Sabbatical Leave Report

Darrow Soares

Spring Semester 2003
Spring Semester 2004

Submitted
September 13, 2004

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Statement of Purpose

The purpose of this report is to provide a chronicle of my one year work sabbatical that occurred during the spring semester of 2003 and the spring semester of 2004. Section one contains my initial sabbatical proposal to enter the work force and my request to the Salary and Leaves Committee for flexibility with the organizations I worked with. Section two describes the actual work I performed and the background to why I chose these activities. Section three documents the educational seminars and conferences I attended that augmented my activities in the field. It also includes several trade related certifications I received during my leave. Section four describes the derived benefits and values to both the college and myself.

Ten months and two summers later, I feel lucky to have been able to immerse myself in the trade I have worked with since high school. I feel luckier, however, to be blessed with the job I am returning to. I would like to thank the Salary and Leaves Committee for approving this sabbatical and granting flexibility with my original proposal. I hope this document provides the necessary evidence that the time I spent away from Mount San Antonio College was a good investment for the tax payers and useful to me as a teacher.

Section One

Sabbatical Proposal

Sabbatical Leave Proposal for the 2002-2003 School Years

Darrow Soares
Air Conditioning and Refrigeration

Proposed Sabbatical Activities for Spring Semester 2003 and Spring Semester 2004

To reenter the work environment of air conditioning and refrigeration and work with controls for building automation and energy management.

Description of the activity:

I propose to reenter the work environment and culture of construction and building facilities management for air conditioning and refrigeration. This will include being involved with the labor and commerce of at least four air conditioning and refrigeration contracting companies and at least one organization in facilities management. I plan to restore my awareness of work culture and study the practical use of new technologies for building automation and energy management.

The technologies I plan to focus on include Computer Process Controls (CPC) used in the control of super market refrigeration and Honeywell controls used in building automation. Both applications have become very important in our industry and deserve a prominent place in our curriculum. Practicing the use of these controls in industry will enhance my knowledge and my ability to teach.

In order to gain short term access to business organizations, I will reactivate my contractor's license and subcontract my labor and skills to each firm on a project by project basis. The purpose of contracting is to eliminate the expense, to the businesses participating, of worker's compensation, payroll and tooling. As an independent contractor, I will be much more attractive as a short term team member for construction and facilities projects.

Methods of Reporting Activities

To report on my activities and observations, I will keep a personal journal based on the Observation_Report developed by Cindi Anderson, Professor of Biology at Mount San Antonio College for her 1998-99 Sabbatical Leave to Sasebo, Japan. The observation report will document my activities and experiences described in the previous section. Relevant materials including digital photos, manufacturers literature, and schematics will be collected to support my written accounts

Upon my return, I plan to share my experiences with my department, students, and other interested persons during informal sessions designed for this purpose.

Proposed Time Line/Itinerary for Spring 2003

Month	Company	Outcome
January	Encompass Mechanical Ontario, CA.	Honeywell Controls for Building Automation and Energy Management
February	City of Riverside Riverside, CA	Facilities Management
March	Market Refrigeration Corona, CA	CPC Controls for Supermaket Refrigeration
April	Source Mechanical Fullerton, CA	CPC Controls for Supermaket Refrigeration
May	Riverside Refrigeration Riverside, CA	CPC Controls for Building Automation and Commercial Refrigeration

Proposed Time Line/Itinerary for Spring 2004

Month	Company	Outcome
January	Encompass Mechanical Ontario, CA.	Honeywell Controls for Building Automation and Energy Management
February	Environmental Control La Vern, CA	Liebert Air Conditioning for Clean Room and Computer Applications
March	Market Refrigeration Corona, CA	CPC Controls for Supermaket Refrigeration
April	Source Mechanical Fullerton, CA	CPC Controls for Supermaket Refrigeration
May	Riverside Refrigeration Riverside, CA	CPC Controls for Building Automation and Commercial Refrigeration

Participation with these specific organizations is not guaranteed. Construction and maintenance activities are strongly affected by the economy. If it appears my participation in the industry does not match the hours required for a full teaching load, I will contact the Salary and Leaves Committee to establish alternatives.

Anticipated Value and Benefits

To Mount San Antonio College

Many teachers of air conditioning and refrigeration are viewed as being "out of touch" with the trades since they have not experienced the work environment in years. This is a negative reflection on the Community College System since some industry experts question the relevancy of public education in teaching the building trades. If I am allowed to reenter the work force and represent the community college system, I will add to the credibility of our system.

To the Air Conditioning and Refrigeration Department

Technologies and air conditioning design has transformed since I began teaching. My 15 years of industry experience prior to teaching, are based on an era before an understanding of digital controls and energy management were considered entry level skills. During this project, I plan to apply the knowledge and skills I have developed in the lab environment, and test their relevancy in industry. I hope to relate these experiences through the documentation of digital images, equipment performance data and literature to classes I teach. These include:

AIRC 10	Math for Air Conditioning and Refrigeration
AIRC 20	Refrigeration Fundamentals
AIRC 25	Electrical Fundamentals
AIRC 26a	Heat Pump Fundamentals
AIRC 26b	Gas Heating Fundamentals
AIRC 34	Advanced Mechanical Refrigeration.

Other benefits to the department include improved ties to industry and work culture, and exposure to new air conditioning and refrigeration design.

To Myself

Reentering the work environment is an outstanding opportunity for professional growth. Through this experience I hope to better understand the critical connection between mechanical air conditioning and building automation. It is my intent to develop applications to better teach this connection and, as a result, improve my presentation.

Request to Augment Sabbatical Activities
Spring 2003 and Spring 2004

Darrow Soares
Air Conditioning and Refrigeration

Changes in Sabbatical Activities for Spring Semester 2003 and Spring Semester 2004

To request flexibility in working with companies named in the original Sabbatical Proposal.
To allocate Sabbatical time to study and practice Heat Load Calculations as they apply to energy management and building automation systems.

Revised description of activity:

I have reactivated my contractor's license and currently subcontract on a project by project basis. The companies I have been involved with, however, are different from the firms submitted in the Sabbatical Proposal. Opportunities have changed as a result of the economy. The City of Riverside has suffered cutbacks and my contact in the Facilities Department has been reassigned. Encompass Mechanical has been bought out by Pacific Rim Mechanical and management has reorganized. As a result of these unpredictable times, I ask the committee for flexibility in my contracting assignments.

I also request the allocation of time to research and practice procedures for heat load calculations and duct design as applied to zoned air conditioning systems and energy management. The initial heat load design for air conditioning and refrigeration systems affects equipment efficiency and energy consumption as much as the application of new technology. Energy efficient motors and computerized management systems are only effective if the heat load calculations are performed accurately. The air conditioning and refrigeration industry is revising the methods to conduct heat loads in order to support these new technologies. As a result, these procedures should be included into my project. This will require attending seminars and training in addition to applying the new procedures in industry. I have included a proposed schedule of training.

Schedual of Conferences

Conference/Seminar Title	Activity
Forced Air Zoning System Design. By Honeywell Controls, Riverside, CA. Feb. 18, 2003	Networked zoning system design including damper selection, EMM controller selection, ducting and system set up
Air Handlers for Energy Management Systems.	Variable and constant air volume systems, adjustable speed drives and energy conservation methods.

Irwindale, CA March 5.	
Controls for Market Refrigeration Systems. By CPC. Reno, Nevada. March 13 &14	Energy Management Using Computer Process Controls (CPC) for Market Refrigeration. Refrigeration Service Engineers Society Certification
Scroll Compressors. By Copeland Corporation. Los Angeles CA March 18.	Scroll compressor design and application to Part-Load conditions for energy management
Energy Management Systems. By Southern California Edison Irwindale, CA March 19.	Current technology in HVAC control methods. Explore a systematic approach for identifying, designing, and planning an EMS. Communication networks, conducting equipment studies, conceptual system design and cost/benefit analysis.

Revised Time Line/Itinerary for Contracting Spring 2003

Month	Company	Activity
January	**Southern California Air Conditioning Distributors, CA.**	**Job shadowing in the Technical Support Department. Focusing on Carrier and Venstar Controls for Residential & Light Commercial Zoning Building, Automation and Energy Management**
February through May	**Subcontracting as Central Air Contracting and Mechanical. Darrow Soares sole proprietor.**	**Contracting Services to Southwest Heating and Air Conditioning, Chino, California. Installing high efficiency Lennox air conditioning systems.** **Hasco Refrigeration, Riverside, California. Contracting services and participating in the installation of Honeywell variable air volume zoned air conditioning systems.** **Perform heat loads to design and install residential and light commercial Honeywell variable air volume zoned air conditioning systems.** **Vacom Industries. LaVerne, California. of Eschelon direct digital controls and energy management systems.** **Other opportunities as available**

Revised Time Line/Itinerary for Contracting Spring 2004

Month	Company	Activity
January through May	**Contracting or Subcontracting as Central Air Contracting and Mechanical. Darrow Soares sole proprietor.**	**VaCom Technologies, LaVern, CA. Participating in the installation of Eschelon direct digital controls and energy management systems.** Market Refrigeration Corona, CA **Participating in the installation of** CPC Controls for Supermaket Refrigeration Source Mechanical Fullerton, CA **Participating in the installation of** CPC Controls for Supermaket Refrigeration. Riverside Refrigeration Riverside, CA **Participating in the installation of** CPC Controls for Building Automation and Commercial Refrigeration **Other opportunities as available**

Participation with these specific organizations is not guaranteed. Construction and maintenance activities are strongly affected by the economy. If it appears my participation in seminars, training and industry does not match the hours required for a full teaching load, I will contact the Salary and Leaves Committee to establish alternatives.

Section Two

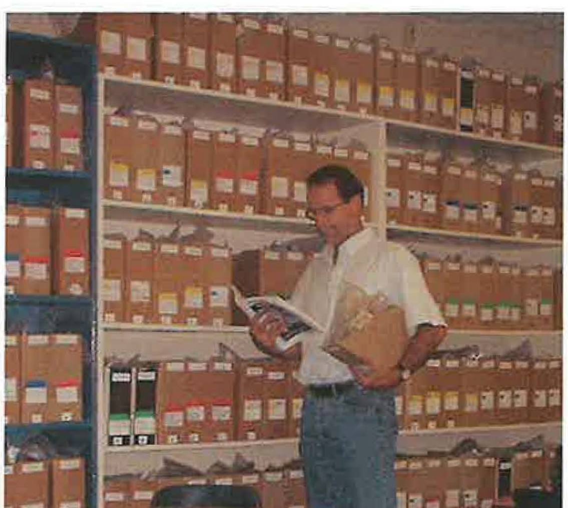
Work Activities

Southern California Air Conditioning Distributors

The Background

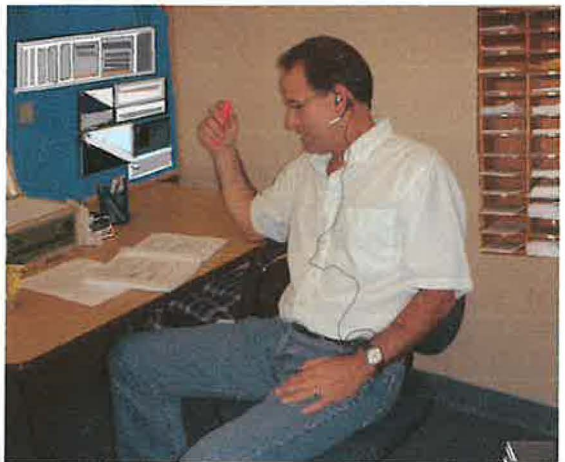
In January of 2003, Southern California Air Conditioning Distributors (SCACD) was the largest distributor of air conditioning equipment in the United States. Based in City of Industry, California, SCACD became closely tied to Carrier Corporation when Carrier's manufacturing plant was located on Chestnut Avenue in City of industry. The plant shut down in 1994, but SCACD continued to control the distribution of Carrier equipment throughout California until it downsized and sold many of its distributors in 2004.

SCACD built a loyal contractor following by offering the best technical support of any air conditioning distributor in California. Many of the industries best HVAC technicians started out in the Customer Assurance Department and numerous air conditioning teachers have worked there. For my sabbatical leave I applied to "work the phones" in the Customer Assurance Department. It proved to be very intense and educational.



SCACD holds technical literature on all equipment manufactured by Carrier

The purpose of the Customer Assurance Department is to serve as technical support to installing contractors and service technicians that buy any of the many products sold by SCACD. This included the entire line of residential, commercial and industrial air conditioners manufactured by Carrier Corporation, including Bryant, Day & Night, and Payne. In addition, assistance is offered on products made by Mitsubishi, Reznor, Venstar and many other lines of parts and controls.



Discussing thermostat functions

Calls come in to the Customer Assurance Department from service technicians working on the equipment in the field. The technicians are usually billing an hourly rate to solve a problem they may not understand. As a result, they are frustrated and very intense. Calls can range from the basics of measuring ductwork air flow, to electronic hardware failures on 200 ton Carrier water chillers.

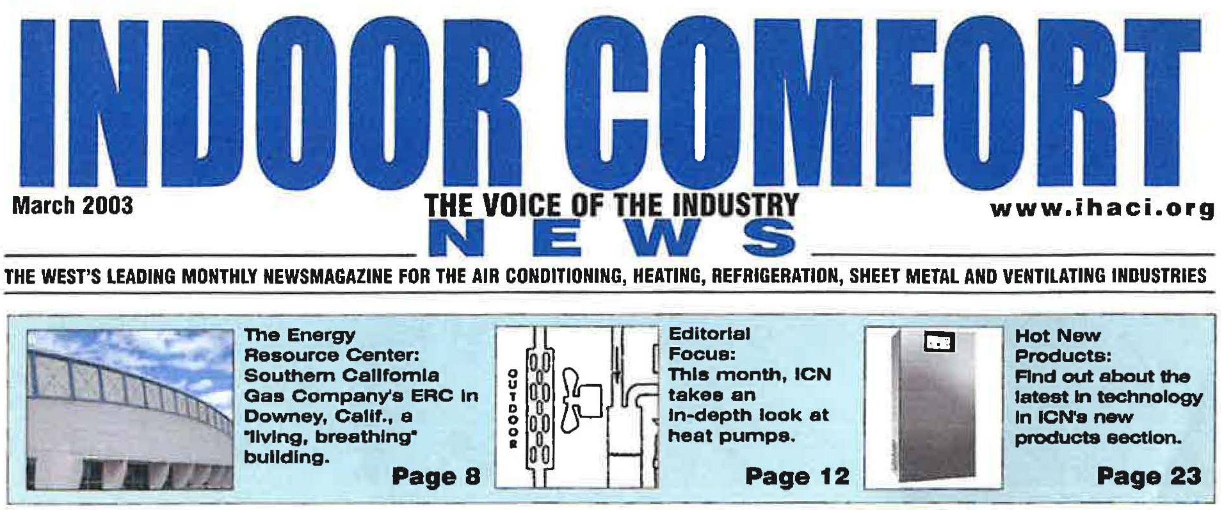
The Application

The breadth of equipment manufactured by Carrier Corporation alone, requires the Customer Assurance Representative (CAR) to spend much of their time on research. While I worked in the Customer Assurance Department, I spent many hours studying digital thermostat functions and receiver/controller operation on their digital line of controls. Often, I was required to locate a schematic or refrigerant charging chart developed thirty years ago. This was achievable since the Customer Assurance library holds hard copies of the installation and service manuals of almost every piece of equipment manufactured by Carrier, Day & Night, Payne and Mitsubishi Air Conditioning.

After 11 years in the classroom, my strength was in explaining basic air conditioning principles that technicians missed during their education. One of the key principles often centered on their inability to properly measure air flow. This lack of understanding then resulted in many mechanical system problems and nuisance warranty claims. Other issues that influenced warranty included diagnosing failed heat pump reversing valves, understanding of digital thermostat functions and residential and light commercial zoning.

At the request of Scott Strong, the Customer Assurance leader, I wrote a series of short articles for The Institute of Heating and Air Conditioning Industries (IHACI) of which Strong serves on the board. IHACI publishes the trade journal Indoor Comfort News. These articles were written while I worked with the Customer Assurance Department and then published in later issues.

The first article appeared in the March 2003 issue. The subject of this article was diagnosing a failed reversing valve on a heat pump. This was importance since the process of removing a reversing valve and then welding it back in place often contaminates the air conditioning system. Contamination results in more problems in the long run by restricting metering devices and ceasing the replacement reversing valve. The purpose of the article was to illustrate the proper method of diagnosis so operational valves would not mistakenly be replaced


INDOOR COMFORT NEWS

March 2003 — THE VOICE OF THE INDUSTRY — www.ihaci.org

THE WEST'S LEADING MONTHLY NEWSMAGAZINE FOR THE AIR CONDITIONING, HEATING, REFRIGERATION, SHEET METAL AND VENTILATING INDUSTRIES

The Energy Resource Center: Southern California Gas Company's ERC in Downey, Calif., a "living, breathing" building. Page 8

Editorial Focus: This month, ICN takes an in-depth look at heat pumps. Page 12

Hot New Products: Find out about the latest in technology in ICN's new products section. Page 23

Heat Pumps Special Section

Diagnosing and Replacing the Reversing Valve of a Heat Pump

By Darrow Soares
Special Correspondent

Editor's Note: *Darrow Soares is an HVAC/R professor at Mount San Antonio College in Walnut, Calif. He is a member of RSES and ACCA, and currently serves on the NATE Technical Committee.*

The reversing valve is the heart of the heat pump. It is the device that controls the direction of the refrigerant flow exiting the compressor. By directing hot gas to either the indoor or outdoor coil, heat is added to the conditioned space, or rejected to the outdoors for cooling.

Reversing valves are prone to mechanical failure when particulate matter or other contamination is allowed to enter the system. If a reversing valve is found to be defective, proper removal and re-installation will ensure against further contamination and repeat failure.

Defective reversing valves can be tricky to diagnose, but a few simple procedures will remove the mystery. First, determine if the reversing valve solenoid is energized. When the reversing valve is being called for, apply a flat shank screw driver to the end of the solenoid. There should be magnetic pull. If no magnetism is present, check for correct voltage to the coil. When voltage is present without magnetic pull, an open coil should be confirmed by de-energizing the system and checking the coil with an ohmmeter. Check for continuity or a short to ground.

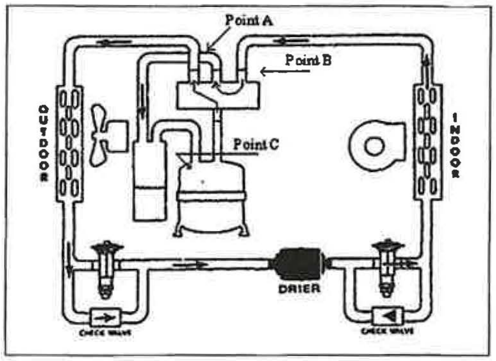


Figure 1. Heat pump in the cooling mode showing points to troubleshoot the reversing valve.

Reversing valves can seize mechanically. If the valve seizes midway, the symptoms can be confused with weak compressor valves: higher than normal back pressure and lower than normal head pressure. To determine which component has failed, apply two remote sensors of an electronic thermometer to the reversing valve. Attach one to the common suction line exiting the valve (Figure 1, point A) and the other to the suction line entering the reversing valve (Point B). Under normal operation, the temperature difference between these two lines should not exceed 4°. A greater difference may be the result of the reversing valve not shifting completely and allowing hot gas to bleed over to the common suction line, raising the common suction line temperature.

A second procedure will confirm the diagnosis. Remove the temperature probe from the suction line entering the reversing valve (point B) and apply it to the dome of the compressor (point C) where the suction line enters the compressor. "Hot wire" the reversing valve solenoid coil so it stays energized through the test. Next, disable the condenser fan motor and run the system until the high side pressure rises to a head pressure that converts to 150° on the temperature-pressure chart. For R-22, this equals 380 psig and for R-410 it equals 613 psig. Turn the system off by breaking control voltage and watch both temperatures. If the temperature on the reversing valve common suction line rises faster than the compressor dome, the reversing valve is the problem and should be replaced. If the compressor dome temperature rises faster, weak compressor valves are causing the pressures to equalize and the compressor should be replaced.

Proper removal and the re-installation of the new reversing valve will prevent repeat failures. Begin the process by recovering the refrigerant using approved EPA standards. Do not remove the reversing valve with a hack saw. This will introduce copper chips into the system that will cause repeat failure. Always cut the failed valve out with a tubing cutter. Travel down the refrigerant lines until there is enough clearance to rotate a standard tubing cutter 360°. This distance will allow enough room to manipulate the torch during re-installation and reduce the risk of overheating the Teflon seals.

Once the defective valve has been removed, mark the refrigerant lines entering the old valve with a scratch awl as a reference to line them up with the new valve. Apply the refrigerant lines to the new reversing valve by lining up the scratches applied earlier and brazing into place.

When brazing, first apply heat to the refrigerant line entering the valve until the brazing rod flows. Once this occurs, move the flame to the valve and allow capillary action to draw the rod material completely into the fitting. Quickly apply one more layer of rod material to the outside of the fitting to ensure coverage.

Always protect the new valve by rapping it with wet rags or using thermo paste. When the copper lines are completely brazed and the fittings are cool, blow the valve and lines out with dry nitrogen to remove all copper oxide. Re-attach the entire manifold into the heat pump with slip couplings.

Before brazing the couplings, bleed dry nitrogen through the system to displace air inside the system. This will prevent copper oxide from forming inside the refrigerant lines at the new fittings.

After [illegible] leak check the system, and evacuate using approved methods. Weigh in the refrigerant based on the name plate refrigerant charge and operate the system in both modes to be sure the valve operates properly.

The biggest risk in replacing reversing valves is overheating and introducing contamination during the installation process. If properly diagnosed and installed, the reversing valve will operate trouble free for the life of the equipment.

The second article appeared in the April, 2003 issue of the Indoor Comfort News. This article discussed the method of diagnosing refrigerant side problems in basic residential and light commercial air conditioners with fixed bore metering devices. Refrigerant side problems exist when a system is low on refrigerant charge or contamination has entered the system. During my experience at SCACD, I did not sense this was information service technicians lacked. As a result, this subject did not result in numerous warranty claims. It did, however, support the previous article on diagnosing reversing valves and the subsequent article on duct design.

Kick-off to the Cooling Season

Tips for Technicians: Know the Refrigerant Side Vital Signs

By Darrow Soares, CMS
Special Correspondent

Maintaining the refrigerant level on critically charged air conditioning systems is essential to mechanical operation and efficiency. Manufacturers agree that the best method dealing with a questionable charge is to recover the refrigerant, evacuate and then weigh it back in. The manufacturer's charging data is also an accurate reference when it is available and charging slide rules are popular. Knowing the vital signs of operation, however, will allow the service technician to quickly determine if refrigerant problems exist and then take extra measures if required.

The first vital sign to check is the split between supply and return air. Allow 20 minutes of run time for conditions to balance and condensation to collect on the evaporator. Place a thermometer in the supply and return air duct close to the evaporator coil to account for duct leakage. The temperature difference across the evaporator coil should be between 18° and 20°. This sensible temperature split will be closer to 18° when the relative humidity is high and closer to 20° when it is low. This is because the latent process of removing moisture from a conditioned space requires more energy than lowering the sensible temperature. As a result, an air conditioner can be running at full capacity with an 18° split if the latent load is high. The technician can easily check for high latent heat removal by observing the volume of water being removed through the condensate line. But, if a split of 18° is recorded and there is no evidence of latent heat removal, the technician should continue to check other vital signs.

If the split between supply and return is below 18°, a system problem exists. The technician should observe the rise across the condenser and the split between the return air and evaporator temperature. These are found by applying the gauges and converting high and low side pressures to temperature. Based on the standard temperature-pressure chart, an R-22 air conditioner with a high side pressure of 296 psig is condensing its refrigerant from a hot gas into a liquid at 130°. If the air entering the condenser is 100°, the rise across the condenser is 30°. If the low side pressure is 61 psig, the air conditioner is evaporating, or boiling its refrigerant from a liquid to a vapor at 35°. The evaporator temperature is then subtracted from the 75° return air temperature recorded earlier. The split between return air and evaporator is 40°. With this process, the technician can establish evaporating and condensing temperatures over a range of operating conditions.

Condensing Temperature
—Ambient Temperature
Rise Across the Condenser

Return Air Temperature
—Evaporating Temperature
Split Return Air and Evaporator

A 30° rise across the condenser and a 40° split between return air and evaporator is considered normal for old air cooled systems manufactured during the early 1980s with SEER ratings of 7. But, today those splits are lower. Improvements in evaporator and condenser coil efficiency have resulted in lower head pressures and higher suction pressures. By reducing the gap between high side and low side pressures, manufacturers have cut compressor power requirements and improved SEER ratings. As a result, technicians will see different temperature splits on single stage, high efficiency equipment. Expect a 20° rise across the condenser and 30° split between return air and evaporating temperature. The split between supply and return air temperatures remain at 18° to 20°.

