATION



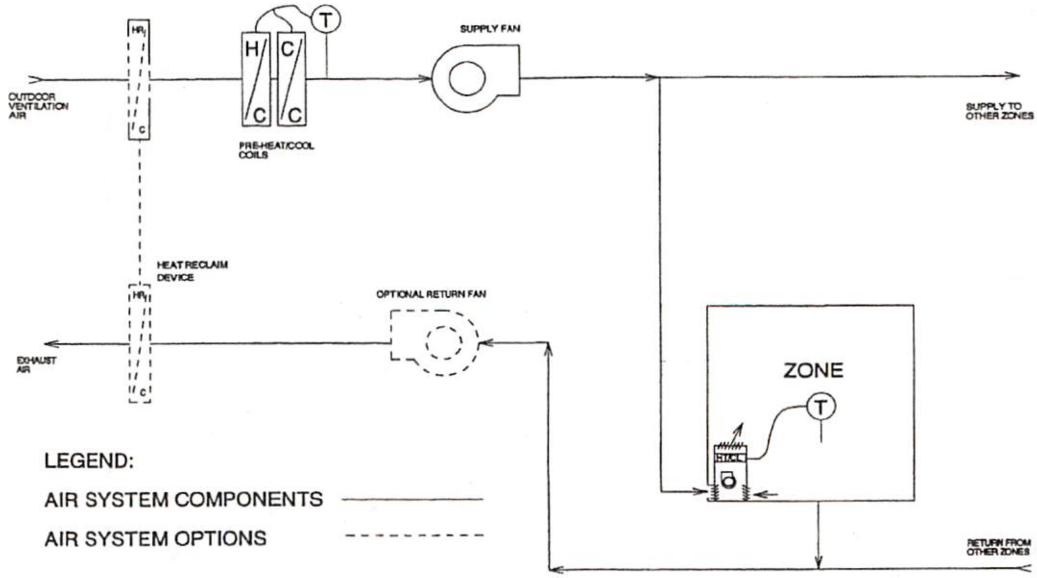
AIR SYSTEM SCHEMATICS
PTAC TERMINALS WITH CENTRAL VENTILATON



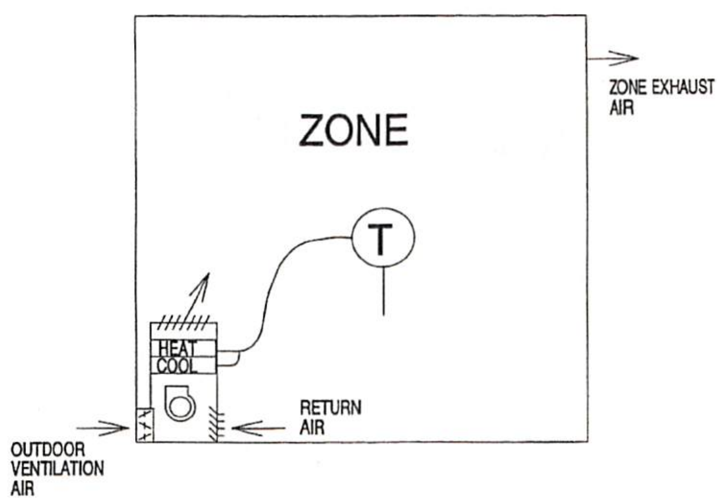
AIR SYSTEM SCHEMATICS
2 PIPE FAN COILS WITH DIRECT VENTILATION



AIR SYSTEM SCHEMATICS
2 PIPE FAN COILS WITH CENTRAL VENTILATION

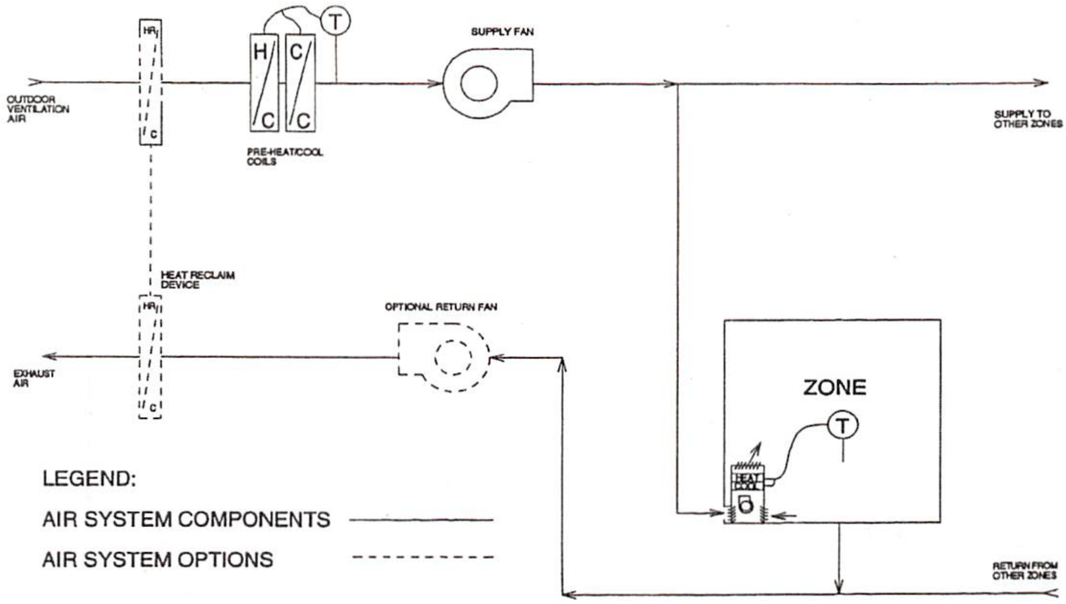


AIR SYSTEM SCHEMATICS
4 PIPE FAN COILS WITH DIRECT VENTILATION

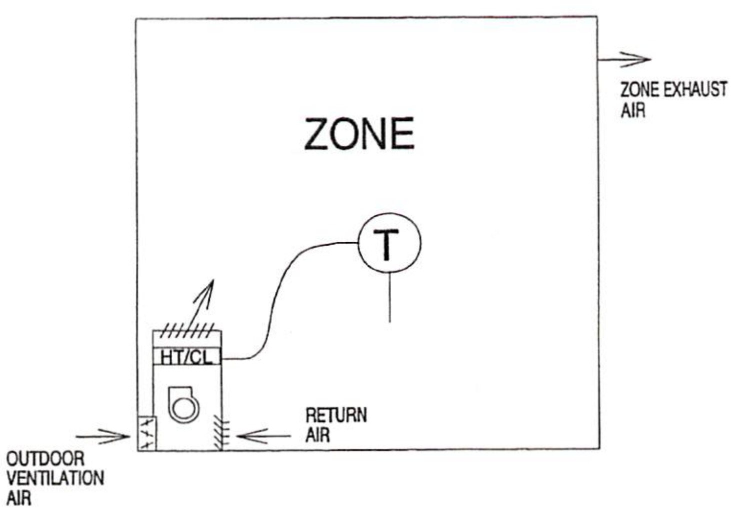


21

AIR SYSTEM SCHEMATICS
4 PIPE FAN COILS WITH CENTRAL VENTILATION



AIR SYSTEM SCHEMATICS
WATER SOURCE H.P. WITH DIRECT VENTILATION



AIR SYSTEM SCHEMATICS
WATER SOURCE H.P. WITH CENTRAL VENTILATION