The technician should be aware of superheat exiting the evaporator and subcooling exiting the condenser. Superheat is the difference between the evaporating temperature and the vapor temperature measured anywhere in the suction line.

When checking the refrigerant charge, superheat should be measured at the outlet of the evaporator. Subcooling is the difference between the condensing temperature and the liquid temperature measured anywhere in the liquid line. Subcooling should be checked exiting the condenser when considering a refrigerant side problem.

Subcooling measures the effective ness of the condenser and indicates if total liquid refrigerant is supplied to the metering device. It is adequate between 10° to 15°. Unfortunately, superheat readings on systems with fixed metering devices are a moving target. As the load changes, fixed metering devices have no means to control the refrigerant flow into the evaporator. Refrigerant flow through a fixed metering device is the result of the pressure differences between the high side and low side. If head pressure rises in relation to the low side, a fixed metering device floods the evaporator and superheat falls. Or, if the low side pressure increases in relation to the high side, because of high return air temperature, the evaporator could starve and superheat will increase. Maintaining superheat is critical because it protects the compressor against liquid slugging and it provides compressor cooling. Expect superheat temperatures as low as 6° during low interior load conditions and as high as 35° during high load conditions. This is not the case with TXVs. High SEER rated systems with TXVs modulate the flow of refrigerant based on the interior load and maintain a constant superheat between 8° to 10°.

Suction Line Temperature
—Evaporating Temperature
Superheat

Condensing Temperature
—Liquid Line Temperature
Subcooling

Before hoisting the equipment to recover and recharge, compare a few vital signs. The system may be reacting to normal conditions and operating to full capacity, or it could require further attention.

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The third article finally appeared in the July 2003 issue. This article focused on the process required to correctly design air conditioning ductwork. Of all the basic subjects I discussed with service technicians, air properties, air measurement and basic duct design occupied the majority of my time.

Editorial Focus

Tech Tips: Basic Steps to Size Duct Runs

By Darrow Soares, CMS
Special Correspondent

The airside design for HVAC systems is critical. Often, poor system performance is blamed on undersized equipment or low refrigerant charge, when the real issue is a restricted duct system. Countless dollars are spent on adjustment and repair because of low airflow across the evaporator or unbalanced air distribution. This article introduces the basic steps to size duct runs and avoid costly mistakes.

Duct sizing begins with the heat load. The heat load determines the required air volume to heat and cool each room. For the purpose of this article, it is assumed this process has occurred and the equipment has been selected to meet an accepted load calculation. The example in this article will take six steps to size the longest duct run associated with a 36,000 Btuh air conditioner and a 40,000 Btuh furnace. Five steps will be recorded on the Friction Rate Worksheet at figure 1.

Step 1. To size duct runs for selected equipment, the designer must obtain the manufacturer's blower performance data. The performance data identifies the equipment's external static pressure (ESP) available to move the required air volume through the supply and return ducts. ESP is the difference in outward static pressure between the supply and the return air during blower operation. It is the result of the blower pushing against the resistance of the ductwork, evaporator, registers and other components in the air stream. Manufacturers provide these values in order to rate their equipment performance against common field conditions. Figure 2 (see page 30) shows the performance data for the 40,000 Btuh furnace operating at high speed. According to the data, the furnace moves 1220 cubic feet per minute (CFM) of air when an external static pressure differential of .5 inches of water column (IWC) exists between supply and return. This value is applied to step 1 of the Friction Rate Worksheet in figure 1. If the designer requires the furnace to move 1220 CFM, the resistance caused by ductwork fittings and other airside devices cannot exceed this value of .5 IWC. As ESP increases, airflow falls. If the ESP were increased to .7 IWC, airflow for the same 40,000 Btuh furnace would be reduced to 1115 CFM.

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Step 2. Once the ESP is established, pressure losses by airside components must be identified. All pressure losses are applied to the Friction Rate Worksheet. Evaporator coils, filters, and registers all add resistance to airflow. Figure 3 (see Page 30) shows the pressure drop associated with the selected three-ton evaporator coil. When 1,200 CFM of air moves through this coil, a pressure drop of .18 IWC will occur. This .18 IWC must be subtracted from the .5 ESP produced by the blower. The evaporator restricts airflow and reduces the available pressure to move air. All airside components in the longest run must be applied to the Friction Rate Worksheet at step 2. If pressure drop values do not exist, default values are available. This example uses common default pressure drops for the damper, register, and the 1" standard filter.

Step 3. Subtract the total pressure drop caused by all airside devices in step 2 from the Manufacturers Blower Performance ESP found in step 1. This difference indicates the available static pressure (ASP) to move air through fittings and ductwork. The Friction Rate Worksheet indicates that after all airside components have been accounted for, .191 IWC remains to move the required air volume of 1220 CFM through the duct work

Friction Rate Worksheet

Step 1. Record Manufacturers Blower Performance External Static Pressure (ESP) .5 IWC CFM 1220

Step 2. Record Device Pressure Losses

Evaporator Coil	.18
Filter	.04
Electronic Air Cleaner	Ø
Supply Register	.022
Return Grill	.027
Balancing Dampers	.04
Humidifier	Ø
Total Device Pressure Loss	.309

Step 3. Determine Available Static Pressure Loss for Duct.

Manufacturers Blower External Static Pressure - Total Device Pressure Loss = Available Static Pressure Loss in Duct Work

.5 - .309 = .191 IWC

Step 4. Determine the Total Equivalent Length of Longest Duct Run

Supply Side Equivalent Length + Return Side Equivalent Length = Total Equivalent Length

172' + 48' = 220'

Step 5. Calculate the Friction Rate Applied to Duct Sizing Slide Rule

Available Static Pressure (Step 3) X 100 / Total Equivalent Length (Step 4) = Friction Rate Applied to Duct Slide Rule

.191 X 100 / 220' = .087 or .09 Rounded up

Figure 1

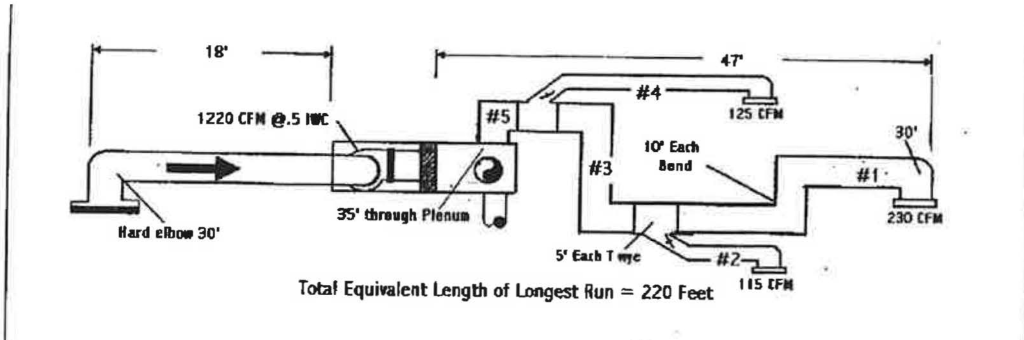


Figure 4

Step 4. As stated earlier, the size of each duct run is based on the single longest duct run. The designer must determine the Total Equivalent Length (TEL) from the return air grill to the end of the longest supply. The TEL of the longest run is found by adding each straight length of the duct and the equivalent length of all fittings in the longest run. The equivalent fitting length represents the resistance a fitting offers to airflow compared to a straight duct run. For example, round ducts taped into a plenum offer the same resistance to airflow as 35 feet of straight duct. The equivalent length of common fittings is available in appendix 3 of ACCA's Manual D. Figure 4 illustrates the TEL of the longest duct run. The longest duct run is summarized in table 1.

Step 5. Calculate the ductwork friction rate. This friction rate is applied to the duct sizing slide rule in order to determine the diameter of each duct run and fitting. The friction rate refers to the pressure loss in ductwork between two points in a system. It is based on the available static pressure (ASP) found in step 3 and the total equivalent length (TEV) of the longest run found in step 4. Duct slide rules are based on 100 feet of duct. As a result, the pressure drop data found in step 3 must be converted to a friction rate per 100 feet. The following equation is used in step 5 to make the conversion.

$$FR = \frac{ASP \times 100}{TEL}$$

Where:
FR = Duct Work Friction Rate
ASP = Available static pressure after airside devices
TEL = Total equivalent length of the longest duct run

Apply the figures found in step 3 and 4 to step 5 of the Friction Rate

Supply			Return		
No.	Name	Equiv. Length	No.	Name	Equiv. Length
1	Supply Plenum	35'	1	Hard Elbow	30'
2	T Wye Trunk@5'	10'	18'	Return Duct	18'
5	Bends@10'	50'			
1	Hard Elbow	30'			
47'	Supply duct	47'			
Supply Total		172'	Return Total		48'
			Total Equivalent Length (TEL)		220'

Table 1

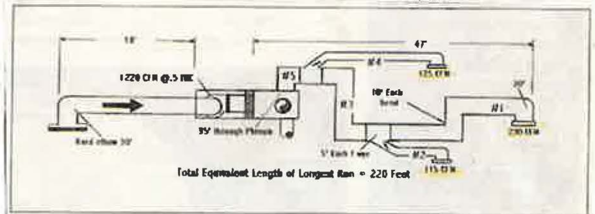


Figure 4

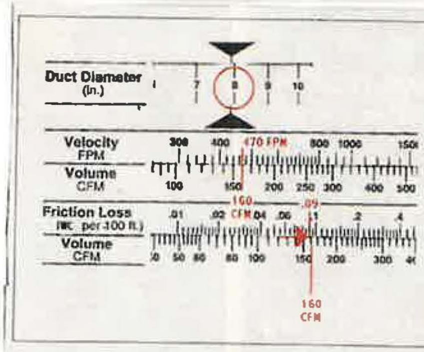


Figure 5

Education

Tech Tips: Basic Steps to Size Duct Runs

Continued from Page 19

Worksheet. The value of .087 IWC represents the pressure loss caused by the ductwork every 100 feet of run. This value is rounded up to .09 IWC and used as the friction loss value for each duct sized in the system.

Step 6. Apply the friction loss value to the duct slide rule to determine each duct diameter. Figure 4 shows an abbreviated system with three supply runs and a single return. From this abbreviated illustration, five duct sizes will be calculated to complete the longest run from the supply air plenum to duct #1. Begin by sizing duct #1 and work back to size each duct until the supply air plenum is reached. Begin by lining the required airflow of 160 CFM with the friction rate of .09, as illustrated in figure 5. The slide rule shows an 8" duct is required to move the required air at a velocity below 600 feet per minute. Use the same process to size duct 2. At 115 CFM and .09 IWC of friction loss, the required duct diameter is 7". Duct 3 must be sized to carry the air volume of duct 1 plus duct 2 for a total of 275 CFM. The slide rule shows a required duct diameter of 10", as illustrated in figure 6. Working back, duct 5 is responsible for the volume of ducts 1,2, and 4 for a total of 400 volume is 12". The duct runs are summarized on table 2.

Duct Run	Dia.	CFM	FPM
1	8"	160	480
2	7"	115	440
3	10"	275	510
4	7"	125	420
5	12"	400	560

Table 2

Duct systems designed using the longest run method require balancing dampers in each branch duct. Without dampers, the shorter runs will receive excess air and starve the longer runs. When dampers are installed and adjusted, the equivalent length of each duct will be equal and airflow will be stable.

Complete details of the procedure using the Friction Rate Worksheet and performance data can be found in Manual D, published by the Air Conditioning Contractors of America. If a standard method is used to properly size ductwork, costly mistakes resulting in discomfort, mechanical failure and dissatisfied customers

BLOWER PERFORMANCE DATA—RGTA MODELS

MODEL RGTA-	BLOWER SIZE IN. [mm]	MOTOR H.P. [W]	BLOWER SPEED	CFM [L/s] AIR DELIVERY EXTERNAL STATIC PRESSURE INCHES WATER COLUMN [kPa]					
				0.1 [.02]	0.2 [.05]	0.3 [.07]	0.4 [.10]	0.5 [.12]	0.6 [.15]
04	11 x 7 [279 x 178]	1/2 [373]	LOW	820 [387]	790 [373]	760 [359]	725 [342]	690 [326]	650 [306]
			MED-LO	930 [439]	890 [420]	850 [401]	815 [384]	785 [370]	750 [354]
			MED-HI	1150 [543]	1120 [528]	1090 [514]	1045 [493]	1002 [473]	950 [448]
			HIGH	1414 [667]	1365 [644]	1320 [622]	1270 [599]	1220 [576]	1165 [550]
05	11 x 7 [279 x 178]	1/2 [373]	LOW	795 [375]	760 [359]	730 [344]	695 [328]	660 [311]	615 [290]
			MED-LO	910 [429]	885 [418]	860 [406]	815 [384]	770 [363]	725 [342]
			MED-HI	1115 [526]	1080 [510]	1045 [493]	1005 [474]	965 [455]	920 [434]
			HIGH	1365 [644]	1315 [620]	1270 [600]	1225 [578]	1180 [557]	1125 [531]
07EM	11 x 7 [279 x 178]	1/2 [373]	LOW	780 [368]	750 [354]	720 [339]	675 [318]	635 [300]	595 [281]
			MED-LO	890 [420]	860 [406]	835 [394]	790 [373]	750 [354]	705 [332]
			MED-HI	1100 [519]	1060 [500]	1025 [484]	980 [462]	940 [443]	890 [420]
			HIGH	1340 [632]	1295 [611]	1250 [590]	1200 [566]	1150 [543]	1090 [514]

Figure 2

Coil Specifications/Airflow Pressure Drop

Model Number RCQC-	Type Air Flow ①	Approx. Design Air Flow CFM [L/s] Range	Face Area Sq. Ft. [m²]	Fins-in Rows Deep	Static Pressure Drop Through Wet Cooling Coil [kPa] (Inches H₂O) CFM [L/s]							
					600 [285]	700 [330]	800 [380]	900 [425]	1000 [470]	1100 [519]	1200 [565]	1300 [614]
STANDARD HORIZONTAL COOLING COILS												
2417AS	U-H-D	600/1000 [283/472]	3.89 [0.36]	14/3	.10 [.025]	.14 [.035]	.19 [.047]	.23 [.057]	.27 [.067]			
3617AS	U H	800/1200 [378/566]	4.38 [0.41]	14/3			.14 [.035]	.17 [.042]	.21 [.052]	.25 [.062]	.29 [.072]	
3621AS	U-H	800/1400 [378/661]	4.38 [0.41]	14/3			.08 [.020]	.10 [.025]	.13 [.032]	.16 [.040]	.18 [.045]	.21 [.052]
4821AS	U-H	1200/1600 [566/755]	5.83 [0.54]	14/3					.14 [.035]	.17 [.042]	.19 [.047]	.22 [.055]
4824AS	U-H	1200/1800 [566/850]	5.83 [0.54]	14/3					.11 [.027]	.13 [.032]	.15 [.037]	.17 [.042]
6024AS	U H	1500/1900 [708/897]	5.83 [0.54]	14/3								.17 [.042]

① H = Horizontal air flow, U = Upflow, D = Downflow

Figure 3

Conclusion

The opportunity to work in the Customer Assurance Department at SCACD was a valuable experience to me as a teacher. I developed my understanding and knowledge of current equipment and practiced my strength of explaining the basic concepts. I was also able to see, first hand, the gaps in understanding many technicians face in our industry. Some technicians I spoke to were alumni of the AIRC program at Mt. SAC. From this experience, I learned that we must put more effort into teaching air properties, air measurement and duct design.

Zoning of air conditioning for residential and light commercial applications intrigued me. From my work at SCACD I became motivated to learn more about this emerging application. As a result, I planned to design and install these systems under my contractor's license. I ended my experience with the pledge to remain current in the air conditioning industry and to emphasis the basics when teaching the advanced concepts.


Carrier

Certificate of Achievement

Awarded to

Darrow P. Soares

for completing all the requirements of the Application & Service Training for the Environmentally Sound Refrigerant, Puron™

Puron REFRIGERANT SPECIALIST Carrier

Instructor

Distributor S.C.A.C.D

Date 02/04/03

Certification was required to answer technical questions about alternative refrigerants

Habitat for Humanity

The Background

Habitat for Humanity is a nonprofit, nondenominational Christian housing organization with the mission of providing affordable housing to families below the poverty line. Since 1976, Habitat has built more than 50,000 houses throughout the United States and over 100,000 houses in communities around the world (Egan, 2004). Habitat homes are not given away. Families must purchase the homes and maintain monthly payments. Three factors make the houses affordable to families living below the poverty line in their community:

- Houses are sold at no profit, with no interest charged on the mortgage
- Volunteers build the houses and provide materials at cost
- Individuals, businesses, religious groups and others provide financial support

Habitat houses are modestly sized, but large enough for the homeowner family's needs. In order to keep construction and maintenance costs to a minimum, Habitat for Humanity guidelines state that a 3-bedroom Habitat house may have no more than 1,050 square feet of living space. Other restrictions apply to appliances, carpeting, and electronic accessories.

Each local Habitat affiliate coordinates the house building and selects the homeowner family. Each family is chosen according to their need; their ability to repay the no-profit, no-interest mortgage; and their willingness to work in partnership with Habitat. In addition to a down payment and the monthly mortgage payments, homeowners are required to work 500 hundred hours building their house and the houses of other Habitat families in their community.

In the United States, Habitat houses have an average cost of $46,600 (Habitat, 2003). Habitat homes constructed in Southern California are higher than the national average. Homes constructed by the Riverside affiliate range in cost from $78,000 in Moreno Valley to $84,000 in Riverside. Mortgage payments run approximately $400 per month.

Purpose

During my Sabbatical leave, I participated in various levels of planning and construction of five Habitat homes under the contractor's license for Darrow P. Soares. Initially, I volunteered to provide the Title 24 heat load calculations for projects in Riverside and San Bernardino. This important process is required to properly size air conditioning and heating systems for homes and businesses. Heat load calculations, by California law, must be submitted to city planning departments for approval before construction can begin. This process was of interest to me since the Air Conditioning and Refrigeration Department at Mount San Antonio College recently integrated heat load software into the AIRC 30 Heat Load Calculations class. The software purchased by our department is one of the few programs approved the California Energy Commission and recognized by many city planning departments. This was a good opportunity to use this software on a practical basis. In addition, I then navigated it through the bureaucracy of city planning departments, often defending the results against planners and architects. Once approval was granted, I volunteered to install the equipment and further practice my skills as a tradesman and technician.

I performed heat load calculations on five homes for Habitat for Humanity. Of those five, I was able to install the air conditioning and heating systems on four. All heat load calculations and my labor on the installations was provided free of charge. The equipment and material on the four systems were installed at the cost of equipment with no mark up or profit. Following is a summary of work provided to Habitat for Humanity during my sabbatical leave from Mount San Antonio College.

24161 Clover Avenue. Moreno Valley

The first house I participated in was located in Moreno Valley and built by the Riverside Habitat for Humanity affiliate. I was involved with this house periodically from February 2003 to the end of my sabbatical in 2004. The heat load was submitted to the Moreno Valley Planning Department in March of 2003. I provided this service because the original architect had not included a heat load calculation plans. Unfortunately, it was not noticed until they were submitted for approval and then turned down. Since I had been requesting work from Habitat, I was called and I submitted the load calculations.

Half the crew at 24161 Clover Avenue

Installation of the air conditioning equipment began on February 24th of 2004. I performed the rough mechanical construction with two helpers made available through the local high school Co-op work study. In the rough phase of construction, the furnace is typically set in place and all sheet metal and duct work is installed and insulated. In addition, the refrigerant lines are run, insulated and leak checked. Then the plumbing is installed to remove condensate during the cooling cycle. Finally, the electrical wiring, including control wiring and main power wiring is put in place. The rough installation should take a professional contractor with skilled technicians about two and one half days. Although my helpers had excellent mechanical skills, their knowledge of air conditioning and mechanical codes were nonexistent. As a result, the rough installation was slow and often chaotic and required twice as much time to install as usual.

Preparing for the refrigerant lines

City inspection of the air conditioning equipment resulted in few changes. The Uniform Mechanical Code UMC 908.0 put the furnace clearances in question. The code violation was resolve by extending the flooring out in front of the furnace. In addition, the inspector questioned if the ducts were attached based on UMC 1601.3.1. This code requires that all duct joints be air tight. The inspector requested that insulation be removed at specific duct joints in order to see if the ducts were properly attached with band clamps. The joints passed inspection, but he recommended that I not insulate the duct joints until after rough inspection is complete.

Horizontal furnace installed in the attic

As of this writing, the home is in the final stages of construction and finish is currently under way. The finish process includes installing the thermostat and all registers and grills. The air conditioning condensing unit is installed during this phase which includes brazing the refrigerant lines, evacuation and setting the electrical disconnect. When all the equipment is in place, the system is evacuated of air and other non condensables. The system is then operated and charged with refrigerant. The furnace is then operated. This involves burning off the polymers and oils applied to the furnace during the manufacturing process. This is a critical step since the process usually trips the smoke alarms. During this process the furnace venting system and all safety devices are checked. Once the airflow is balanced to each room and the duct work leak checked, the installation is complete. The contractor will return, however, when the home is occupied to explain thermostat function and system maintenance to the homeowner.

Building Analysis
Entire House
Sabbatical Project

Job: Habitat for Humanity
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
24161 Clover Avenue, Moreno Valley, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

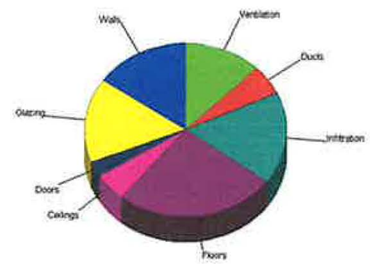
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

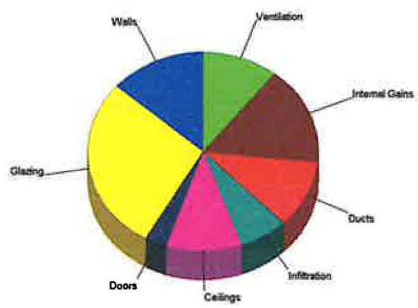
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	3081	15.2
Glazing	29.6	3195	15.8
Doors	13.3	557	2.8
Ceilings	1.1	1071	5.3
Floors	5.3	5216	25.8
Infiltration	3.3	3480	17.2
Ducts		1129	5.6
Piping		0	0.0
Humidification		0	0.0
Ventilation		2504	12.4
Adjustments		0	
Total		**20232**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.2	2159	13.5
Glazing	41.9	4526	28.3
Doors	11.7	491	3.1
Ceilings	1.7	1685	10.5
Floors	0.0	0	0.0
Infiltration	1.1	1099	6.9
Ducts		1756	11.0
Ventilation		1694	10.6
Internal gains		2580	16.1
Blower		0	0.0
Adjustments		0	
Total		**15989**	**100.0**



Overall U-value = 0.124 Btuh/ft²-°F

Data entries checked.

AED Assessment
Entire House
Sabbatical Project

Job: Habitat for Humanity
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
24161 Clover Avenue, Moreno Valley, CA

Design Conditions

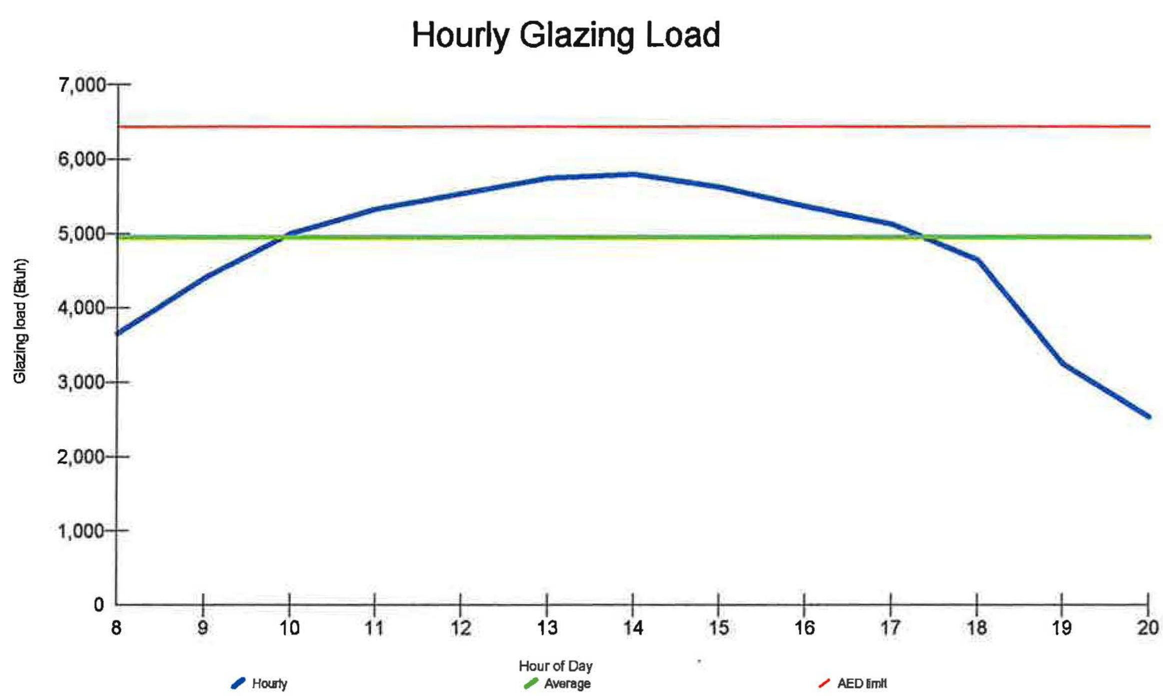
Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:	
Method	Simplified
Construction quality	Average
Fireplaces	0

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 17.0%.

House has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

Component Constructions
Entire House
Sabbatical Project

Job: Habitat for Humanity
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
24161 Clover Avenue, Moreno Valley, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

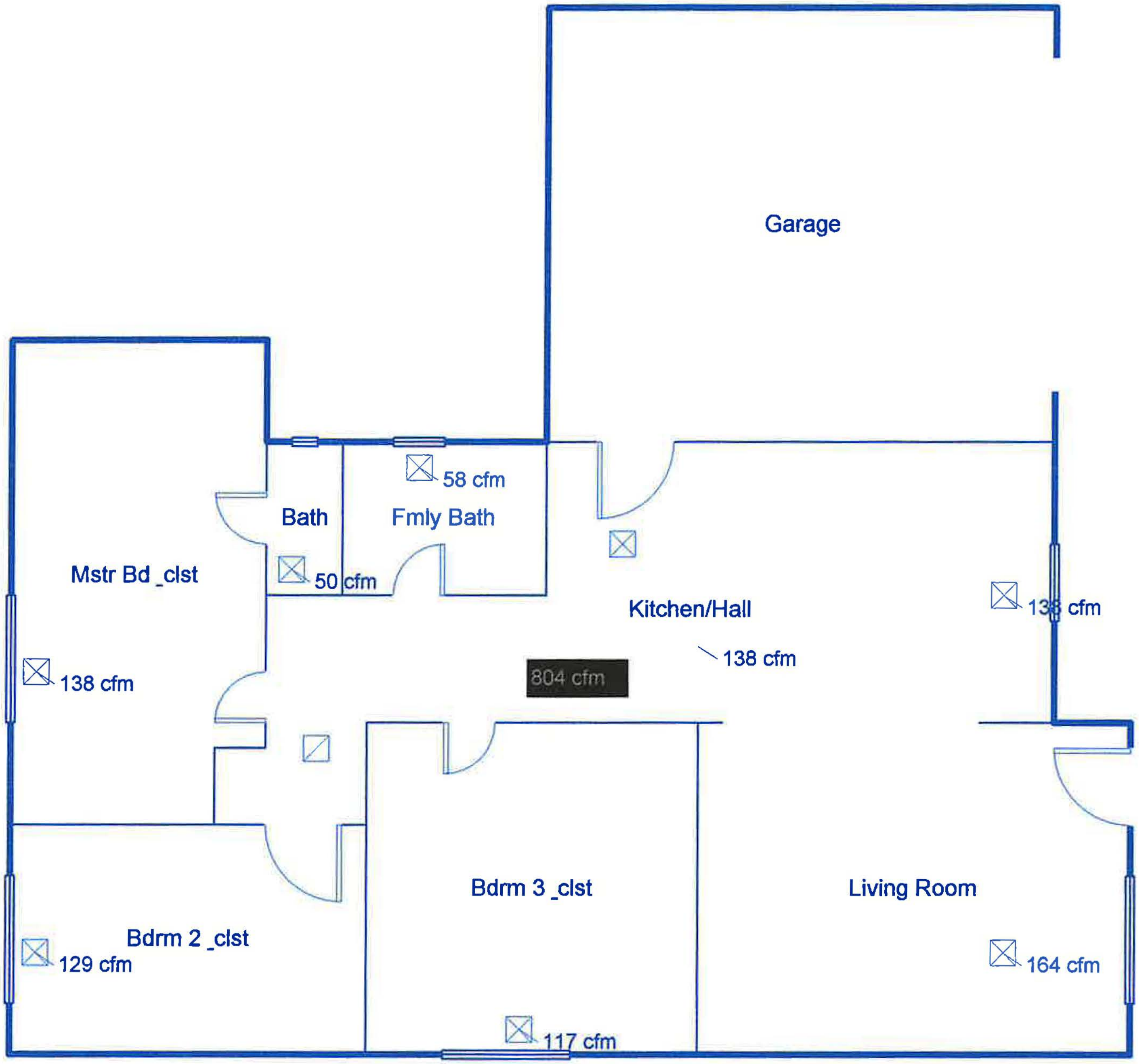
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation	n	139	0.091	13.0	3.09	430	2.27	316
	e	308	0.091	13.0	3.09	953	2.27	701
	s	152	0.091	13.0	3.09	470	2.27	346
	w	291	0.091	13.0	3.09	900	2.27	662
	all	890	0.091	13.0	3.09	2754	2.27	2025
Partitions								
12D-0sw: Wood stud frame, siding or stucco, no board insulation, R-15 cavity insulation		112	0.086	15.0	2.92	327	1.20	134
Windows								
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 50% drapes, medium; 50% outdoor insect screen	n	20	0.870	0.0	29.6	592	24.1	481
	s	40	0.870	0.0	29.6	1183	30.3	1210
	all	60	0.870	0.0	29.6	1775	28.2	1692
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane	n	12	0.870	0.0	29.6	355	33.7	404
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 50% drapes, medium; 50% outdoor insect screen; 2 ft overhang	e	20	0.870	0.0	29.6	592	57.6	1152
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 2 ft overhang	w	8	0.870	0.0	29.6	237	84.1	673
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 50% outdoor insect screen; 2 ft overhang	w	8	0.870	0.0	29.6	237	75.7	606
Doors								
11D0: Wood door, solid core, no storm	n	21	0.390	0.0	13.3	278	11.7	246
	w	21	0.390	0.0	13.3	278	11.7	246
	all	42	0.390	0.0	13.3	557	11.7	491
Ceilings								
16B-30ad: Ceiling under vented attic, no radiant barrier, dark shingles, R-30 insulation		984	0.032	30.0	1.09	1071	1.71	1685
Floors								
22A-tpm: Tile covered slab on grade, heavy dry or light wet soil, No edge insul, No horiz insul		130	1.180	0.0	40.1	5216	0.00	0

Sheet 1



Job #: Habitat for Humanity **Performed by Darrow Soares for:** Habitat For Humanity 24161 Clover Avenue Moreno Valley, CA	**Sabbatical Project** Mount San Antonio College February 2003,	Scale: 1 : 76 Page 1 Right-Suite Residential 5.9.37 RSR31228 2004-Sep-13 12:26:00 C:\My Documents\Wrightsoft HVAC\...

Project Summary
Entire House
Sabbatical Project

Job: **Habitat for Humanity**
Date: **February 2003**
By: **Darrow Soares**

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
24161 Clover Avenue, Moreno Valley, CA

Notes:

Design Information

Weather: Riverside, March AFB, CA, US

Winter Design Conditions

Outside db	36	°F
Inside db	70	°F
Design TD	34	°F

Heating Summary

Structure	16599	Btuh
Ducts	1129	cfm
Central vent (71 cfm)	2504	Btuh
Humidification	0	Btuh
Piping	0	Btuh
Equipment load	20232	Btuh

Infiltration

Method	Simplified
Construction quality	Average
Fireplaces	0

	Heating	Cooling
Area (ft²)	984	984
Volume (ft³)	7872	7872
Air changes/hour	0.75	0.35
Equiv. AVF (cfm)	98	46

Summer Design Conditions

Outside db	98	°F
Inside db	75	°F
Design TD	23	°F
Daily range	H	
Relative humidity	50	%
Moisture difference	-8	gr/lb

Sensible Cooling Equipment Load Sizing

Structure	14295	Btuh
Ducts	1756	Btuh
Central vent (71 cfm)	1694	Btuh
Blower	0	Btuh
AED excursion	0	Btuh
Use manufacturer's data	n	
Rate/swing multiplier	1.03	
Equipment sensible load	16469	Btuh

Latent Cooling Equipment Load Sizing

Structure	964	Btuh
Ducts	-92	Btuh
Central vent (71 cfm)	-364	Btuh
Equipment latent load	507	Btuh
Equipment total load	16976	Btuh
Req. total capacity at 0.70 SHR	2.0	ton

Heating Equipment Summary

Make	RHEEM AIR CON
Trade	Rheem
Model	RRMA-A042JK04E

Efficiency	80	AFUE
Heating input	40000	Btuh
Heating output	31000	Btuh
Temperature rise	37	°F
Actual air flow	800	cfm
Air flow factor	0.045	cfm/Btuh
Static pressure	0.08	in H2O
Space thermostat		

Cooling Equipment Summary

Make	Rheem
Trade	Rheem RAPA Series
Cond	RAPA-024JA
Coil	RGFD-06?MCK?+RCGJ-24A2

Efficiency	13.4	SEER
Sensible cooling	16660	Btuh
Latent cooling	7140	Btuh
Total cooling	23800	Btuh
Actual air flow	800	cfm
Air flow factor	0.056	cfm/Btuh
Static pressure	0.08	in H2O
Load sensible heat ratio	0.97	

Printout certified by ACCA to meet all requirements of Manual J 8th Ed.

21170 Clover Avenue. Moreno Valley

This house was also located in Moreno Valley and built by the Riverside affiliate.

The heat load was submitted to Moreno Valley Planning in March of 2003. In submitting the heat loads, I had to make one visit to Moreno Valley planning to defend the heat load calculation. The issue was not technical but a matter of my credentials and that of the software. The issue was resolved and calculations were accepted.

The air conditioning equipment was installed during weekends in March 2004. In the process of providing the heat load calculations, working with Planning and the builder, and installing the equipment, I worked on this house periodically from February

The Mt. SAC crew at 21170 Clover Avenue

2003 to the end of my sabbatical in 2004. Rough mechanical construction was performed by Mount San Antonio College AIRC students and me. The AIRC students were eager to practice their skills and willing to work uncompensated through The Mount San Antonio College Work Experience Program. As a result, the installation was far more structured and enjoyable than the 24161 Clover project. Since the students were involved in classes during the week, the installation was performed during weekends in March. Inspection of the air conditioning equipment resulted in minor changes. Again, the Uniform Mechanical Code UMC 908.0 put access to the furnace in question. In this case the code violation was resolve by lifting the furnace and rebuilding the furnace platform. Other issues included UMC 310.2 which requires that the secondary condensate line be drained to a conspicuous location. The purpose of the secondary line is to act as a back up if the primary line becomes restricted. It must drain to a conspicuous location to alert the home owner that a plumbing issue exists and requires immediate attention. The students plumbed the condensate line through the

A student installs the return air can

freeze block above a bathroom window. Since the window was frosted, the inspector did not consider it conspicuous and the line was rerouted above a bathroom window. According to UMC 605.0, the inspector turned down the installation because there was no insulation on the duct boots and connectors. Since the inspector on

Students installing flex duct for the supply air

the previous job requested that insulation be removed at specific duct joints and then recommended that I not insulate before rough inspection, I left all connections un-insulated so the duct bands could be seen. As a result, all the fittings had to be insulated and the job superintendent had to call for inspection again.

As of this writing, the house is in the final stages of finish. In September, an open house is planned and the Mt SAC students that participated in construction will be invited.

Building Analysis
Entire House
Sabbatical Project

Job: Sabbatical Project
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
21170 Clover Avenue, Moreno Valley, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

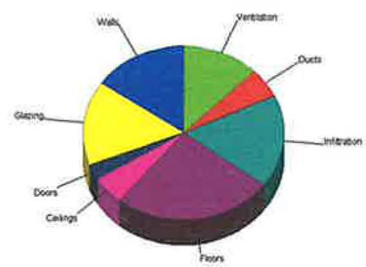
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method Simplified
Construction quality Average
Fireplaces 0

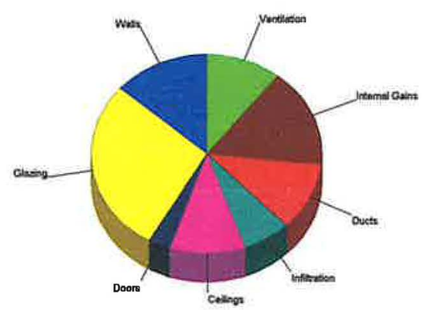
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	3081	15.2
Glazing	29.6	3195	15.8
Doors	13.3	557	2.8
Ceilings	1.1	1071	5.3
Floors	5.3	5216	25.8
Infiltration	3.3	3480	17.2
Ducts		1129	5.6
Piping		0	0.0
Humidification		0	0.0
Ventilation		2504	12.4
Adjustments		0	
Total		**20232**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.2	2159	13.5
Glazing	41.9	4526	28.3
Doors	11.7	491	3.1
Ceilings	1.7	1685	10.5
Floors	0.0	0	0.0
Infiltration	1.1	1099	6.9
Ducts		1756	11.0
Ventilation		1694	10.6
Internal gains		2580	16.1
Blower		0	0.0
Adjustments		0	
Total		**15989**	**100.0**



Overall U-value = 0.124 Btuh/ft²-°F

Data entries checked.

AED Assessment
Entire House
Sabbatical Project

Job: Sabbatical Project
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
21170 Clover Avenue, Moreno Valley, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

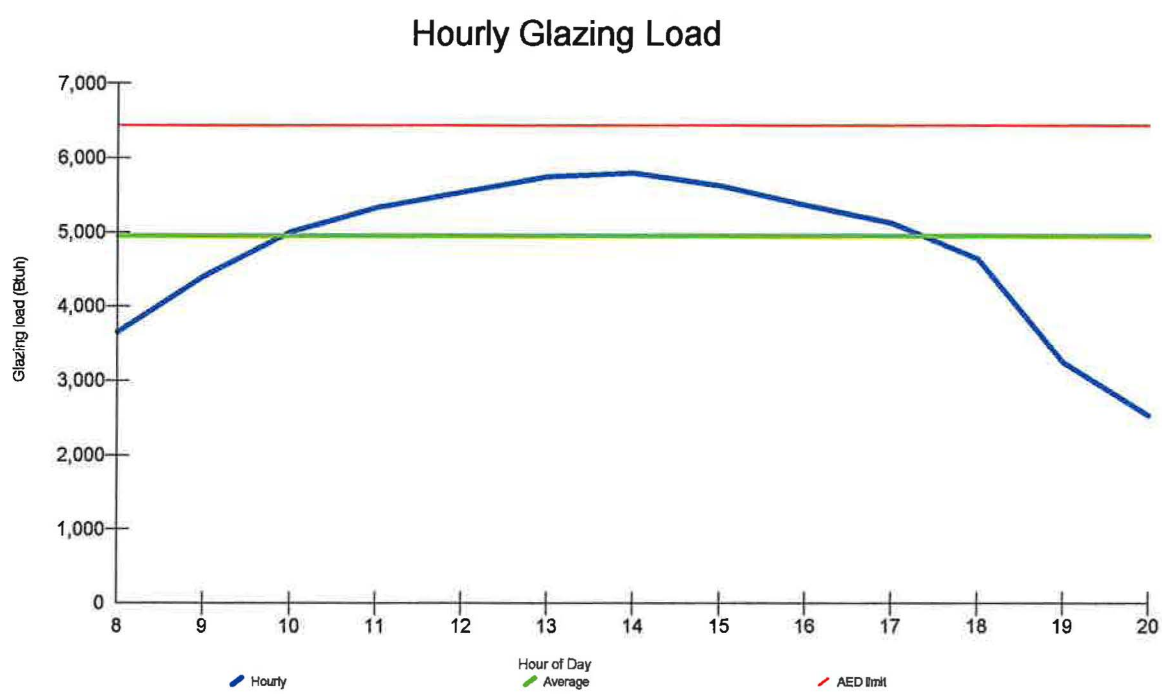
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	0

Test for Adequate Exposure Diversity

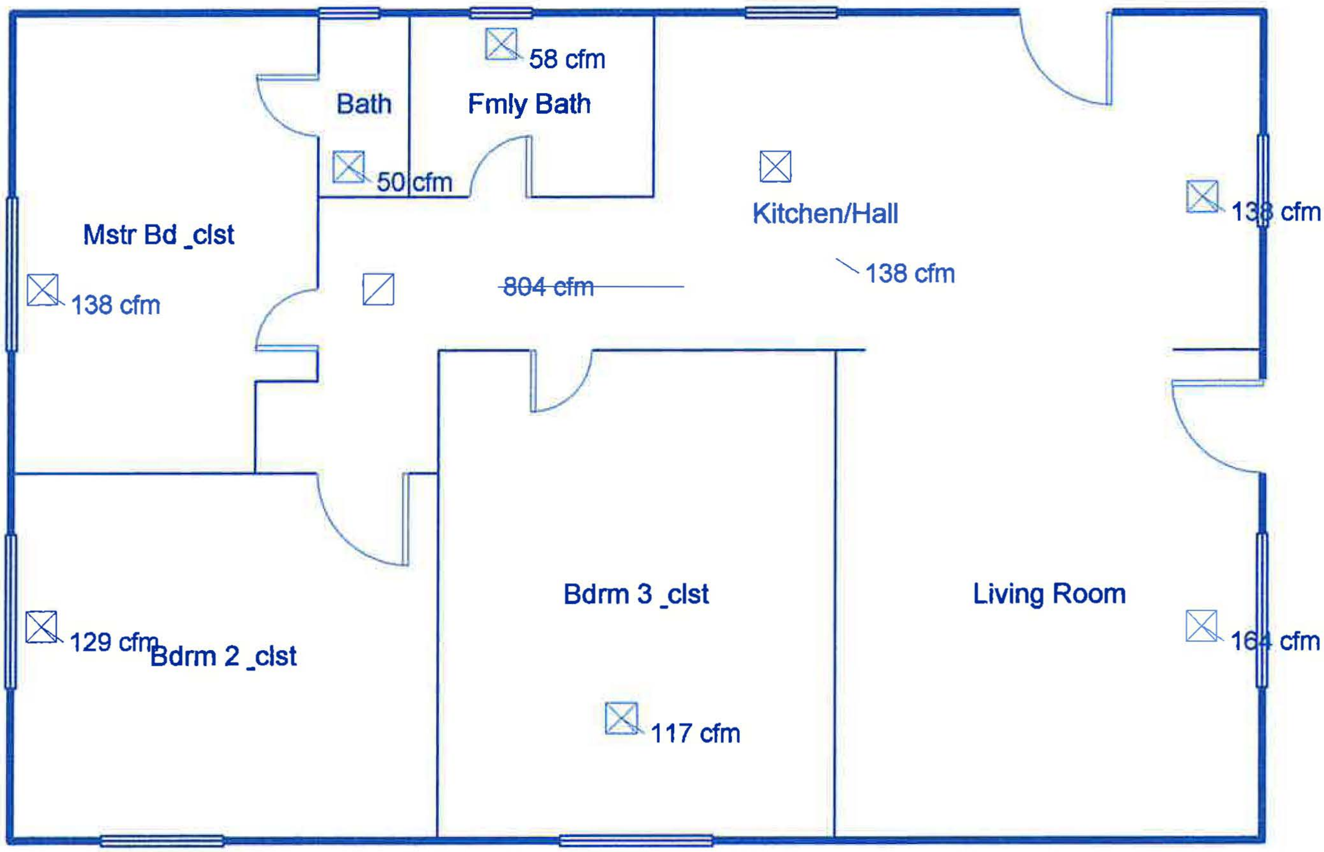


Maximum hourly glazing load exceeds average by 17.0%.

House has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

Sheet 1



Job #: Sabbatical Project Performed by Darrow Soares for: Habitat For Humanity 21170 Clover Avenue Moreno Valley, CA	Sabbatical Project Mount San Antonio College February 2003,	Scale: 1 : 76 Page 1 Right-Suite Residential 5.9.37 RSR31228 2004-Sep-13 12:19:49 C:\My Documents\Wrightsoft HVAC\...

Project Summary
Entire House
Sabbatical Project

Job: Sabbatical Project
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
21170 Clover Avenue, Moreno Valley, CA

Notes: Perform as a Sabbatical Project for the AIRC Department at Mount San Antonio College

Design Information

Weather: Riverside, March AFB, CA, US

Winter Design Conditions

Outside db	36	°F
Inside db	70	°F
Design TD	34	°F

Heating Summary

Structure	16599	Btuh
Ducts	1129	cfm
Central vent (71 cfm)	2504	Btuh
Humidification	0	Btuh
Piping	0	Btuh
Equipment load	20232	Btuh

Infiltration

Method	Simplified
Construction quality	Average
Fireplaces	0

	Heating	Cooling
Area (ft²)	984	984
Volume (ft³)	7872	7872
Air changes/hour	0.75	0.35
Equiv. AVF (cfm)	98	46

Heating Equipment Summary

Make	RHEEM AIR CON
Trade	Rheem
Model	RRKA-A036JK04E

Efficiency	80	AFUE
Heating input	40000	Btuh
Heating output	31000	Btuh
Temperature rise	30	°F
Actual air flow	1007	cfm
Air flow factor	0.057	cfm/Btuh
Static pressure	0.00	in H2O
Space thermostat		

Summer Design Conditions

Outside db	98	°F
Inside db	75	°F
Design TD	23	°F
Daily range	H	
Relative humidity	50	%
Moisture difference	-8	gr/lb

Sensible Cooling Equipment Load Sizing

Structure	14295	Btuh
Ducts	1756	Btuh
Central vent (71 cfm)	1694	Btuh
Blower	0	Btuh
AED excursion	0	Btuh
Use manufacturer's data	n	
Rate/swing multiplier	1.03	
Equipment sensible load	16469	Btuh

Latent Cooling Equipment Load Sizing

Structure	964	Btuh
Ducts	-92	Btuh
Central vent (71 cfm)	-364	Btuh
Equipment latent load	507	Btuh
Equipment total load	16976	Btuh
Req. total capacity at 0.70 SHR	2.0	ton

Cooling Equipment Summary

Make	Rheem
Trade	Rheem RANB Series
Cond	RANB-030JA
Coil	RGLL-05?BMK?+RCHJ-36A1

Efficiency	14	SEER
Sensible cooling	21140	Btuh
Latent cooling	9060	Btuh
Total cooling	30200	Btuh
Actual air flow	1007	cfm
Air flow factor	0.070	cfm/Btuh
Static pressure	0.08	in H2O
Load sensible heat ratio	0.97	

Printout certified by ACCA to meet all requirements of Manual J 8th Ed.

Component Constructions
Entire House
Sabbatical Project

Job: Sabbatical Project
Date: February 2003
By: Darrow Soares

Mount San Antonio College, February 2003,

Project Information

For: Habitat For Humanity
21170 Clover Avenue, Moreno Valley, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:

	Heating	Cooling
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:

	Heating	Cooling
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation	n	139	0.091	13.0	3.09	430	2.27	316
	e	308	0.091	13.0	3.09	953	2.27	701
	s	152	0.091	13.0	3.09	470	2.27	346
	w	291	0.091	13.0	3.09	900	2.27	662
	all	890	0.091	13.0	3.09	2754	2.27	2025
Partitions								
12D-0sw: Wood stud frame, siding or stucco, no board insulation, R-15 cavity insulation		112	0.086	15.0	2.92	327	1.20	134
Windows								
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 50% drapes, medium; 50% outdoor insect screen	n	20	0.870	0.0	29.6	592	24.1	481
	s	40	0.870	0.0	29.6	1183	30.3	1210
	all	60	0.870	0.0	29.6	1775	28.2	1692
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane	n	12	0.870	0.0	29.6	355	33.7	404
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 50% drapes, medium; 50% outdoor insect screen; 2 ft overhang	e	20	0.870	0.0	29.6	592	57.6	1152
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 2 ft overhang	w	8	0.870	0.0	29.6	237	84.1	673
1D-c2om: Operable, metal frame, no break, clear glass, 2 pane; 50% outdoor insect screen; 2 ft overhang	w	8	0.870	0.0	29.6	237	75.7	606
Doors								
11D0: Wood door, solid core, no storm	n	21	0.390	0.0	13.3	278	11.7	246
	w	21	0.390	0.0	13.3	278	11.7	246
	all	42	0.390	0.0	13.3	557	11.7	491
Ceilings								
16B-30ad: Ceiling under vented attic, no radiant barrier, dark shingles, R-30 insulation		984	0.032	30.0	1.09	1071	1.71	1685
Floors								
22A-tpm: Tile covered slab on grade, heavy dry or light wet soil, No edge insul, No horiz insul		130	1.180	0.0	40.1	5216	0.00	0

680 Columbia Avenue. Redlands

The Columbia house was a premanufactured home that was installed by the Redlands Habitat for Humanity affiliate. Under most conditions, a premanufactured home is easier to complete than a structure constructed from the ground up. Premanufactured homes are constructed in a facility, under controlled conditions and then transported, usually in two sections, to the job sight. The need for numerous on sight contractors and working crews is minimized and construction time is greatly reduced. The manufacturer of the home, Skyline, and The California Manufacturing Housing Industry donated half the cost of the home to the Redlands affiliate. In addition, the property was completely donated by the city of Redlands. This savings, in turn, was passed on to the homeowner.

The completed home on Columbia

The work required to install the air conditioning system on this type of home includes joining the existing ductwork between the two housing sections, installing the furnace, running the refrigerant and condensate lines, setting the condenser and running main power from the electrical service panel.

The electrical disconnect is installed

I submitted the heat load calculation for the Columbia house to Habitat for Humanity in February of 2004. The manufacturer of the home, Skyline called for a

48,000 BTU air conditioner to be installed. Since the home only measures 1,200 square feet, there was a question if a system of that size would be too large. My heat load calculation put the sensible heat load at 31,000 BTUs, which would have been satisfied with an air conditioning system delivering 36,000 BTUs. Since Skyline stood by there heat load estimate, and Habitat was receiving the air conditioning system at cost, the 48,000 BTU system was installed.

On April 12th I began the air conditioning installation with my son, Taylor. Although premanufactured homes are designed to reduce on site installation, we faced many challenges that could have been avoided with better planning and communication. The biggest challenge for the air conditioning installation was access to the areas we had to work in. This was because the home was in its finish phase before the air conditioning installation was ever considered. Provisions to run refrigerant lines, plumbing and electrical below the floor should have been made before the brick cinder block footings were set and sealed. As a result of this poor timing, we found ourselves attaching ductwork, running refrigerant lines and electrical wiring under an enclosed floor. In many cases, the crawl space clearances were reduced to less than 12 inches. To resolve this, we spent many hours digging out our routes below the floor.

The refrigerant lines are brazed

When the installation was finally complete, the air conditioning installation did not suffer any mechanical code violations. The home owner took ownership of house on July 20th, 2004.

Building Analysis
Entire House
Sabbatical Project

Job: Columbia Habitat for Hu...
Date: March 20, 2003
By: Darrow P. Soares

Mount San Antonio College, February 2004,

Project Information

For: Habitat for Humanity
680 Columbia Avenue, Redlands, CA

Design Conditions

Location:
Redlands, CA, US
Elevation: 1318 ft
Latitude: 34°N

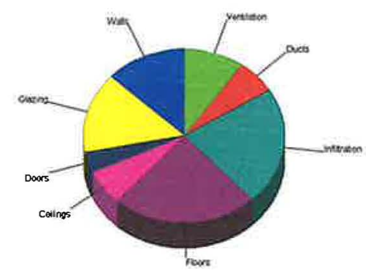
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	33	99
Daily range (°F)	-	33 (H)
Wet bulb (°F)	-	69
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	37	24
Relative humidity (%)	30	50
Moisture difference (gr/lb)	11.1	-4.3

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

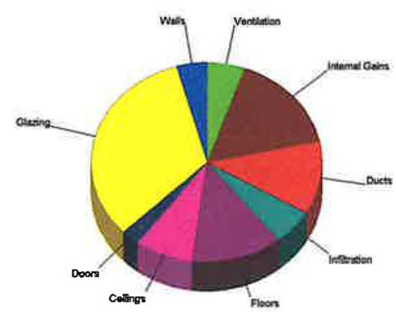
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	2.6	2433	13.0
Glazing	24.0	2790	14.9
Doors	20.7	725	3.9
Ceilings	1.2	1257	6.7
Floors	4.1	4355	23.3
Infiltration	3.7	4120	22.1
Ducts		1180	6.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		1820	9.7
Adjustments		0	
Total		**18680**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	1.0	953	4.3
Glazing	62.2	7217	32.9
Doors	16.2	568	2.6
Ceilings	1.7	1784	8.1
Floors	2.7	2825	12.9
Infiltration	1.1	1247	5.7
Ducts		2621	11.9
Ventilation		1180	5.4
Internal gains		3550	16.2
Blower		0	0.0
Adjustments		0	
Total		**21947**	**100.0**



Overall U-value = 0.157 Btuh/ft²-°F

WARNING: suspicious slab-on-grade floor perimeter in Bedroom 2.

AED Assessment
Entire House
Sabbatical Project

Mount San Antonio College, February 2004,

Project Information

For: Habitat for Humanity
680 Columbia Avenue, Redlands, CA

Design Conditions

Location:
Redlands, CA, US
Elevation: 1318 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	33	99
Daily range (°F)	-	33 (H)
Wet bulb (°F)	-	69
Wind speed (mph)	15.0	7.5

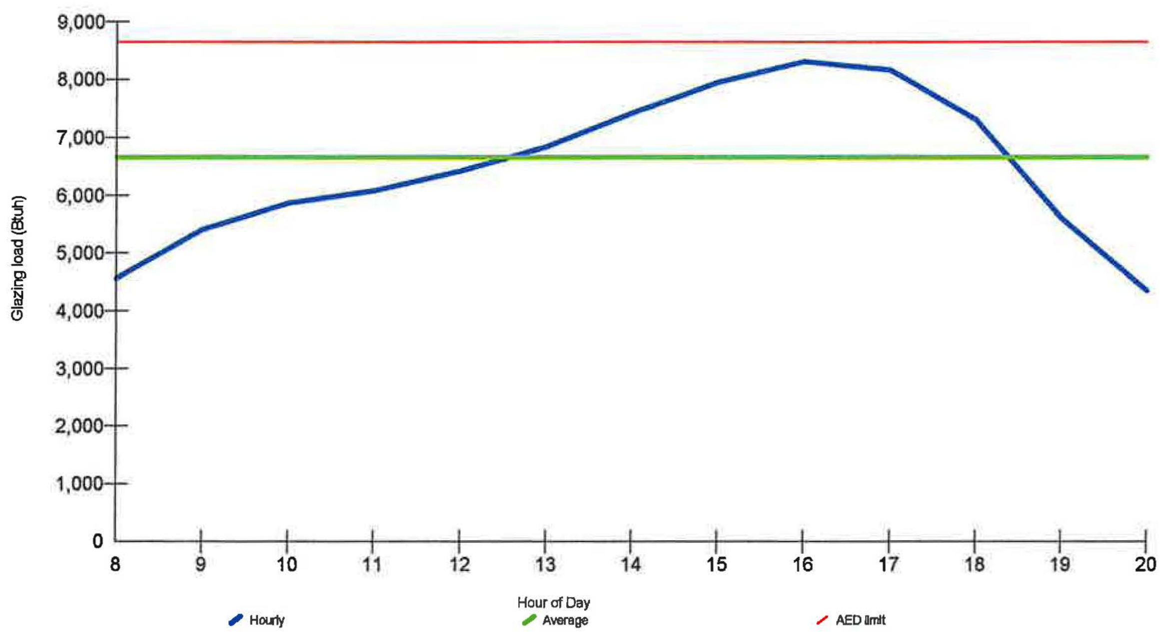
Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	37	24
Relative humidity (%)	30	50
Moisture difference (gr/lb)	11.1	-4.3

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	0

Test for Adequate Exposure Diversity

Hourly Glazing Load

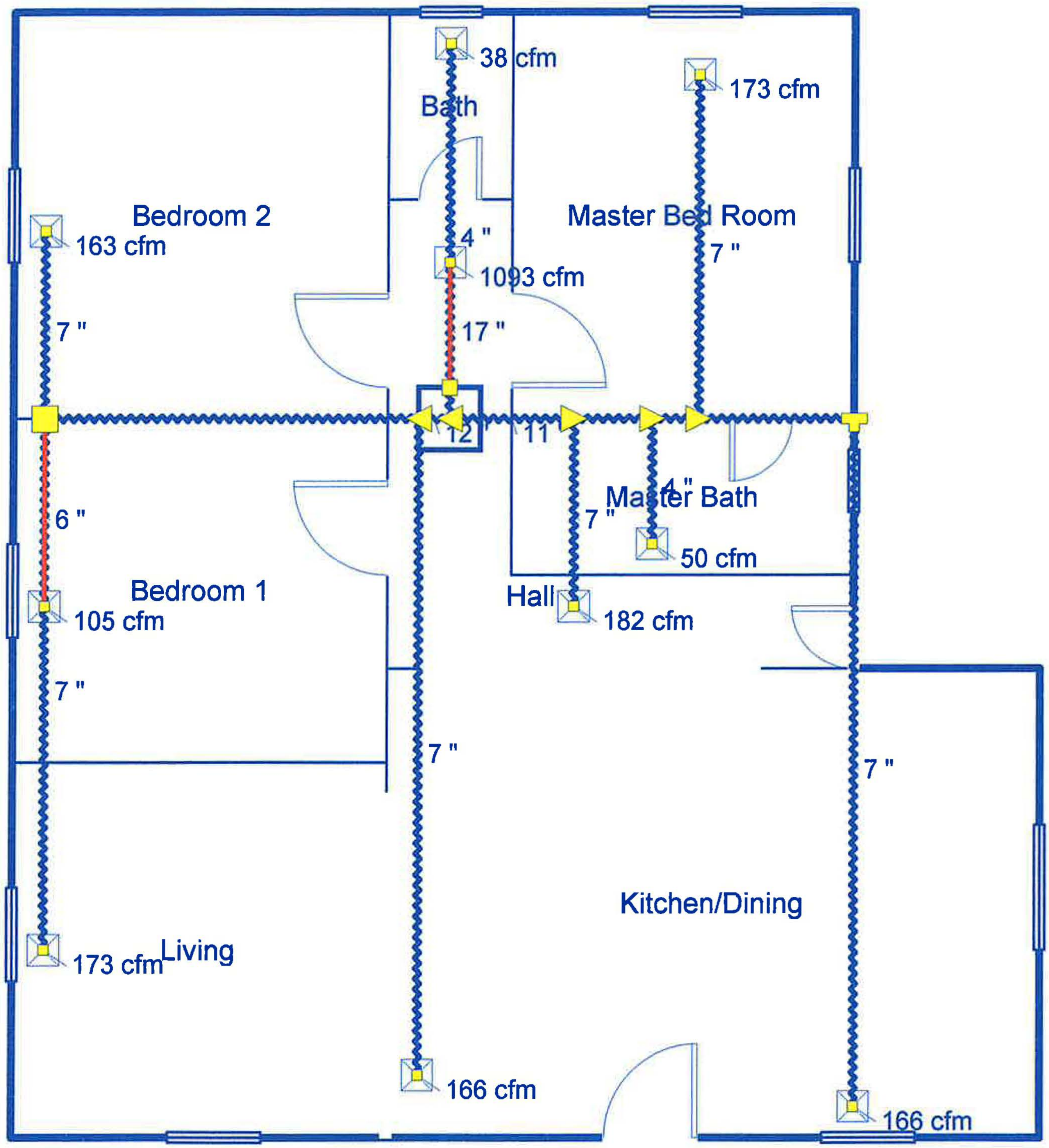


Maximum hourly glazing load exceeds average by 24.7%.

House has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

Sheet 1



Job #: Columbia Habitat for Humanity **Performed by Darrow P. Soares for:** Habitat for Humanity 680 Columbia Avenue Redlands, CA	**Sabbatical Project** Mount San Antonio College February 2004,	Scale: 1 : 58 Page 1 Right-Suite Residential 5.9.37 RSR31228 2004-Sep-13 12:10:03 C:\My Documents\Wrightsoft HVAC\8...

Duct System Summary
Entire House
Sabbatical Project

Job: Columbia Habitat for Hu...
Date: March 20, 2003
By: Darrow P. Soares

Mount San Antonio College, February 2004,

Project Information

For: Habitat for Humanity
680 Columbia Avenue, Redlands, CA

	Heating		Cooling	
External static pressure	0.50	in H2O	0.50	in H2O
Pressure losses	0.00	in H2O	0.00	in H2O
Available static pressure	0.50	in H2O	0.50	in H2O
Supply / return available pressure	0.38 / 0.12	in H2O	0.38 / 0.12	in H2O
Lowest friction rate	0.182	in/100ft	0.182	in/100ft
Actual air flow	1093	cfm	1093	cfm
Total effective length (TEL)		274 ft		

Supply Branch Detail Table

Name		Design (Btuh)	Htg (cfm)	Clg (cfm)	Design FR	Diam (in)	Rect Size (in)	Duct Matl	Actual Ln (ft)	Ftg.Eqv Ln (ft)	Trunk
Bath	c	726	35	38	0.358	4	0x0	VIFx	12.0	95.0	
Hall	c	3454	63	182	0.365	7	0x0	VIFx	10.0	95.0	st1
Kitchen/Dining	h	2559	166	160	0.252	7	0x0	VIFx	22.0	130.0	st2
Living	h	2671	173	156	0.197	7	0x0	VIFx	30.0	165.0	st2
Master Bath	h	768	50	47	0.273	4	0x0	VIFx	10.5	130.0	st1
Master Bed Room	h	2665	173	145	0.208	7	0x0	VIFx	19.0	165.0	st1
Kitchen/Dining-A	h	2559	166	160	0.182	7	0x0	VIFx	35.0	175.0	st1
Bedroom 1	h	1622	105	92	0.208	6	0x0	VIFx	19.0	165.0	st2
Bedroom 2	h	2515	163	113	0.208	7	0x0	VIFx	19.0	165.0	st2

Supply Trunk Detail Table

Name	Trunk Type	Htg (cfm)	Clg (cfm)	Design FR	Veloc (fpm)	Diam (in)	Rect Duct Size (in)	Duct Material	Trunk
st1	Peak AVF	451	534	0.182	809	11	0 x 0	VinlFlx	
st2	Peak AVF	607	521	0.197	773	12	0 x 0	VinlFlx	

Return Branch Detail Table

Name	Grill Size (in)	Htg (cfm)	Clg (cfm)	TEL (ft)	Design FR	Veloc (fpm)	Diam (in)	RectSize (in)	Stud/Joist Opening (in)	Duct Matl	Trunk
rb1	0x0	1093	1093	64.0	0.182	693	17	0x 0		VIFx	

Component Constructions
Entire House
Sabbatical Project

Job: Columbia Habitat for Hu...
Date: March 20, 2003
By: Darrow P. Soares

Mount San Antonio College, February 2004,

Project Information

For: Habitat for Humanity
680 Columbia Avenue, Redlands, CA

Design Conditions

Location:
Redlands, CA, US
Elevation: 1318 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	33	99
Daily range (°F)	-	33 (H)
Wet bulb (°F)	-	69
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	37	24
Relative humidity (%)	30	50
Moisture difference (gr/lb)	11.1	-4.3

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	0

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
13B-4ocws: Above grade open core concrete block, siding/stucco, R-4 board insulation, wood frame R-11	ne	238	0.069	15.0	2.55	608	1.00	238
	se	219	0.069	15.0	2.55	559	1.00	219
	sw	252	0.069	15.0	2.55	643	1.00	252
	nw	244	0.069	15.0	2.55	623	1.00	244
	all	953	0.069	15.0	2.55	2433	1.00	953
Partitions								
(none)								
Windows								
1D-c2ob: Operable, metal frame with break, clear glass, 2 pane	ne	36	0.650	0.0	24.0	866	58.7	2114
	se	24	0.650	0.0	24.0	577	65.5	1572
	sw	36	0.650	0.0	24.0	866	65.5	2358
	nw	20	0.650	0.0	24.0	481	58.7	1174
	all	116	0.650	0.0	24.1	2790	62.2	7217
Doors								
11L0: Metal door, paper honeycomb core, no storm	ne	14	0.560	0.0	20.7	290	16.2	227
	se	21	0.560	0.0	20.7	435	16.2	341
	all	35	0.560	0.0	20.7	725	16.2	568
Ceilings								
16B-30ad: Ceiling under vented attic, no radiant barrier, dark shingles, R-30 insulation		1062	0.032	30.0	1.18	1257	1.68	1784
Floors								
19A-0cvcp: Carpeted floor over vented enclosed crawl, No wall insul, No insul		1062	0.295	0.0	4.10	4355	2.66	2825

Project Summary
Entire House
Sabbatical Project

Job: Columbia Habitat for Hu...
Date: March 20, 2003
By: Darrow P. Soares

Project Information

For: Habitat for Humanity
680 Columbia Avenue, Redlands, CA

Notes: Sabbatical Project for Mount San Antonio College AIRC Department

Design Information

Weather: Redlands, CA, US

Winter Design Conditions

Outside db	33	°F
Inside db	70	°F
Design TD	37	°F

Summer Design Conditions

Outside db	99	°F
Inside db	75	°F
Design TD	24	°F
Daily range	H	
Relative humidity	50	%
Moisture difference	-4	gr/lb

Heating Summary

Structure	15680	Btuh
Ducts	1180	cfm
Central vent (47 cfm)	1820	Btuh
Humidification	0	Btuh
Piping	0	Btuh
Equipment load	18680	Btuh

Sensible Cooling Equipment Load Sizing

Structure	20767	Btuh
Ducts	2621	Btuh
Central vent (47 cfm)	1180	Btuh
Blower	0	Btuh
AED excursion	0	Btuh
Use manufacturer's data	n	
Rate/swing multiplier	1.04	
Equipment sensible load	22825	Btuh

Infiltration

Method	Simplified
Construction quality	Average
Fireplaces	0

	Heating	Cooling
Area (ft²)	1062	1062
Volume (ft³)	8496	8496
Air changes/hour	0.75	0.35
Equiv. AVF (cfm)	106	50

Latent Cooling Equipment Load Sizing

Structure	861	Btuh
Ducts	-98	Btuh
Central vent (47 cfm)	-132	Btuh
Equipment latent load	630	Btuh
Equipment total load	23455	Btuh
Req. total capacity at 0.70 SHR	2.7	ton

Heating Equipment Summary

Make RHEEM AIR CON
Trade Rheem
Model RRMA-A042JK04E

Efficiency	80	AFUE
Heating input	40000	Btuh
Heating output	31000	Btuh
Temperature rise	27	°F
Actual air flow	1093	cfm
Air flow factor	0.065	cfm/Btuh
Static pressure	0.50	in H2O
Space thermostat		

Cooling Equipment Summary

Make Rheem
Trade Rheem RANB Series
Cond RANB-036JA
Coil RCGA-36A2

Efficiency	11	SEER
Sensible cooling	22960	Btuh
Latent cooling	9840	Btuh
Total cooling	32800	Btuh
Actual air flow	1093	cfm
Air flow factor	0.053	cfm/Btuh
Static pressure	0.50	in H2O
Load sensible heat ratio	0.97	

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786 Draciea. Redlands

The Draciea home was a premanufactured home installed by the Habitat for Humanity affiliate in Redlands. I submitted the heat load calculation for the Draciea house to Habitat for Humanity in March of 2004. Skyline, the home manufacturer, called for a 48,000 BTU air conditioner to be installed. An aggressive heat load calculation using software developed by the Air Conditioning Contractors of America (ACCA)\ put the sensible heat load at 34,000 BTUs. Skyline, however, insisted on their estimate, and since the duct work design was based on a four ton air conditioner, the 48,000 BTU system was installed.

The Draciea house is installed on footings

The process to install the air conditioning equipment was similar to the Columbia house. The air conditioning installation began in May of 2004. As of this writing, the duct work is joined and the furnace is set and installed. In addition, the refrigerant lines are installed and brazed to the evaporator. The condensate is in place and main power is available where the condenser will be set.

As of this writing, the home is incomplete. This house ran behind schedule and had many disappointing set backs. Habitat suffered the loss of a fine construction supervisor and during the ensuing job search for a new one, construction was at a stand still. When construction continues, the air conditioning condensing unit should be set in September and finish construction should be completed soon after.

Building Analysis
Entire House
Sabbatical Project

Job:
Date: March 2004
By: Darrow P. Soares

Mount San Antonio College, March 2004,

Project Information

For: Habitat for Humanity
786 Draciea, Redlands, CA

Design Conditions

Location:
Redlands, CA, US
Elevation: 1318 ft
Latitude: 34°N

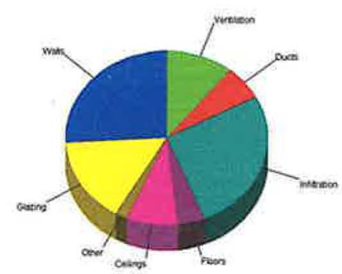
Outdoor:	**Heating**	**Cooling**	
Dry bulb (°F)	33	99	
Daily range (°F)	-	33	(H)
Wet bulb (°F)	-	69	
Wind speed (mph)	15.0	7.5	

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	37	24
Relative humidity (%)	30	50
Moisture difference (gr/lb)	11.1	-4.3

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

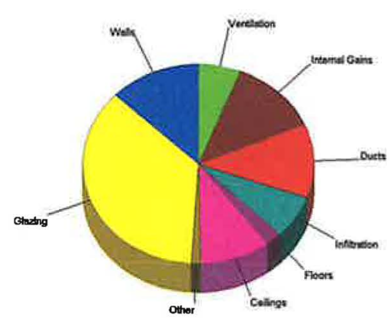
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.4	4152	25.9
Glazing	24.0	2549	15.9
Doors	14.4	303	1.9
Ceilings	1.2	1311	8.2
Floors	0.6	696	4.3
Infiltration	4.1	4295	26.8
Ducts		1013	6.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		1732	10.8
Adjustments		0	
Total		**16051**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.0	2412	12.8
Glazing	64.5	6833	36.3
Doors	11.3	238	1.3
Ceilings	1.7	1860	9.9
Floors	0.4	451	2.4
Infiltration	1.2	1300	6.9
Ducts		2281	12.1
Ventilation		1124	6.0
Internal gains		2350	12.5
Blower		0	0.0
Adjustments		0	
Total		**18849**	**100.0**



Overall U-value = 0.078 Btuh/ft²-°F

Data entries checked.

AED Assessment
Entire House
Sabbatical Project

Job:
Date: March 2004
By: Darrow P. Soares

Mount San Antonio College, March 2004,

Project Information

For: Habitat for Humanity
786 Draciea, Redlands, CA

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Redlands, CA, US
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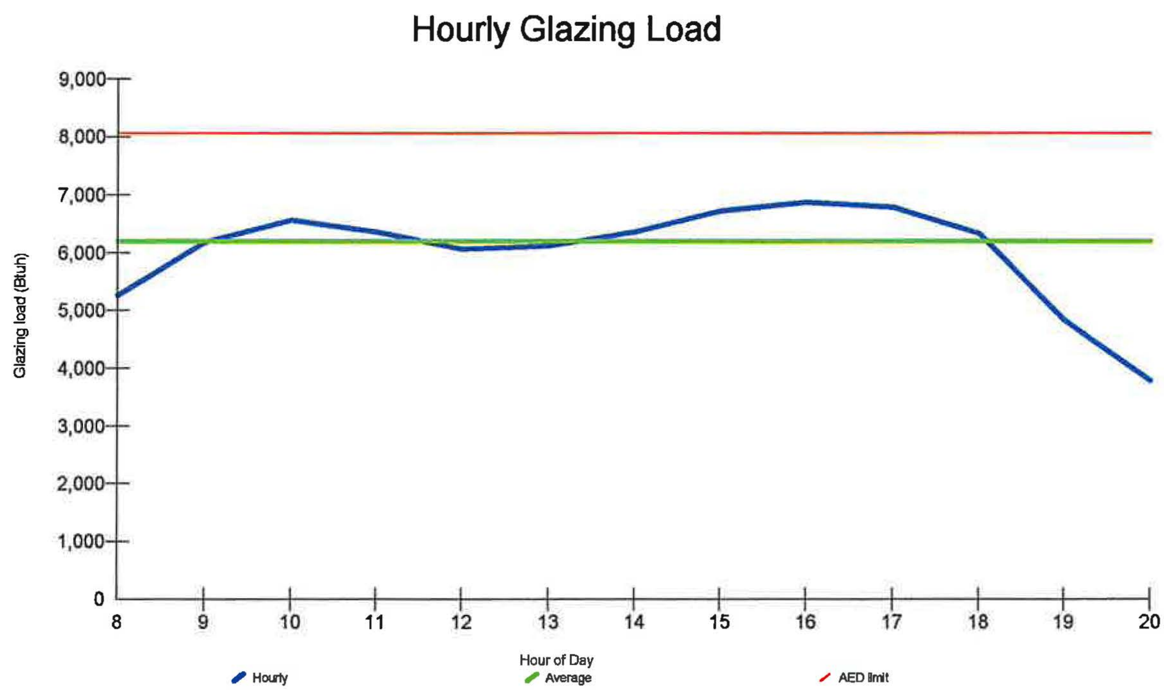
Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

Test for Adequate Exposure Diversity

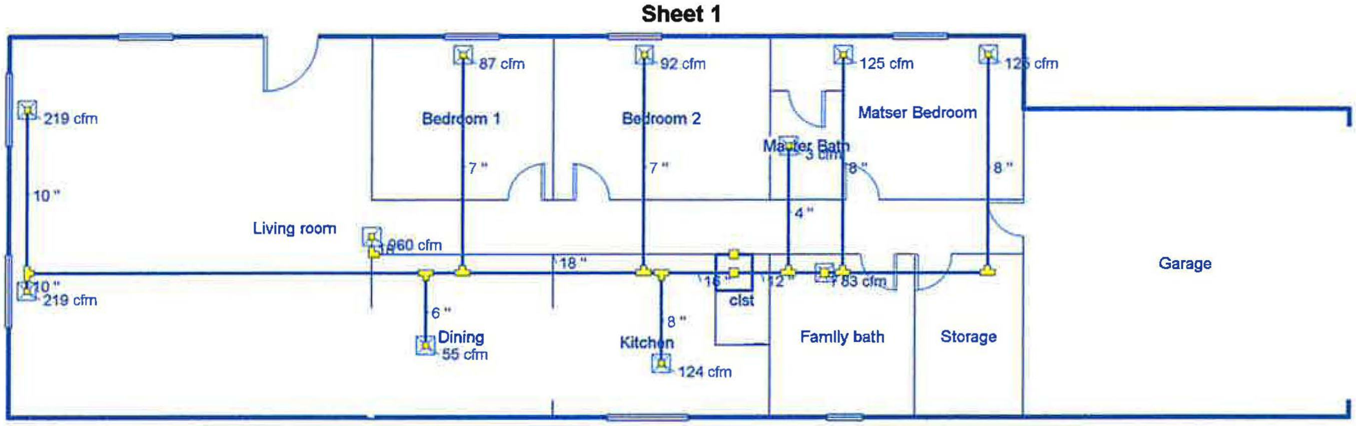


Maximum hourly glazing load exceeds average by 10.6%.

House has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

Sheet 1



Job #: **Performed by Darrow P. Soares for:** Habitat for Humanity 786 Draciea Redlands, CA	**Sabbatical Project** Mount San Antonio College March 2004,	Scale: 1 : 128 Page 1 Right-Suite Residential 5.9.37 RSR31228 2004-Sep-13 12:12:35 C:\My Documents\Wrightsoft HVAC...

Return Branch Detail Table

Name	Grill Size (in)	Htg (cfm)	Clg (cfm)	TEL (ft)	Design FR	Veloc (fpm)	Diam (in)	RectSize (in)	Stud/Joist Opening (in)	Duct Matl	Trunk
rb1	0x0	960	960	91.0	0.026	543	18	0x 0		ShMt	rt1

Return Trunk Detail Table

Name	Trunk Type	Htg (cfm)	Clg (cfm)	Design FR	Veloc (fpm)	Diam (in)	Rect Duct Size (in)	Duct Material	Trunk
rt1	Peak AVF	960	960	0.026	543	18	0 x 0	ShtMetl	

Duct System Summary
Entire House
Sabbatical Project

Job:
Date: March 2004
By: Darrow P. Soares

Mount San Antonio College, March 2004,

Project Information

For: Habitat for Humanity
786 Draciea, Redlands, CA

	Heating		Cooling	
External static pressure	0.08	in H2O	0.08	in H2O
Pressure losses	0.00	in H2O	0.00	in H2O
Available static pressure	0.08	in H2O	0.08	in H2O
Supply / return available pressure	0.06 / 0.02	in H2O	0.06 / 0.02	in H2O
Lowest friction rate	0.026	in/100ft	0.026	in/100ft
Actual air flow	960	cfm	960	cfm
Total effective length (TEL)		304 ft		

Supply Branch Detail Table

Name	Design (Btuh)	Htg (cfm)	Clg (cfm)	Design FR	Diam (in)	Rect Size (in)	Duct Matl	Actual Ln (ft)	Ftg.Eqv Ln (ft)	Trunk
Living room-A	h 3264	219	152	0.031	10	0x 0	ShMt	48.0	130.0	st2
Living room	h 3264	219	152	0.033	10	0x 0	ShMt	40.0	130.0	st2
Family bath	h 1238	83	70	0.037	7	0x 0	ShMt	5.0	145.0	st1
Matser Bedroom-A	c 2317	59	125	0.026	8	0x 0	ShMt	18.0	195.0	st1
Matser Bedroom	c 2317	59	125	0.030	8	0x 0	ShMt	26.0	160.0	st1
Master Bath	c 47	3	3	0.033	4	0x 0	ShMt	10.0	160.0	st1
Dining	h 818	55	29	0.035	6	0x 0	ShMt	21.0	140.0	st2
Kitchen	c 2296	106	124	0.032	8	0x 0	ShMt	9.0	165.0	st2
Bedroom 1	c 1597	73	87	0.032	7	0x 0	ShMt	27.0	150.0	st2
Bedroom 2	c 1703	84	92	0.032	7	0x 0	ShMt	17.0	160.0	st2

Supply Trunk Detail Table

Name	Trunk Type	Htg (cfm)	Clg (cfm)	Design FR	Veloc (fpm)	Diam (in)	Rect Duct Size (in)	Duct Material	Trunk
st1	Peak AVF	205	325	0.026	413	12	0 x 0	ShtMetl	
st2	Peak AVF	755	635	0.031	541	16	0 x 0	ShtMetl	

Component Constructions
Entire House
Sabbatical Project

Job:
Date: March 2004
By: Darrow P. Soares

Mount San Antonio College, March 2004,

Project Information

For: Habitat for Humanity
786 Draciea, Redlands, CA

Design Conditions

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Redlands, CA, US
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Latitude: 34°N

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Daily range (°F)	-	33 (H)
Wet bulb (°F)	-	69
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	37	24
Relative humidity (%)	30	50
Moisture difference (gr/lb)	11.1	-4.3

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation	n	136	0.091	13.0	3.37	458	2.18	297
	e	379	0.091	13.0	3.37	1276	2.18	828
	s	32	0.091	13.0	3.37	108	2.18	70
	w	374	0.091	13.0	3.37	1259	2.18	817
	all	921	0.091	13.0	3.37	3101	2.18	2011
Partitions								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation		312	0.091	13.0	3.37	1051	1.28	400
Windows								
1D-c2ob: Operable, metal frame with break, clear glass, 2 pane	n	32	0.650	0.0	24.0	770	29.3	937
	e	48	0.650	0.0	24.0	1154	79.7	3825
	w	26	0.650	0.0	24.0	625	79.7	2072
	all	106	0.650	0.0	24.1	2549	64.5	6833
Doors								
11D0: Wood door, solid core, no storm	e	21	0.390	0.0	14.4	303	11.3	238
Ceilings								
16B-30ad: Ceiling under vented attic, no radiant barrier, dark shingles, R-30 insulation		1107	0.032	30.0	1.18	1311	1.68	1860
Floors								
19C-19cscp: Carpeted floor over tight enclosed crawl, R-11 wall, R-19 blanket		1107	0.049	19.0	0.63	696	0.41	451

Project Summary
Entire House
Sabbatical Project

Job:
Date: March 2004
By: Darrow P. Soares

Mount San Antonio College, March 2004,

Project Information

For: Habitat for Humanity
786 Draciea, Redlands, CA

Notes: A Project for Sabbatical Leave for the AIRC Department. Mount San Antonio College

Design Information

Weather: Redlands, CA, US

Winter Design Conditions

Outside db	33	°F
Inside db	70	°F
Design TD	37	°F

Summer Design Conditions

Outside db	99	°F
Inside db	75	°F
Design TD	24	°F
Daily range	H	
Relative humidity	50	%
Moisture difference	-4	gr/lb

Heating Summary

Structure	13306	Btuh
Ducts	1013	cfm
Central vent (45 cfm)	1732	Btuh
Humidification	0	Btuh
Piping	0	Btuh
Equipment load	16051	Btuh

Infiltration

Method	Simplified
Construction quality	Average
Fireplaces	0

	Heating	Cooling
Area (ft²)	1107	1107
Volume (ft³)	8857	8857
Air changes/hour	0.75	0.35
Equiv. AVF (cfm)	111	52

Sensible Cooling Equipment Load Sizing

Structure	17725	Btuh
Ducts	2281	Btuh
Central vent (45 cfm)	1124	Btuh
Blower	0	Btuh
AED excursion	0	Btuh
Use manufacturer's data	n	
Rate/swing multiplier	1.04	
Equipment sensible load	19603	Btuh

Latent Cooling Equipment Load Sizing

Structure	855	Btuh
Ducts	-103	Btuh
Central vent (45 cfm)	-126	Btuh
Equipment latent load	626	Btuh
Equipment total load	20229	Btuh
Req. total capacity at 0.70 SHR	2.3	ton

Heating Equipment Summary

Make	Carrier
Trade	WeatherMate 38AYC
Model	38AYC03033

Efficiency	7.5	HSPF
Heating input		
Heating output	29400	Btuh @ 47°F
Temperature rise	29	°F
Actual air flow	960	cfm
Air flow factor	0.067	cfm/Btuh
Static pressure	0.08	in H2O
Space thermostat		

Cooling Equipment Summary

Make	Carrier
Trade	WeatherMate 38AYC
Cond	38AYC03033
Coil	CK5A/CK5BW036+TDR

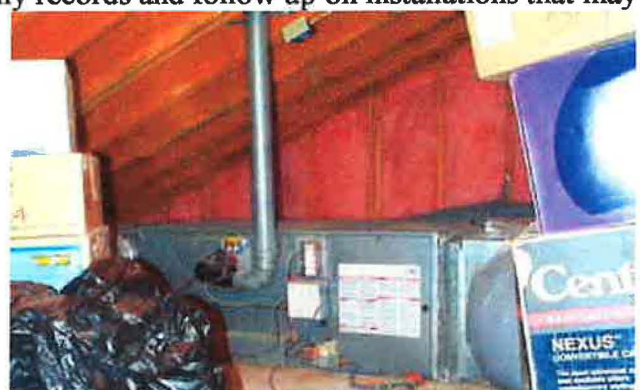
Efficiency	11	SEER
Sensible cooling	20160	Btuh
Latent cooling	8640	Btuh
Total cooling	28800	Btuh
Actual air flow	960	cfm
Air flow factor	0.054	cfm/Btuh
Static pressure	0.08	in H2O
Load sensible heat ratio	0.97	

Printout certified by ACCA to meet all requirements of Manual J 8th Ed.

Furnace Recall

The Background

Soon after beginning my sabbatical leave I reactivated my contractor's license. I was quickly notified of an equipment recall that involved gas-fired furnaces installed between 1983 and 1994. This notice requested me, as a C-20 HVAC contractor, to check my records and follow up on installations that may be effected. 190,000 recalled furnaces were installed in California homes (Oldham, 2000). All were manufactured by Indiana-based Consolidated Industries. They were sold under brand names that include Premiere, Sears, Bard, Coleman, Kenmore and Heatmaster. After reviewing my records, I was able to identify 19 furnaces installed by my company, Central Air Contracting and Mechanical. Of the 19 installed, four were still in operation.



The Bender furnace was located dangerously close to combustible material

In California, the Consolidated furnaces have been tied to at least 31 fires, but no deaths or serious injuries (Sorza, 2001). Fires have been reported throughout Orange County, including Irvine, Yorba Linda, Coto de Caza, Foothill Ranch and Laguna Niguel. The U.S. Consumer Product Safety Commission (CPSC) has known since the mid 1990s that the heaters were faulty, but didn't issue the warning until September of 2000. A formal recall went into effect July of 2001. By that time the normal five year warranty on the heat exchangers had expired on most of the furnaces. As a result, it was difficult to assign responsibility of contacting the building owners to alert them of the danger.

The Bender furnace showed signs of flame roll-out caused by a cracked heat exchanger

As with any recall or with any hazardous product, the CPSC wanted to negotiate some kind of repair, replacement or refund with Consolidated Industries. But, the negotiations dragged on for years, complicated by class-action lawsuits. Before any remedy could be found, Consolidated Industries went out of business, filed for bankruptcy and liquidated its assets. News of the recall had to be circulated through the media, or the installing contractor.

There were two main problems with the furnaces. First, a coating on the burner designed for high temperature protection was damaged during the manufacturing process . Second, NOx rods added to the furnace burner assembly to meet California's stringent air-quality standards actually radiated heat to the damaged coating and the heat exchanger. The NOx rods caused heat exchanger temperatures to exceed that allowable for the materials. Over time, the heat exchanger cracked, and circulating air

The Habitat furnace had a major rupture in the heat exchanger, but no sign of flame roll-out

was allowed to pressurize the heat exchanger and push the flames out of the furnace. Combustible material, including wood flooring allowed by Uniform Mechanical Code, caught fire and homes were destroyed.

In a study conducted by the Consumer Product Safety Commission (1999) in Washington DC, 96 furnaces were selected at random from the western United States. The majority (85.5 %) of the 100,000 BTU burners with NOx rods had at least some degree of heat exchanger cracking. One quarter (25.9%) of the burners were in the final stage of full failure. But for the non-NOx rod units, 100% of the burners had no cracking How long the furnace lasts before it fails depends on how much it is used. According to the study, heat exchangers break down faster in Northern California because the weather is cooler.

NOx rods on the Habitat furnace were clearly fatigued

The furnaces involved in the recall were identified by their model numbers. The recalled Consolidated furnaces had the following pattern: HCCIOONDSRX (Grossberg, 2001)

- **HCC** stands for Horizontal, Model C and Cold rolled steel exchanger. (Models with aluminized steel heat exchangers used the designation "A" instead of "C".)
- The number **100** is the BTU rating in thousands. The recalled furnaces ranged from 40,000 to 100,000 BTU input.
- **N** is natural gas.
- **DS** is control type.

- **R** identifies the use of a relay for blower operation.
- **X** designates the application of Nox rods.

The Application

Between 1987 and 1990 my contracting company, Central Air Contracting and Mechanical, installed 14 furnaces matching the Model number. In all cases, I had records on the installations and was able to contact the occupants. Contact was made either in person or by phone if the original occupant was available. Of the furnaces installed by my contracting company, four had not been replaced and were still in operation. They included the following installations:

The Gant furnace showed no signs of heat exchanger fatigue, but the model number matched the recall.

The Gant Dance Studio	1345 Belvedere. Riverside, Ca.	Installed November, 1989
Bill Bender Construction	3430 Overlook. Riverside, Ca.	Installed November, 1989
Habitat for Humanity	6231 Evans Street. Riverside, Ca.	Installed May, 1990
Corydon Construction	1345 Hollyhock. Hemet, Ca.	Installed December, 1990

Of the four, only the Gant Dance Studio was occupied by the original owner. The Bender, Corydon and Habitat homes had changed owners several times since the installation. I contacted the occupants through their address and arranged to inspect the furnaces. All four matched the recall model number. As a result, I coordinated the replaced of the furnaces and charged only for my cost of material.

Of the furnaces replaced, two had ruptured heat exchangers that may have resulted in fire and destruction of the home. The Bender home showed clear signs of flame roll-out on the wood platform it was placed on. The Habitat house showed no such signs even though its heat exchanger was ruptured. If space permitted, the replacement furnaces were hung from the roof rafters in order to be isolated from combustibles. The Corydon and Bender furnaces allowed this type of installation. The Gant and Habitat furnaces remained on their wood platforms, as allowed by the Uniform Mechanical Code.

The Bender replacement furnace was hung away from combustible material

Another concern of the recall was exposure to carbon monoxide (CO). These poisonous fumes could enter the home through the ruptured heat exchanger. A CO test conducted on the Bender and Habitat homes before the recalled furnaces were removed indicated low levels of CO. In the Bender home, a peak CO level of 7 parts of CO gas to million parts of Air (ppm) after 20 minutes

The Gant attic space was too confined to hang the replacement furnace

of operation was recorded. The Habitat home showed a peak CO level of 9 ppm after 20 minutes. By comparison, residential kitchens with gas stoves will show 3 to 8 ppm of CO to air while OSHA standards prohibit worker exposure to more than 50 ppm average during an 8 hour time period (Altouse).

The Corydon furnace was hung from rafters and hard duct attached to the existing air distribution system

Conclusion

The furnace recall was a good sabbatical opportunity. I was able to practice methods of installation taught in the AIRC 12 Building Codes class and the AIRC 34 Advanced Mechanical class. Practicing these methods in an uncontrolled lab environment will aid the teaching process. In addition, I was able to explore new methods of energy conservation through the installation and testing of high efficiency condensing furnaces. In all four cases, the recalled furnaces were rated at efficiencies of 70% . The Habitat and Gant furnaces were replaced with systems in the 80% efficiency range. In the case of the Bender and Corydon installations, the replacement furnaces were rated at efficiencies of 94%. In order to achieve this level, furnace construction and controls have been highly modified from earlier models.

Checking flame conditions for ruptured heat exchanger

The opportunity to install and test these furnaces will help teach these new technologies in the classroom.

The Habitat replacement furnace

Installing the replacement furnace at the Corydon home

Furnace Replacement Schedule

Bender Construction	3430 Overlook. Riverside, Ca.	Replaced January 8th-10th 2004
Habitat for Humanity	6231 Evans Street. Riverside, Ca.	Replaced January 15th -17th 2004
Gant Dance Studio	1345 Belvedere. Riverside, Ca.	Replaced February 19th & 20th 2004
Corydon Construction	1345 Hollyhock. Hemet, Ca.	Replaced March 10th & 11th 2004

Southwest Heating and Air Conditioning

The Background

Southwest Heating and Air Conditioning, in Ontario, California is a residential and commercial contracting and service company. Their services include installing, upgrading and repairing comfort cooling systems for both residential and commercial markets. My interest in Southwest Heating and Air Conditioning was their involvement with The Proctor Engineering Group (PEG), in San Rafael, California. PEG provides air conditioning design and energy efficiency evaluations for regional gas and utility companies. I worked with Southwest Heating and Air Conditioning in order to learn the PEG methods of evaluation and improve my own diagnostic methods used in the classroom at Mount San Antonio College.

The California Energy Commission (CEC) has long identified air conditioning systems as a major source of energy consumption in Southern California. During the cooling season, comfort cooling systems place a huge demand on utilities and compete for power with manufacturing and life support organizations. According to PEG, much of this consumption is due to waste caused by improper refrigerant charge and poor duct work installation (Proctor 1991). In their study, out of a sample of 175 air conditioning systems, 22% of the systems sampled were undercharged with refrigerant and 33% were over charged. Duct leakage exceeded 150 cubic feet per minute (CFM) in 98% of the systems tested. Their report suggests that the manner of equipment installation has a greater impact on operating efficiency than the Seasonal Energy Efficiency Rating (SEER) assigned to the equipment by the Air Conditioning and Refrigeration Institute (ARI). As a result, PEG identified a substantial potential for energy savings by developing a program that systematically checks and adjusts residential and commercial air conditioning systems. The adjustments made after the PEG analysis result in increased air distribution and equipment efficiency. A 1999 study reported a 13% peak savings on air conditioning systems adjusted using the PEG method (Neme).

The energy consumption and peak Kilowatt draw are based on the following values:

- .7 coincidence factor
- average size air conditioning unit in 2.5 ton category: 2 tons
- average size air conditioning unit in 3 to 5 ton category: 3.2 tons
- average residential air conditioning energy consumption in CEC Climate Zone 15
- average residential air conditioning energy consumption for 2 ton capacity @ 3260 kWh and 3.2 ton capacity @ 5216 kWh.
- Average system Energy Efficiency Rating (EER) 7

PEG has developed energy conservation plans with utility companies in Massachusetts and Nevada, The Sacramento Municipal Utility District, PG&E and Southern California Edison.

The Application

Air conditioning contractors participating in the PEG analysis and upgrades are required to fulfill eight hours of PEG specific training. Once completed, the contractor is free to market and solicit their services to specified geographic areas of need identified by PEG and Southern California Edison. The procedure is trade marked by PEG under the name CheckMe!®.

The participating contractor does not charge the home or business owner for the system analysis. The contractor is compensated for this serviced by Southern California Edison through PEG. If an upgrade or repair is recommended, however, a proposal is made by the air conditioning contractor and the home or business owner pays for their services.

To perform the initial analysis, the PEG trained technician uses a digital thermometer and accurate refrigerant gages to follow a systematic protocol to make readings on the air conditioning system. This requires measuring refrigerant superheat, subcooling and duct work temperature splits to verify the system operation and efficiency. The technician records the results and contacts PEG directly from the job site. With the technician on the line, operators with PEG run the numbers through a diagnostic data base program. The data base diagnoses problems with refrigerant charge and air flow and makes specific recommendations for how the technician should correct the problem. The technician then gives the customer price quote on the repairs required to improve the efficiency of the air conditioning system. Repairs range from a minor refrigerant charge adjustment to major duct work retrofit. The technician and customer discuss the cost of the repair to the benefit of the savings.

If the repairs are made, the unit is re-tested and the readings are submitted again to PEG. This report documents the post repair condition and the improvement in efficiency. Following the re-test, a certificate of service is sent to the customer. The certificate documents the improved efficiency and explains the results. The customer is also provided with a survey card to provide feedback to PEG and the utility that sponsored the project.

<u>The PEG Procedure through Southwest Heating and Air Conditioning</u>

I worked with Southwest Heating and Air Conditioning in April and May of 2003 and again in February of 2004. From April 14^{th} to April 18^{th}, I participated in an air

Two ten ton package units served the sanctuary at the First Methodist Church in Walnut, CA.

conditioning system analysis at the First Methodist Church and Nursery School in Walnut, CA. The analysis included the following equipment:

- two 10 ton 120,000 Btu/hr Lennox package heat pumps
- two 7.5 ton 90,000 Btu/hr Lennox split heat pumps
- four 3 ton 36,000 Btu/hr Lennox split heat pumps

Following, is one analysis: the 3 ton heat pump serving a zone on the nursery school.

The process began by applying electronic thermocouples to the suction and liquid refrigerant lines at the outdoor condensing unit.

Two 3 ton air conditioners are checked for saturation temperatures, superheat and subcooling.

The system was then operated in the cooling mode. With manifold gages attached to the refrigerant lines, data was collected from the condensing unit that included saturation temperatures, sensible superheat and subcooling temperatures of the refrigerant. This information was required to determine if the system had the proper refrigerant charge and was operating efficiently. The process continued by measuring the treatment of air as it passed across the evaporator coil. This was achieved by drilling holes in the supply and return air plenums, inserting thermometers and recording the dry bulb and wet bulb temperatures.

Service Manager Ralf Kies prepares to measure wet and dry bulb temperatures across the air handler.

Once all temperatures and readings were taken, we reported them to a PEG operator for analysis. If the refrigerant charge and airflow was correct, PEG and SCE would issue the Methodist Church a verification certificate indicating proper operation and no expense would be incurred on that system. If the air flow or refrigerant charge was not correct, Southwestern would sell the customers on the required repairs and then retest the equipment.

The insulation is removed and the duct sealed based on PEG procedure.

The results of the tests on the equipment serving one zone on the day care indicated a system problem involving the refrigerant charge. This was determined by calling in the data from the initial reading to a PEG representative. This data is indicated in region A on the Air Conditioner Data Entry Form.

CheckMe!® Air Conditioner Data Entry Form

CALL 1-(877)-243-2563 Toll Free for Data Entry or Technical Help

Se habla Español

Customer ID# 2412CA **Zip** 91789

Program: ____
New Install: ☐ Yes ☑ No **Title 24:** ☐ Yes ☐ No

Contractor: Southwest **Tech ID:** 5420
AC Information: Apt/Space/Suite # ____ AC# ____
☐ Dog Data Compressor # ____
☑ Initial Test ☐ Too Low to Test ☐ Test After Repair

Customer Information:
First & Last Name or Company: First Methodist Church
Attn: ____

Property Location:
Address: 20601 La Puente Road
City: Walnut State: CA Zip: ____
Phone: (909) 594 - 4228

Mail-To *(if different)*:
First & Last Name or Company: Same
Attn: ____
Address: ____
City: ____ State: ____ Zip: ____
Phone: (____) ____ - ____

Outdoor Unit Info: Make: Lennox
Model #: ____ ☐ Not Legible
Capacity: 36,000 btu/hr
AC Type: ☑ Split ☐ Package
Year Manufactured: ____ ☐ Not Legible

Dog Data *(measured values from existing unit)*:
Amps ____ Volts ____ Phase ____

Title 24 Info: Serial # ____
Calibration Dates: Gauge ____ Thermometer ____

CPUC Customer Information:
- Utility Acct. # ____ ☑ Not Avail.
- Tenant status: ☑ Owner ☐ Renter/Lessee
- Tenant Full Name: ____
- Customer has signed authorizatio...
- Language preference: ☑ English...
- Mobile Home: ☐ Yes ☑ No

Commercial Jobs: # of employees...

Test Information:
Minutes AC running: Before Initial ...
Since Repairs Made ____
Refrigerant Type: ☑ R-22 ☐ R-410a
TrueFlow Meter: ☐ Yes ☐ No
High Side Port: ☐ Yes ☐ No
Metering Device Type: ☐ Non-TXV (superheat) ☐ TXV/Lennox Non-TXV (sub-cooling) ☑ Lennox TXV (approach)
Target Sub-cooling/Approach ____

Area A indicates the initial data required to determine refrigerant charge and system operation.

Temperatures/Pressures:	Initial Test	Test After Repairs
Condenser Air Entering Temp	85°	
Return Air Wet Bulb Temp	68°	
Return Air Dry Bulb Temp	78°	
Supply Air Dry Bulb Temp	63°	
Suction Line Temp	68°	
Evaporator Saturation Temp	30°	
Condenser Saturation Temp	105°	
Liquid Line Temp	86°	
Suction (low side) Pressure	55 psig	
Discharge (high side) Pressure	210 psig	

A

TrueFlow Plate(s): ☐ Single ☐ Multiple
AC Nominal Tons: 3 tons

TrueFlow Measurements:	Initial Test		Test After Repairs	
Normal Supply Pressure				
TrueFlow Test Supply Pressure				
TrueFlow Plate Number	14	20	14	20
TrueFlow Plate Pressure				
TrueFlow Plate Measured Airflow				

INITIAL TEST / TEST AFTER REPAIR RESULTS

Refrigerant Charge: *(circle one)* • Undercharge / Undercharge • Correct / Correct • Overcharge / Overcharge
Actual Superheat / Subcooling / Approach ____ / ____ **Target Superheat / Subcooling/Approach** ____ / ____

Airflow: *(circle)* • Low Airflow / Low Airflow • Correct Airflow / Correct Airflow • Low Temp Drop / Low Temp Drop
If Temp. Split Method: **Actual Temperature Drop** ____ / ____ **Target Temperature Drop** ____ / ____
If TrueFlow Method: **Airflow** (reported by CheckMe!): **Initial** ____ cfm/ton **After Repairs** ____ cfm/ton

IF A REPAIR WAS MADE: Factory Stamped Refrigerant Charge: Pounds ____ Ounces ____ ☐ Not Legible
Refrigerant Charge Adjustment: Actual Ounces Added ____ Actual Ounces Removed ____
Airflow Correction: *(check all applicable)* ☐ Opened Registers ☐ Cleaned/Replaced Filter ☐ Changed Blower Speed ☐ Cleaned Blower ☐ Cleaned Evaporator Coil ☐ Modified Ducts

Evaporator Saturation Temperature from the Suction Line Temperature. Based on the Data Entry Form, superheat on this system is 38°. The Target Superheat, however, can

Table 1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser, db}$)	Return Air Wet-Bulb Temperature (°F) ($T_{return, wb}$)																										
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
55	8.8	10.1	11.5	12.8	14.2	15.6	17.1	18.5	20.0	21.5	23.1	24.6	26.2	27.8	29.4	31.0	32.4	33.8	[illegible]	36.4	37.7	39.0	40.2	41.5	42.7	43.9	45.0
56	8.6	9.9	11.2	12.6	14.0	15.4	16.8	18.2	19.7	21.2	22.7	24.2	25.7	27.3	28.9	30.5	31.8	33.2	[illegible]	35.9	37.2	38.5	39.7	41.0	42.2	43.4	44.6
57	8.3	9.6	11.0	12.3	13.7	15.1	16.5	17.9	19.4	20.8	22.3	23.8	25.3	26.8	28.3	29.9	31.3	32.6	[illegible]	35.3	36.7	38.0	39.2	40.5	41.7	43.0	44.2
58	7.9	9.3	10.6	12.0	13.4	14.8	16.2	17.6	19.0	20.4	21.9	23.3	24.8	26.3	27.8	29.3	30.7	32.1	[illegible]	34.8	36.1	37.5	38.7	40.0	41.3	42.5	43.7
59	7.5	8.9	10.2	11.6	13.0	14.4	15.8	17.2	18.6	20.0	21.4	22.9	24.3	25.7	27.2	28.7	30.1	31.5	[illegible]	34.3	35.6	36.9	38.3	39.5	40.8	42.1	43.3
60	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.1	29.6	31.0	[illegible]	33.7	35.1	36.4	37.8	39.1	40.4	41.6	42.9
61	6.5	7.9	9.3	10.7	12.1	13.5	14.9	16.3	17.7	19.1	20.5	21.9	23.3	24.7	26.1	27.5	29.0	30.4	[illegible]	33.2	34.6	35.9	37.3	38.6	39.9	41.2	42.4
62	6.0	7.4	8.8	10.2	11.7	13.1	14.5	15.9	17.3	18.7	20.1	21.4	22.8	24.2	25.5	27.0	28.4	29.9	[illegible]	32.7	34.1	35.4	36.8	38.1	39.4	40.7	42.0
63	5.3	6.8	8.3	9.7	11.1	12.6	14.0	15.4	16.8	18.2	19.6	20.9	22.3	23.6	25.0	26.4	27.8	29.3	[illegible]	32.2	33.6	34.9	36.3	37.7	39.0	40.3	41.6
64	-	6.1	7.6	9.1	10.6	12.0	13.5	14.9	16.3	17.7	19.0	20.4	21.7	23.1	24.4	25.8	27.3	28.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
65	-	5.4	7.0	8.5	10.0	11.5	12.9	14.3	15.8	17.1	18.5	19.9	21.2	22.5	23.8	25.2	26.7	28.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
66	-		6.3	7.8	9.3	10.8	12.3	13.8	15.2	16.6	18.0	19.3	20.7	22.0	23.2	24.6	26.1	27.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
67	-	-	5.5	7.1	8.7	10.2	11.7	13.2	14.6	16.0	17.4	18.8	20.1	21.4	22.7	24.1	25.6	27.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
68	-	-	-	6.3	8.0	9.5	11.1	12.6	14.0	15.5	16.8	18.2	19.5	20.8	22.1	23.5	25.0	26.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
69	-	-	-	5.5	7.2	8.8	10.4	11.9	13.4	14.8	16.3	17.6	19.0	20.3	21.5	22.9	24.4	26.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	-	-	-	-	6.4	8.1	9.7	11.2	12.7	14.2	15.7	17.0	18.4	19.7	20.9	22.3	23.9	25.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	-	-	-	-	5.6	7.3	8.9	10.5	12.1	13.6	15.0	16.4	17.8	19.1	20.3	21.7	23.3	24.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	-	-	-	-	-	6.4	8.1	9.8	11.4	12.9	14.4	15.8	17.2	18.5	19.7	21.2	22.8	24.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	-	-	-	-	-	5.6	7.3	9.0	10.7	12.2	13.7	15.2	16.6	17.9	19.2	20.6	22.2	23.8	[illegible]	26.9	28.5	30.0	31.5	33.1	34.6	36.0	37.5
74	-	-	-	-	-	-	6.5	8.2	9.9	11.5	13.1	14.5	15.9	17.3	18.6	20.0	21.6	23.2	[illegible]	26.4	28.0	29.5	31.1	32.6	34.1	35.6	37.1
75	-	-	-	-	-	-	5.6	7.4	9.2	10.8	12.4	13.9	15.3	16.7	18.0	19.4	21.1	22.7	[illegible]	25.9	27.5	29.1	30.6	32.2	33.7	35.2	36.7
76	-	-	-	-	-	-	-	6.6	8.4	10.1	11.7	13.2	14.7	16.1	17.4	18.9	20.5	22.1	[illegible]	25.4	27.0	28.6	30.1	31.7	33.3	34.8	36.3
77	-	-	-	-	-	-	-	5.7	7.5	9.3	11.0	12.5	14.0	15.4	16.8	18.3	20.0	21.6	[illegible]	24.9	26.5	28.1	29.7	31.3	32.8	34.4	36.0
78	-	-	-	-	-	-	-	-	6.7	8.5	10.2	11.8	13.4	14.8	16.2	17.7	19.4	21.1	[illegible]	24.4	26.0	27.6	29.2	30.8	32.4	34.0	35.6
79	-	-	-	-	-	-	-	-	5.9	7.7	9.5	11.1	12.7	14.2	15.6	17.1	18.8	20.5	[illegible]	23.8	25.5	27.1	28.8	30.4	32.0	33.6	35.2
80	-	-	-	-	-	-	-	-	-	6.9	8.7	10.4	12.0	13.5	15.0	16.6	18.3	20.0	[illegible]	23.3	25.0	26.7	28.3	29.9	31.6	33.2	34.8
81	-	-	-	-	-	-	-	-	-	6.0	7.9	9.7	11.3	12.9	14.3	16.0	17.7	19.4	[illegible]	22.8	24.5	26.2	27.9	29.5	31.2	32.8	34.4
82	-	-	-	-	-	-	-	-	-	5.2	7.1	8.9	10.6	12.2	13.7	15.4	17.2	18.9	[illegible]	22.3	24.0	25.7	27.4	29.1	30.7	32.4	34.0
83	-	-	-	-	-	-	-	-	-	-	6.3	8.2	9.9	11.6	13.1	14.9	16.6	18.4	[illegible]	21.8	23.5	25.2	26.9	28.6	30.3	32.0	33.7
84	-	-	-	-	-	-	-	-	-	-	5.5	7.4	9.2	10.9	12.5	14.3	16.1	17.8	[illegible]	21.3	23.0	24.8	26.5	28.2	29.9	31.6	33.3
85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.0	20.8	22.6	24.3	26.0	27.8	29.5	31.2	32.9
86	-	-	-	-	-	-	-	-	-	-	-	5.8	7.8	9.6	11.3	13.2	15.0	16.7	[illegible]	20.3	22.1	23.8	25.6	27.3	29.1	30.8	32.6
87	-	-	-	-	-	-	-	-	-	-	-	5.0	7.0	8.9	10.6	12.6	14.4	16.2	18.0	19.8	21.6	23.4	25.1	26.9	28.7	30.4	32.2
88	-	-	-	-	-	-	-	-	-	-	-	-	6.3	8.2	10.0	12.0	13.9	15.7	17.5	19.3	21.1	22.9	24.7	26.5	28.3	30.1	31.8
89	-	-	-	-	-	-	-	-	-	-	-	-	5.5	7.5	9.4	11.5	13.3	15.1	17.0	18.8	20.6	22.4	24.3	26.1	27.9	29.7	31.5
90	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	8.8	10.9	12.8	14.6	16.5	18.3	20.1	22.0	23.8	25.6	27.5	29.3	31.1

Tables 1 and 2 are provided to determine system performance prior to calling PEG operator.

be found on the table below based on the conditions the air conditioning system is operating under. In this case, the target superheat is 19°. Since the actual superheat

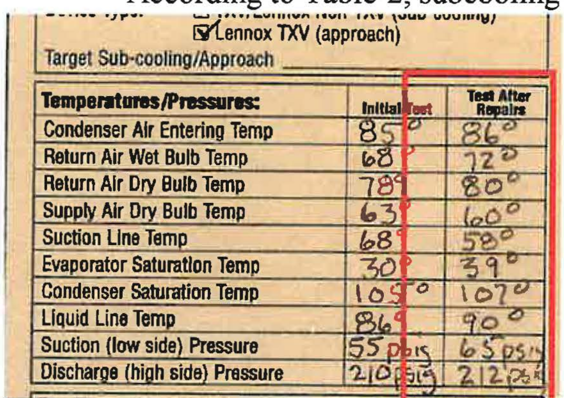
Table 2—Required Liquid-Line Temperature

PRESSURE (PSIG) AT SERVICE FITTING	REQUIRED SUBCOOLING TEMPERATURE (°F)					
	0	5	10	15	20	25
134	76	71	66	61	[illegible]	51
141	79	74	69	64	[illegible]	54
148	82	77	72	67	[illegible]	57
156	85	80	75	70	[illegible]	60
163	88	83	78	73	[illegible]	63
171	91	86	81	76	[illegible]	66
179	94	89	84	79	[illegible]	69
187	97	92	87	82	[illegible]	72
196	100	95	90	85	[illegible]	75
205	103	98	93	88	[illegible]	78
214	[illegible]	[illegible]	[illegible]	[illegible]	86	81
223	109	104	99	94	89	84
233	112	107	102	97	92	87
243	115	110	105	100	95	90
253	118	113	108	[illegible]	[illegible]	[illegible]
264	121	116	111	[illegible]	[illegible]	[illegible]
274	124	119	114	[illegible]	[illegible]	[illegible]
285	127	122	117	[illegible]	[illegible]	[illegible]
297	130	125	120	[illegible]	[illegible]	[illegible]
309	133	128	123	[illegible]	[illegible]	[illegible]
321	136	131	126	121	116	111
331	139	134	129	124	119	114
346	142	137	132	127	122	117
359	145	140	135	130	125	120

Actual subcooling on the Data Entry Form appears normal to the required subcooling on Table 2

is considerably higher than expected, this may indicate a starved evaporator on the low side of the air conditioning system. More information is required. The next step was to analyze the subcooled conditions of the refrigerant as it exited the condenser. Again, specific numbers from the Air Conditioner Data Entry Form were applied to Table-2 made available through PEG.

According to Table-2, subcooling exiting the condenser was within range. As a result, it appeared the low side of the system was starved of refrigerant while the high side was operating normally. The result of these conditions was a lack of cooling. While this type of air conditioner is expected to remove 20° of sensible temperature between the supply and return air, this system was only removing 15°. These symptoms would not be solved by simply adding or removing refrigerant. The problem was a restriction in the refrigerant metering device attached to the evaporator coil. When this occurs, refrigerant remains on the high side of the system and does not flow to the low side. With larger condenser surface areas, the problem may not show up on the high side of the system until the conditions became extreme. Our diagnosis was confirmed by calling the PEG operator. As a result, the refrigerant was recovered, the restriction removed and the system was put back in operation.


☑ Lennox TXV (approach)

Target Sub-cooling/Approach

Temperatures/Pressures:	Initial Test	Test After Repairs
Condenser Air Entering Temp	85°	86°
Return Air Wet Bulb Temp	68°	72°
Return Air Dry Bulb Temp	78°	80°
Supply Air Dry Bulb Temp	63°	60°
Suction Line Temp	68°	58°
Evaporator Saturation Temp	30°	39°
Condenser Saturation Temp	105°	107°
Liquid Line Temp	86°	90°
Suction (low side) Pressure	55 psig	65 psig
Discharge (high side) Pressure	210 psig	212 psig

Detail of the Air Conditioner Data Entry Form shows the new operating conditions.

The diagnostic process, repair and retest of this system lasted 4.5 hours. By the end of the week, Southwestern Heating and Air Conditioning had applied the PEG process to all the air conditioning equipment at the First Methodist Church. In addition to the restriction found on the day care system, others were low on refrigerant and one required modifications to the duct work. First Methodist Church was given a proposal to repair or modify the other systems on their campus and the work was performed incrementally, based on available funding.

Application of the Pressure – Enthalpy Diagram

Plotting the conditions from the Air Conditioner Data Entry Form to a Pressure – Enthalpy (P.E.) diagram helps identify the value of the PEG process.

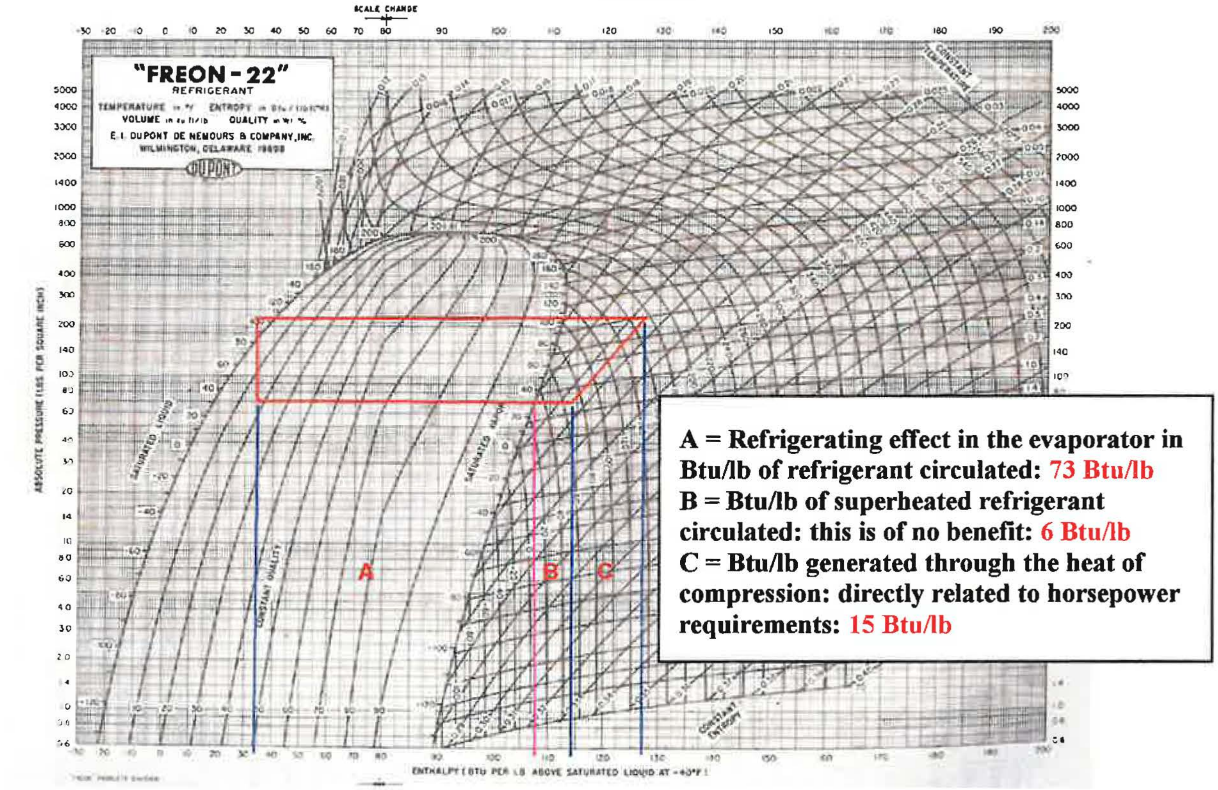
The P. E. diagram identifies the conditions of the refrigerant as it cycles through the components of an air conditioner or refrigeration system. Since the air conditioning industry has long known the state of refrigerant at each point in the cycle, abnormal conditions show clearly on P.E. diagram, when they exist. The information required to plot the cycle include the following conditions taken from an operating system:

The metering device is often deep in the equipment and difficult to repair.

- the condensing temperature
- the evaporating temperature
- subcooling exiting the condenser
- superheat entering the compressor

Each value is available from the Air Conditioner Data Entry Form and transferable to the P.E. diagram. Below, is the refrigeration cycle plotted on a PE diagram but taken from the original Data Entry Form.

Pressure-Enthalpy Diagram



From the P.E. diagram, the following information is available:

Mass flow rate required: m = 200/RE

Where: m = amount of refrigerant circulated in lbs per minute.
200 = Btu per minute per ton of refrigeration.
RE = Btu absorbed into the evaporator per minute (area A on the P.E. diagram).

2.74 lbs circulated per minute = 200/73

Horsepower requirements: Hp. = (H.C. X m) / 42.42

Where: Hp. = horsepower required to achieve the plotted conditions.
H.C. = Heat of compression (area C on the P.E. diagram).
m = amount of refrigerant circulated in lbs per minute.
42.42 = Btu per minute per horsepower.

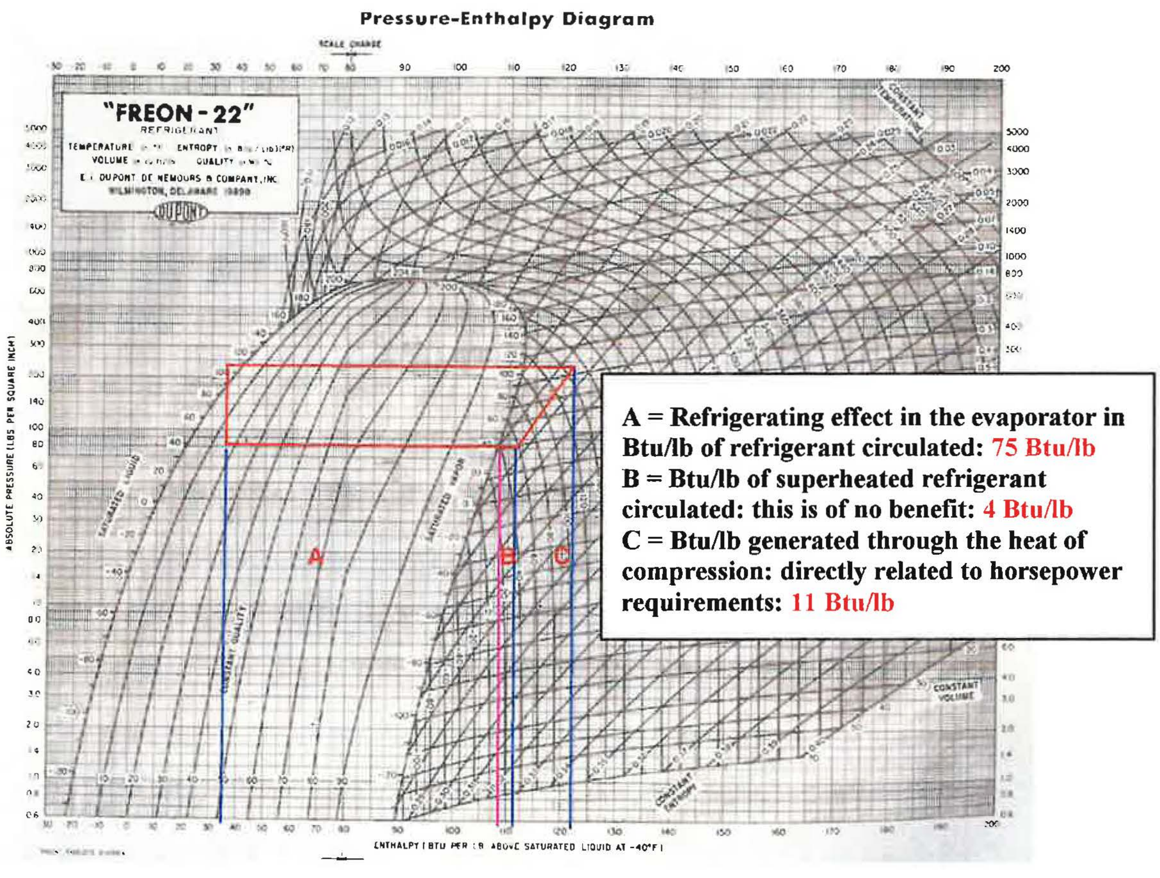
.97 Horsepower per ton = (15 X 2.74) / 42.4

Coefficient of Performance: COP = RE/H.C.

Where: COP = Coefficient of Performance
RE = Btu absorbed into the evaporator per minute (area A on the P.E. diagram).
H.C. = Heat of compression (area C on the P.E. diagram).

4.87 COP = 73/15

After the restriction to the metering device was removed and the refrigerant weighed back in, the new conditions were applied to the Air Conditioner Data Work Sheet and called into a PEG operator. PEG confirmed that the system was operating within its design parameters and a verification certificate was issued to First Methodist Church. Southwest Heating and Air Conditioning applied the new numbers from the Data Entry Form to a P.E. Diagram for comparison.



From the Revised P.E. diagram, the following information is available:

Mass flow rate required: m = 200/RE

Where: m = amount of refrigerant circulated in lbs per minute.
200 = Btu per minute per ton of refrigeration.

RE = Btu absorbed into the evaporator per minute (area A on the P.E. diagram).

2.67 lbs circulated per minute = 200/75

Horsepower requirements: Hp. = (H.C. X m) / 42.42

Where: Hp. = horsepower required to achieve the plotted conditions.
H.C. = Heat of compression (area C on the P.E. diagram).
m = amount of refrigerant circulated in lbs per minute.
42.42 = Btu per minute per horsepower.

.69 Horsepower per ton = (11 X 2.67) / 42.4

Coefficient of Performance: COP = RE/H.C.

Where: COP = Coefficient of Performance
RE = Btu absorbed into the evaporator per minute (area A on the P.E. diagram).
H.C. = Heat of compression (area C on the P.E. diagram).

6.82 COP = 75/11

Summary of Performance Changes

	Before Repair	After Repair	Change
Mass Flow Rate	**2.74**	**2.67**	**-3%**
Horsepower Requirements	**.89**	**.69**	**-29%**
Coefficient of Performance	**4.86**	**6.82**	**40%**

Conclusion

The California Energy Commission has long identified air conditioning systems as a major source of energy consumption on the nation's power grid. During the cooling season, comfort cooling systems place a huge demand on utilities and compete for power with all other electrical consumers. The Procture Engineering Group has found opportunity in this problem by developing the Checkme!® process of air conditioning diagnosis. Through a grant from utility companies, PEG covers the cost of the initial service call to residential and commercial customers. The participating contractor communicates the operating conditions to a PEG operator who then determines if the system requires modification. Income from all repairs goes to the contractor and nothing is shared with PEG or the utilities.

The day care system at First Methodist church exceeded the average savings in the Neme study (1999). This savings may not have been possible if the PEG Checkme!® program was not in place. Residential and commercial customers are more likely to allow the service if there is no initial cost for the service call and the program is sanctioned by their local utility.

The negative side of the PEG Checkme!® program is that it takes trouble shooting skills away from the contractor and service technician. In this program the operating conditions are analyzed by a third party and the diagnosis is then given to the technician working on the job site. As a result, I do not feel I improved my diagnostic skills by working with the PEG system. I did, however, confirm the methods we teach in the AIRC Department at Mount San Antonio College. I feel the successful students of our program are able to make any diagnosis I encountered without the aid of a PEG operator.

Service manager, Ralf Kies, performs PEG procedure

Checking the electrical windings of a hermitic compressor

Riverside Refrigeration

The Background

Riverside Refrigeration is a commercial contracting and service company. Their services include installing, upgrading and repairing commercial and institutional systems for existing manufacturing plants, schools, hospitals and vintage buildings. My interest in Riverside Refrigeration was their participation in system design for retrofit applications. This includes the replacement and upgrade of existing air conditioning systems in established buildings, often of historical status. In addition, I was interested in their involvement in automation and the use of CPC controls and their knowledge of the LonWorks system of communication between building automations systems and their associated controlled devices.

I was not compensated for my work with Riverside Refrigeration and operated under my own contractor's license.

The Application

My experience with Riverside Refrigeration was very diverse. As a subcontractor working under the contractor's license of Darrow P. Soares, I was awarded jobs that ranged from problem warranty calls to boiler retrofits that employees on payroll were unable to profitably complete. All of these projects were important to me since I found value in working with both tools and technology.

The initial job I worked with was a warranty call on a senior housing project in Corona, California. The air conditioning system for The Town Meadows was a combination of package air conditioning systems and a chilled water system with fan coils serving 35 original units built in the early 1970s. The complex had expanded many times since then and the air conditioning was a patchwork of many brands and systems. Recently, Riverside had upgraded the chilled water system. The complaint was a lack of cooling in a section of the complex serving seven units. It appeared that a loop in the chilled water system was starved of water flow. The problem was originally considered a control matter, but it quickly evolved into an issue of plumbing design.

The air conditioning systems at the Town Meadows are controlled by a CPC Reflects BCU and roof top ARTCs serving the package air conditioners. The system is accessible on site through a 20-key key pad or remotely using the Windows based program UltraSite. By viewing the system summary screens through UltraSite, all the information concerning the roof top and chiller controllers was available. Through the status screens, the status of each component associated with the chiller was specifically viewed. This included the status of each thermostat and diverter valve associated with the chilled water coils. By remotely forcing the diverter valves to activate, we watched the supply air temperature react. What we found was that valves in the problem loop were operating in reverse of their intended purpose. On a call for cooling, water was diverted around the coil and when there was no demand, the coil had full flow. This had not been an issue earlier since the

Reconfigured fan coils

automation system had put the chilled water system on winter set back. As a result, the water temperature was not low enough for the residents to notice the malfunction during the mild conditions.

For two weeks in April of 2003, the mixing valves to the troubled fan coil units

were replaced and the plumbing was reconfigured to maximize water flow. The difficulty was working in occupied apartments where set up and meticulous clean up required more time than the actual plumbing. What started out as an automation issue, evolved into a retrofit plumbing installation demanding extra customer care for elderly residences.

Another project was a boiler retrofit at the First Congregational Church in down town Riverside. The church has been using a low pressure steam boiler system to heat the entire structure since 1917. The existing boiler was installed in 1968, but it uses the same distribution design from the original installation.

The boiler is located in the basement of the church. When the boiler fires, it produces steam at 15 psig. The steam naturally rises to the upper levels of the church were fan coils distribute the heat to various zones. As the heat is dissipated from the fan coils, the steam condenses into a subcooled liquid and returns to the boiler to be reheated and repeat the cycle.

According to the Church Sexton, the boiler has been unreliable for many years. On a call for heat, the boiler often becomes "water logged" and fails on safety. The sexton has had to drain the boiler down numerous times a week during high heating demand conditions, requiring hours if the system was cold.

Preparing to replace a check valve and install a condensate pump and receiver

An analysis of the system determined the problem. A check valve in the condensate return line had rusted permanently open. This allowed steam at 15 psig to enter the condensate return and forced the subcooled liquid to back up and not return to the boiler. As a result, the boiler continuously called for water make up since none was returning through the natural process. Once the boiler was shut down at the end of a church service, the boiler pressure would dissipate and all the subcooled water would then return in full force and over fill the boiler. On the next call for heat the system would be off on safety.

The solution was to replace the check valve and install a condensate return pump and receiver. The purpose of the return pump and receiver was to give the condensate a reliable and controlled location to be stored before returning to the boiler. The original design held the condensate in the pipes where it was allowed to back up against the check valve. With normal water treatment, this may not have been and issue. Nonprofit organizations, however, are not diligent with scheduled maintenance. The pump and receiver was installed and the logging discontinued.

Other projects with Riverside Refrigeration involved routine maintenance and repair of air conditioning systems and air balance. Through all of these projects I gained valuable experience working with both the traditional tools and different automated systems. I was also re-exposed to the culture of labor. If I only learned one lesson from my experience, it would be my appreciation for my job at Mount San Antonio College.

Taking readings for an air balance

Checking the operation of package air conditioner

Honeywell TotalZone

The Background.

My interest in zone control for air conditioning stems from my interest in energy efficient methods for comfort cooling. I have attended many seminars in zoning sponsored by Honeywell controls and have been interested in the concept for many years. My interest peaked during my involvement in the Customer Assurance Department at Southern California Air Conditioner Distributors (SCACD). After working with contractors and answering their technical questions regarding Honeywell zoned systems, I was determined to design and install zone control systems of my own.

The TotalZone System

The basic principle of any zone control is to allow one central air conditioning system to be controlled by multiple thermostats. With the addition of zoning, specific areas of buildings or homes are able to thermally set up or back individual areas based on temperature or occupancy. Zone control makes a common air conditioning system more efficient by concentrating the unit's capacity only where and when it is needed. Air conditioning efficiency can be further increased by downsizing the capacity. Downsizing requires a heat load calculation by which the building envelope load is compared to the heat load diversity. If the heat load consistently spikes in predictable zones, downsizing may be an option.

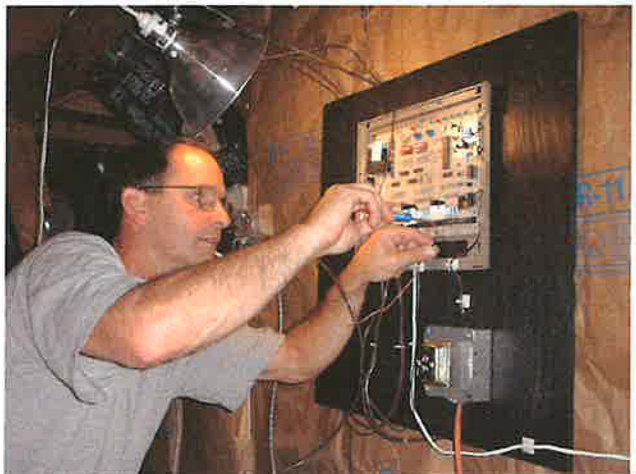
In order to successfully accomplish zone control, a rigorous heat load calculation must be performed. Then, if zoning applies, specific components must be added to the conventional air conditioning system to achieve zoning.

The most obvious addition to a zone controlled systems are duct dampers. These are electrically driven dampers designed direct air to zones only when called for by a zone thermostat. Honeywell designs two basic types of dampers: round for residential applications and rectangular for commercial installations. Both are non modulating, two position dampers, that are power opened and spring closed. Supply air dampers are designed to be mounted in the supply air duct for low pressure applications.

Duct dampers before installation

Dedicated thermostats control the temperature in each zone. Programmable thermostats are most commonly used since they offer options in the form of energy savings and reduced equipment cycling. These options include four time periods and temperature set points for each day schedule and different schedules for each day of the week. The most impressive feature of programmable thermostats is the ability for soft temperature recovery. Recovery occurs at the end of a set back period when the thermostat increases the temperature set point from the energy savings to the comfort temperature. Recovery requires the equipment to run continuously in order to reach the comfort temperature. Over a period of eight days from installation, the Honeywell thermostats like the T8635L, T8601D, and others, adapt from experience. Each time the thermostat calls for heating or cooling it checks how closely it hit the recovery target and adjusts the next recovery start time accordingly. This saves energy by avoiding cycling the equipment and overshooting the comfort temperature.

The zone control panel is the nerve center of a zone controlled system. The zone panel receives the request from the zone thermostat and communicates to the air conditioning system and zone dampers. Honeywell control panels like the TZ-4 and the EMM-3 use control logic of first come first serve. The first Zone thermostat calling for heat or cool is provided with the requested mode. If another zone, the zone control panel logs the request and will start a timing sequence that will allow the first zone to continue for a maximum of 20 minutes. If the current call is not satisfied within the 20 minute time period, the panel will temporarily terminate the first call; hold that one damper open for a field selectable time of 2 to 3.5 minutes in order to purge the duct, and then starting the opposite call for a maximum of 20 minutes, closing the dampers not calling. Most conventional zoning systems operate in this manner so that a dominant call from a zone cannot lock out the other zones or master the control system.



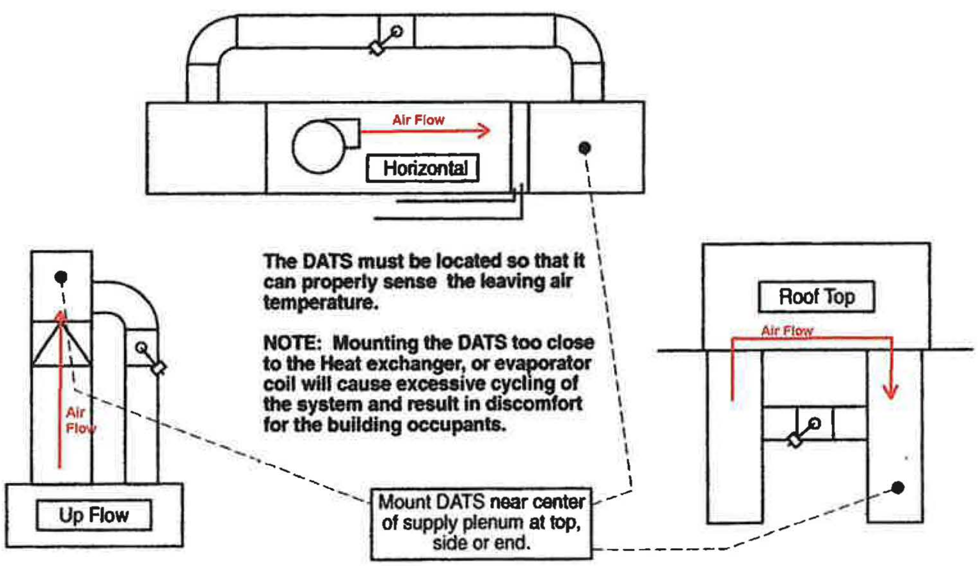
Zone thermostats are connected to the TZ-4 control panel

The counter weight is set on the bypass damper

By pass dampers are required on most conventional zone systems. If only one zone is calling for air conditioning, airflow across the evaporator would be reduced to a dangerous level and possibly damage the compressor. In the heating mode, low air flow can be just as damaging. As a result, provisions must be made to account for low air flow and possible mechanical damage in both modes. The by pass damper controls excess supply air during a single zone call by channeling it back to the return air plenum. Returning excess supply air from the supply plenum to the return air is achieved through the use of a barometric relief counterweight or an electronic static pressure control.

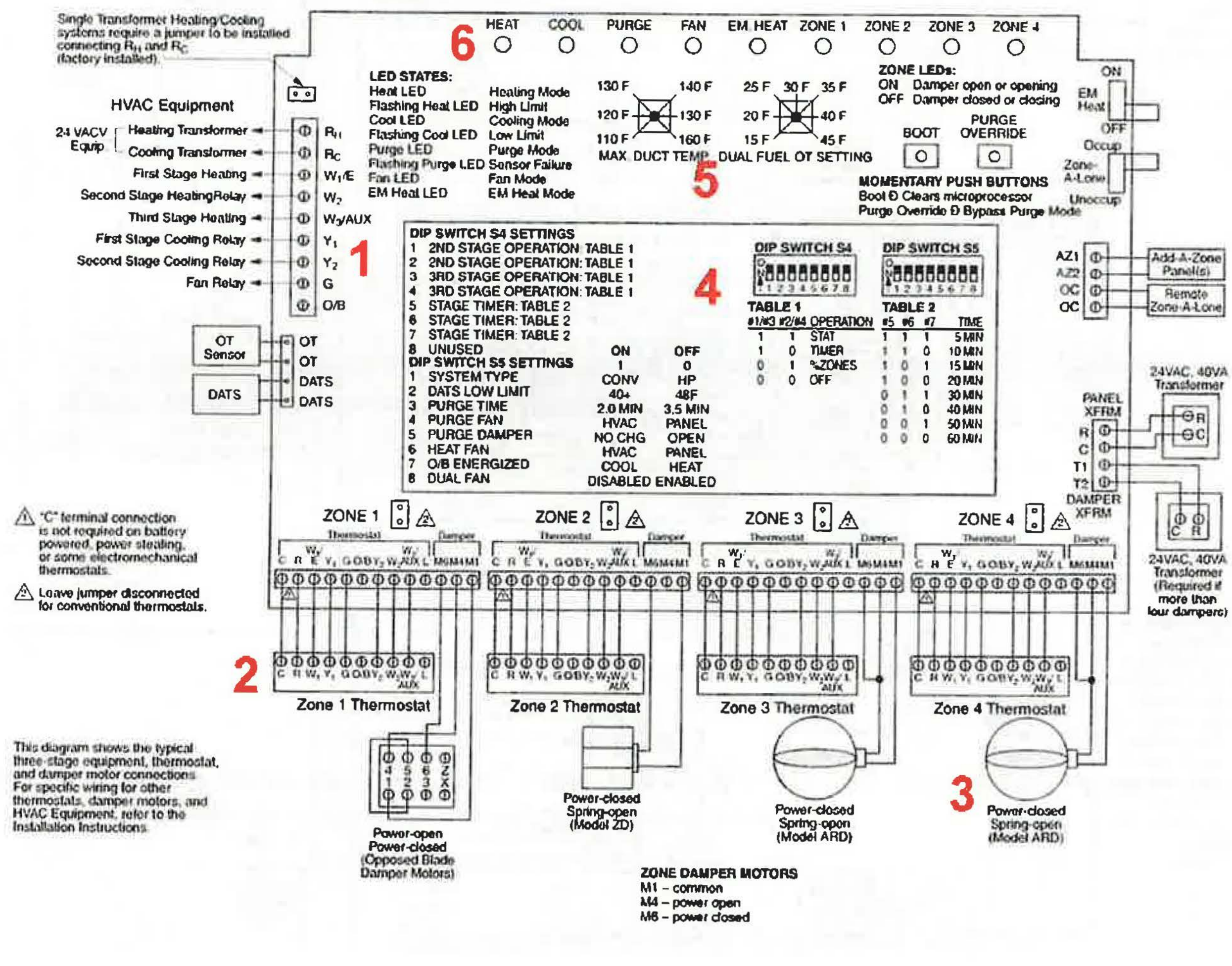
The bypass damper is installed in the supply duct to relieve duct pressure during low loads

In the event of excessive low load conditions, only one zone may call for heat or cooling. Under these conditions in the cooling mode, the by pass damper would circulate



Bypass damper and DAT locations for various duct configurations.

cold supply air directly into the return and reduce the loading effect on the evaporator. The opposite would occur in the heating mode; hot air from the supply plenum would by pass into the return, sending heat exchanger temperatures soaring. As a result, discharge air temperature sensors (DATS) are required in by-pass zoning applications. A discharge air sensor guards against freeze up of the evaporator coil in the cooling mode and excessive operating temperatures in the heating mode.



Methods of wiring equipment, thermostats, dampers and DAT to TZ4 control panel. References include: 1 Terminals for equipment functions. 2 Terminals to zone thermostats. 3 Junctions for zone dampers. 4 DIP switch banks 4 and 5 to establish system function. 5 DATS high-limit temperature dial. 6 LEDs to indicate mode of operation and zones calling for heat or cool.

The TZ-4 has two sets of DIP switches to adjust for a variety of air conditioning applications. It controls up to 3 stages of heat and 2 stages of cool in conventional, heat pump, and dual fuel applications. A stand alone TZ-4 is capable of serving two to four zones. With the addition of a TAZ-4 panel, the TZ-4 is capable of handling four more zones, up to 32 total zones.

Example of DIP Switch Settings and Functions for Bank 5

DIP Switch	Function	On (Default)	OFF
5-1	System Fuel Type	Conventional (Nat Gas)	Heat Pump
5-2	DATS low temperature cut out during by-pass mode	40°F	48°F
5-3	Indoor fan Purge timing at the end of each cycle	Two Minutes	Three and one half minutes
5-4	Method of purge control	Equipment controlled	TZ-4 controlled
5-5	Damper configuration during purge	Last zone calling open	All dampers open
5-6	Fan control method in heat mode	Fan controlled by TZ-4 in cooling mode, by equipment in heat mode	TZ-4 controlling fan in both heat and cooling modes
5-7	Heat pump reversing valve controlled by O/B terminal at point 1 on TZ-4	Reversing valve called for in the cooling mode through O terminal	Reversing valve called for in the heating mode through B terminal
5-8	Dual fuel: system able to switch between natural gas and electricity	Disabled	Enabled

At the end of every call for heat or cool, the panel enters a purge mode. During this mode, the panel holds the calling zone damper open for two or three and a half minutes based on bank 5 DIP switch settings. During purge, the panel or the equipment can be configured to operate the fan. At the end of purge, DIP 5-5 determines the configuration of the dampers: all open or only last-zone-calling remains open. Purging maximizes efficiency by utilizing the residual cooling in the evaporator at the end of every cycle. Thermostats with adaptive recovery like the Honeywell T8635L, T8601D, adjust for this added cooling effect and control the cycle to reduce over shooting the temperature set point.

The Systems Installed

Two Honeywell Totalzone controlled air conditioning systems were installed during my sabbatical leave under the contractors license of Darrow P. Soares. The first system was installed, at my cost of installation, for Susan E. Sawyer in Riverside California. The second system was designed and installed between March and May of 2004 for the First Congregational Church in Riverside. The Sawyer heat load calculation was performed in February of 2003, with the installation beginning soon after and lasting until the last week of March 2003. I performed the Sawyer installation alone. The exception to this occurred during demolition of the original equipment and duct work. I required additional help again in order to set the replacement furnace and condensing unit.

The purpose of installing a zoned air conditioning system in this home was to improve comfort. There was a concern that one large air conditioning system was heating and cooling all areas of the home, 24 hours a day. Since the occupant was a single person, it made sense to design a system that applied air conditioning to areas only when and where they were occupied.

Energy savings was a second reason. If the entire capacity of the air conditioning system was focused on only the occupied zone(s), it would stand to reason that the system run time would be reduced and utility consumption would fall. The risk in this assumption, however, is the possibility of low latent heat removal. In order to control humidity for comfort cooling, air conditioning systems require long run cycles rather than short.

Following is a summary of the system design and heat load calculation for the system installed for Susan E. Sawyer.

Building Analysis
Entire House
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

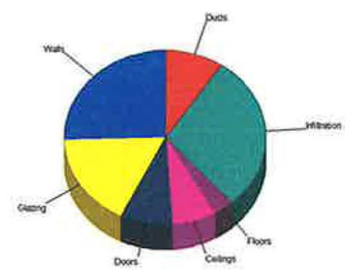
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	22.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

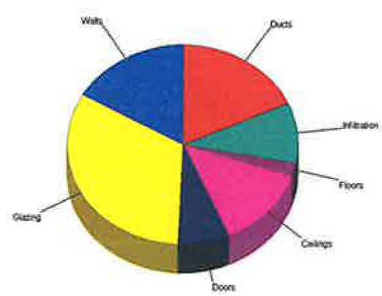
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	9203	25.3
Glazing	22.0	6344	17.5
Doors	16.4	2985	8.2
Ceilings	1.3	2641	7.3
Floors	0.5	1187	3.3
Infiltration	3.9	10580	29.1
Ducts		3383	9.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**36323**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.0	6097	16.7
Glazing	41.5	11960	32.7
Doors	14.5	2633	7.2
Ceilings	2.3	4841	13.2
Floors	0.4	803	2.2
Infiltration	1.3	3578	9.8
Ducts		6663	18.2
Ventilation		0	0.0
Internal gains		0	0.0
Blower		0	0.0
Adjustments		0	
Total		**36576**	**100.0**



Overall U-value = 0.095 Btuh/ft²-°F

WARNING: suspicious slab-on-grade floor perimeter in Day side.

Building Analysis
Night side
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

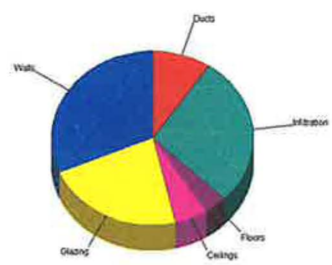
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

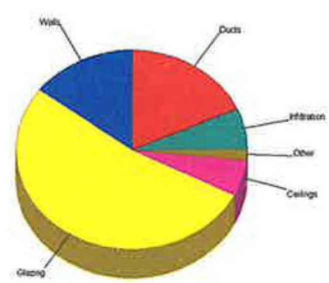
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	2958	31.4
Glazing	19.4	2093	22.2
Doors	0.0	0	0.0
Ceilings	1.1	507	5.4
Floors	0.6	345	3.7
Infiltration	3.9	2633	28.0
Ducts		877	9.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**9413**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.1	1972	14.6
Glazing	65.9	7122	52.9
Doors	0.0	0	0.0
Ceilings	1.7	798	5.9
Floors	0.4	234	1.7
Infiltration	1.3	890	6.6
Ducts		2454	18.2
Ventilation		0	0.0
Internal gains		0	0.0
Blower		0	0.0
Adjustments		0	
Total		**13469**	**100.0**



Overall U-value = 0.091 Btuh/ft²-°F

Data entries checked.

Building Analysis
Day side
Sabbatical Project

Job:
Date: **February 2003**
By: **Darrow P. Soares**

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

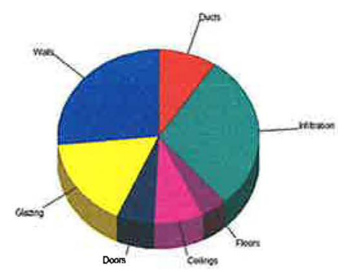
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

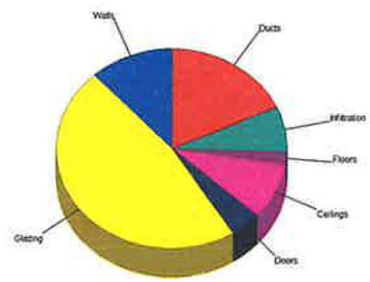
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	2841	26.5
Glazing	20.4	1795	16.8
Doors	13.3	650	6.1
Ceilings	1.0	847	7.9
Floors	0.5	449	4.2
Infiltration	3.9	3132	29.2
Ducts		998	9.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**10712**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	1.9	1713	11.8
Glazing	78.0	6867	47.2
Doors	12.8	627	4.3
Ceilings	1.6	1332	9.2
Floors	0.3	304	2.1
Infiltration	1.3	1059	7.3
Ducts		2651	18.2
Ventilation		0	0.0
Internal gains		0	0.0
Blower		0	0.0
Adjustments		0	
Total		**14553**	**100.0**



Overall U-value = 0.081 Btuh/ft²-°F

WARNING: suspicious slab-on-grade floor perimeter in Bath 1.

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

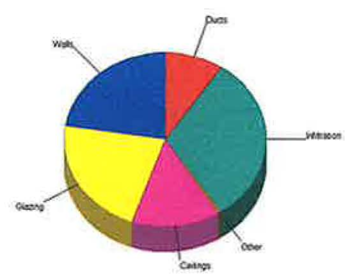
Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	2 (Average)

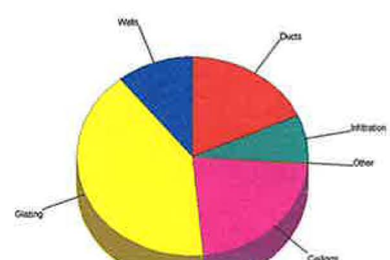
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	1856	22.5
Glazing	30.6	1836	22.2
Doors	0.0	0	0.0
Ceilings	1.7	1166	14.1
Floors	0.6	51	0.6
Infiltration	3.9	2586	31.3
Ducts		770	9.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**8265**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.0	1223	10.8
Glazing	77.3	4638	40.8
Doors	0.0	0	0.0
Ceilings	3.6	2521	22.2
Floors	0.4	35	0.3
Infiltration	1.3	875	7.7
Ducts		2069	18.2
Ventilation		0	0.0
Internal gains		0	0.0
Blower		0	0.0
Adjustments		0	
Total		**11360**	**100.0**



Overall U-value = 0.102 Btuh/ft²-°F

Data entries checked.

Building Analysis
Formal Rm.
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

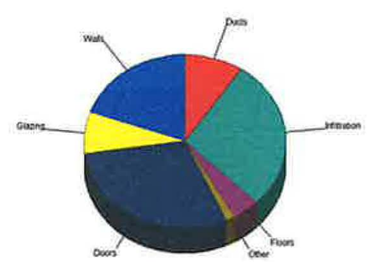
Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	2 (Average)

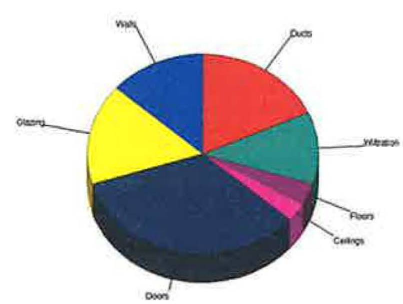
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.1	1547	19.5
Glazing	19.4	620	7.8
Doors	17.6	2335	29.4
Ceilings	1.1	121	1.5
Floors	0.6	341	4.3
Infiltration	3.9	2230	28.1
Ducts		739	9.3
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**7933**	**100.0**



Cooling

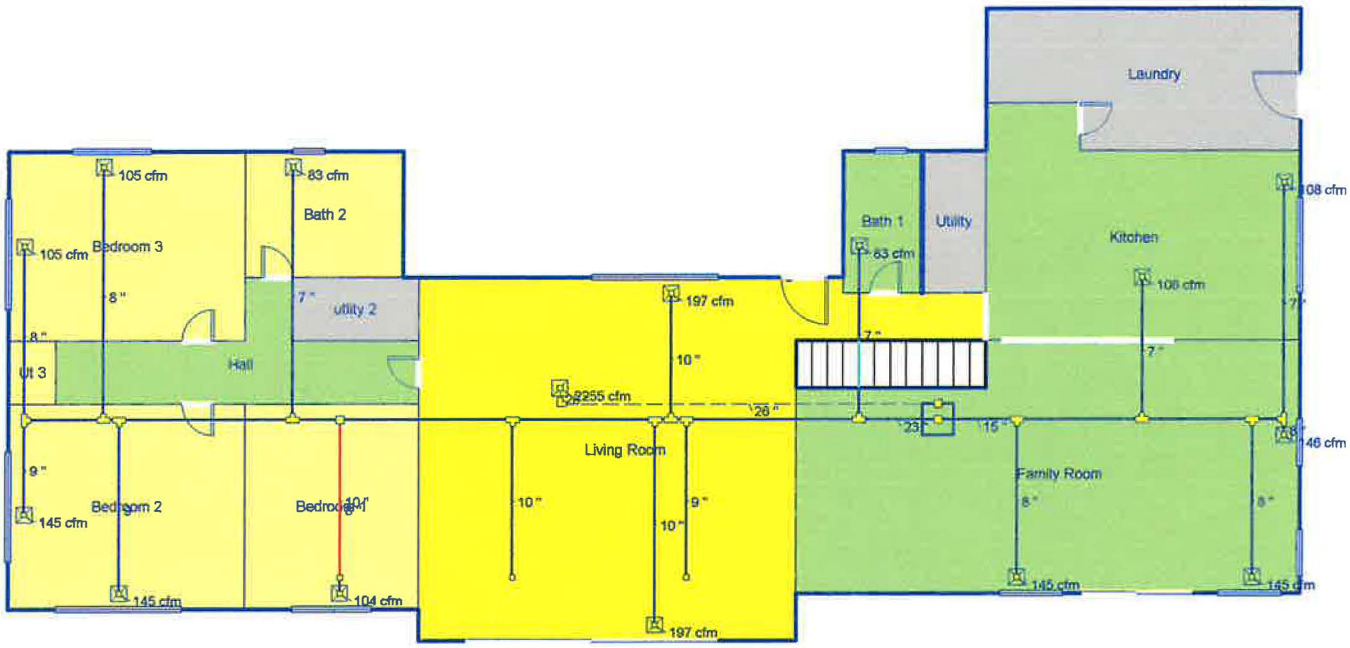
Component	Btuh/ft²	Btuh	% of load
Walls	1.7	866	13.5
Glazing	33.1	1060	16.5
Doors	16.3	2161	33.6
Ceilings	1.7	190	3.0
Floors	0.4	231	3.6
Infiltration	1.3	754	11.7
Ducts		1172	18.2
Ventilation		0	0.0
Internal gains		0	0.0
Blower		0	0.0
Adjustments		0	
Total		**6435**	**100.0**



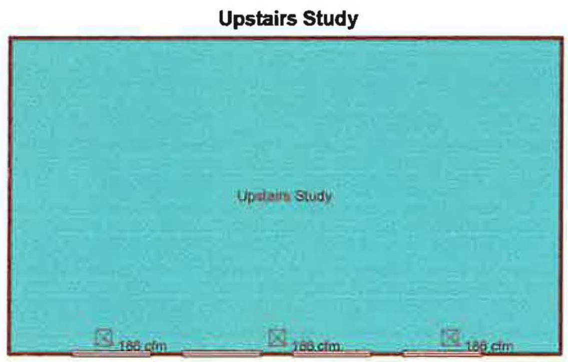
Overall U-value = 0.121 Btuh/ft²-°F

Data entries checked.

Sheet 1



Job #: **Performed by Darrow P. Soares for:** Susan E Sawyer 4204 Homewood Ct Riverside, CA 92506	**Sabbatical Project** Mount San Antonio College February 2003,	Scale: 1 : 147 Page 1 Right-Suite Residential 5.9.37 RSR31228 2004-Sep-13 13:43:26 C:\My Documents\Wrightsoft HVAC...



Job #:
Performed by Darrow P. Soares for:

Susan E Sawyer
4204 Homewood Ct
Riverside, CA 92506

Sabbatical Project

Mount San Antonio College
February 2003,

Scale: 1 : 147

Page 2
Right-Suite Residential
5.9.37 RSR31228
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AED Assessment
Entire House
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

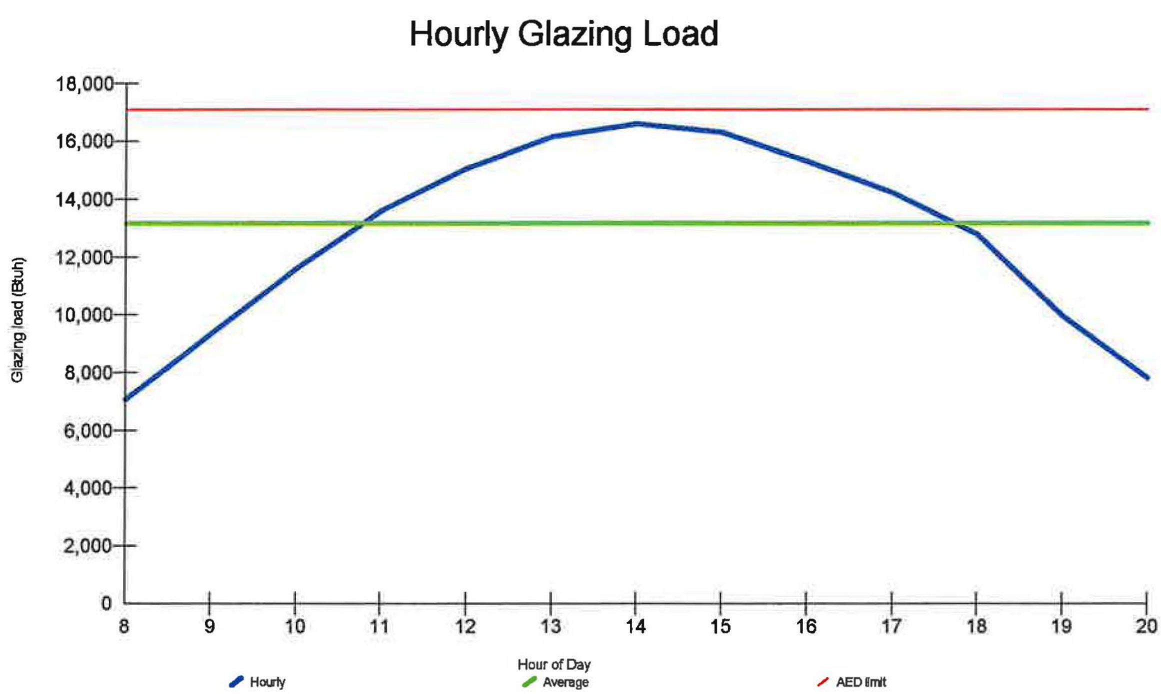
Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	22.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 26.1%.

House has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

AED Assessment
Day side
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

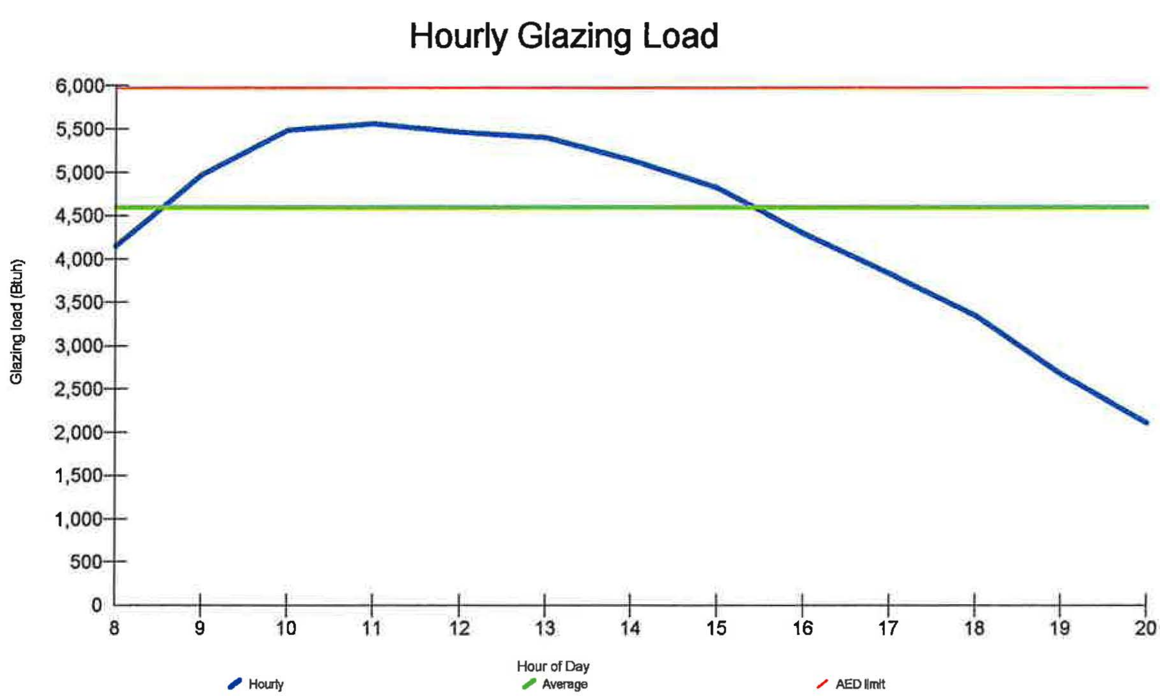
Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 21.0%.

Zone has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

AED Assessment
Night side
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

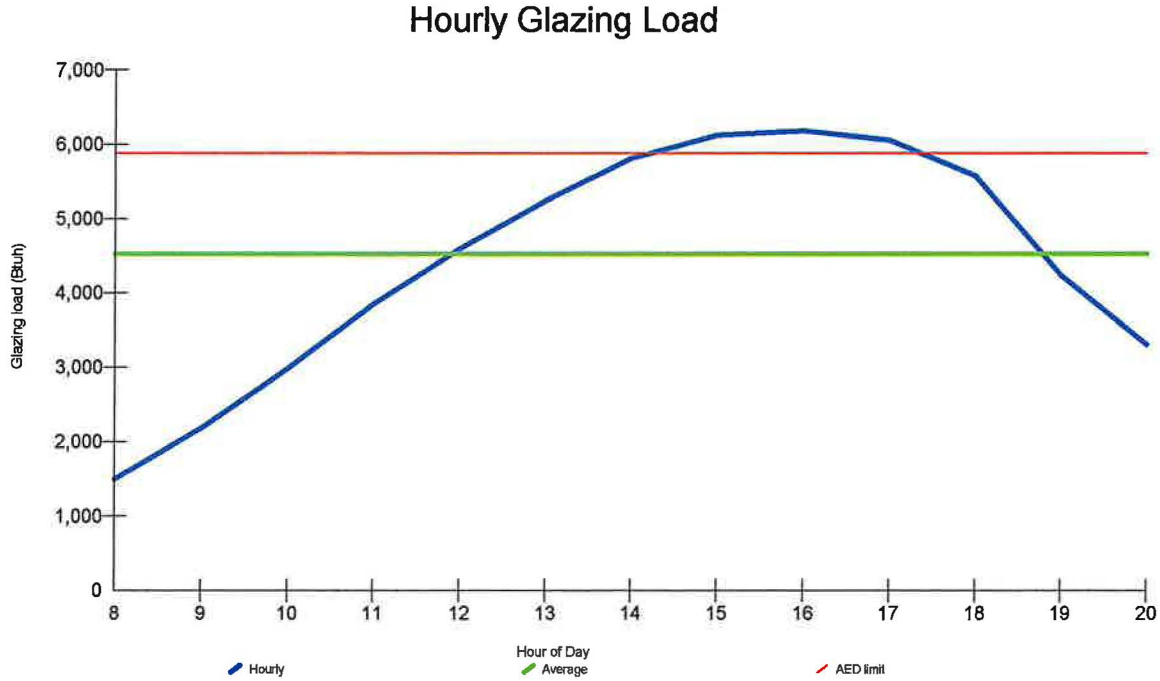
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	2 (Average)

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 36.5%.

Zone does not have adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 294 Btuh

AED Assessment
Upstairs
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

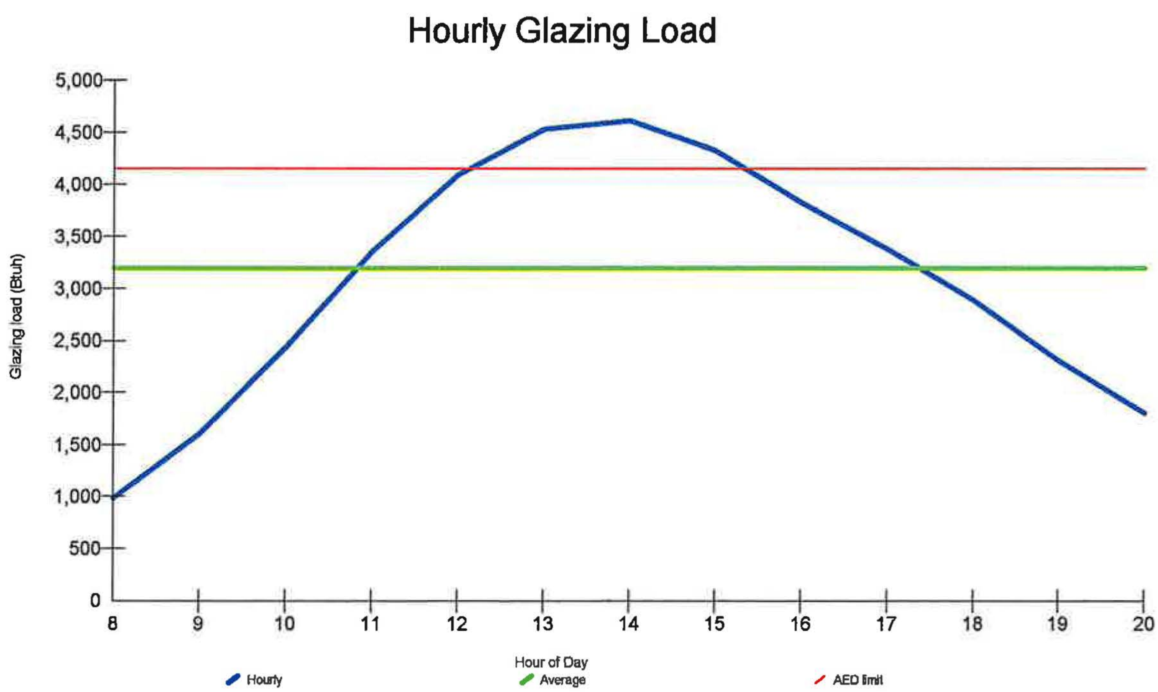
Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 44.3%.

Zone does not have adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 456 Btuh

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

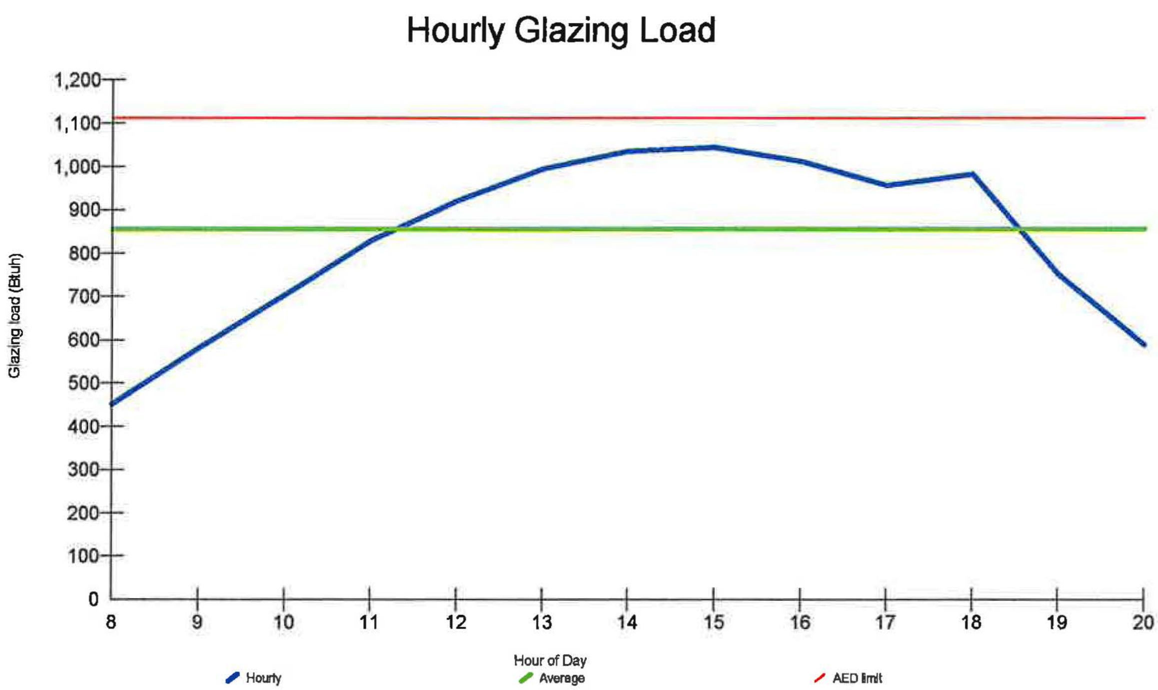
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	2 (Average)

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 22.1%.

Zone has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

Component Constructions
Night side
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	Heating	Cooling
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	Heating	Cooling
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation	n	172	0.091	13.0	3.09	532	1.76	302
	e	64	0.091	13.0	3.09	198	1.37	88
	s	156	0.091	13.0	3.09	483	1.60	250
	w	172	0.091	13.0	3.09	532	3.74	643
	all	564	0.091	13.0	3.09	1745	2.28	1283
Partitions								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation		392	0.091	13.0	3.09	1213	1.76	688
Windows								
1D-c2ow: Operable, clear glass, wood frame, 2 pane	n	28	0.570	0.0	19.4	543	33.1	928
	s	52	0.570	0.0	19.4	1008	63.5	3301
	w	28	0.570	0.0	19.4	543	103	2893
	all	108	0.570	0.0	19.4	2093	65.9	7122
Doors								
(none)								
Ceilings								
16B-30ad: Ceiling under vented attic, no radiant barrier, dark shingles, R-30 insulation		466	0.032	30.0	1.09	507	1.71	798
Floors								
19C-19cscp: Carpeted floor over tight enclosed crawl, R-11 wall, R-19 blanket		598	0.049	19.0	0.58	345	0.39	234

Component Constructions
Day side
Sabbatical Project

Job:
Date: February 2003
By: Darrow P. Soares

Mount San Antonio College, February 2003,

Project Information

For: Susan E Sawyer
4204 Homewood Ct, Riverside, CA 92506

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 2 (Average)

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation	n	127	0.091	13.0	3.09	394	1.76	224
	e	248	0.091	13.0	3.09	767	1.37	341
	s	175	0.091	13.0	3.09	541	1.60	280
	w	112	0.091	13.0	3.09	347	3.74	419
	all	662	0.091	13.0	3.09	2049	1.91	1264
Partitions								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation		256	0.091	13.0	3.09	792	1.76	450
Windows								
1D-c2ow: Operable, clear glass, wood frame, 2 pane	e	48	0.570	0.0	19.4	930	93.5	4486
	s	32	0.570	0.0	19.4	620	63.5	2031
	all	80	0.570	0.0	19.4	1550	81.5	6518
1A-c1ow: Operable, clear glass, wood frame, 1 pane	n	8	0.900	0.0	30.6	245	43.6	349
Doors								
11D0: Wood door, solid core, no storm	s	49	0.390	0.0	13.3	650	12.8	627
Ceilings								
16B-30ad: Ceiling under vented attic, no radiant barrier, dark shingles, R-30 insulation		826	0.032	30.0	1.02	847	1.61	1332
Floors								
19C-19cscp: Carpeted floor over tight enclosed crawl, R-11 wall, R-19 blanket		882	0.049	19.0	0.51	449	0.34	304

The second system installed under the contractor's license of Darrow P. Soares was at the first Congregational Church in Riverside, California. The heat load calculation was performed in March of 2004, with the installation beginning in April and was completed and tested on May 9th 2004. Again, I performed the installation alone. I hired temporary help only during demolition and I used voluntary help to set the furnace and condensing unit.

The existing system serving the upstairs offices was only used sporadically, even though it served the entire zone with no consideration of occupancy. If a single office or the conference room was occupied for a meeting, the air conditioner would condition the entire upstairs zone, even though all other rooms were vacant. The purpose of installing the zoned system was to improve comfort and reduce utility cost. Zoning based on occupancy appeared to be a good application. As a result, the zoned system installed was dedicated to the upstairs section of offices based on occupancy. Based on the heat load calculation, the equipment capacity was reduced and cooling and heating was focused on the areas of use.

Following is a summary of the system design and heat load calculation for the system installed for The Congregational Church in Riverside.

Building Analysis
Entire House
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

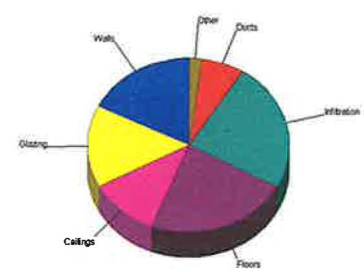
Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	0

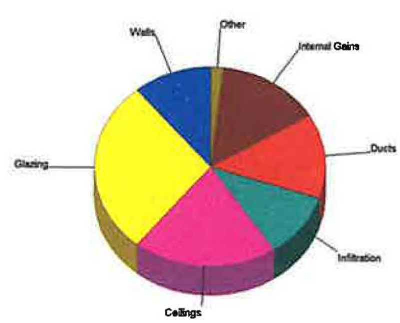
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.0	3554	17.6
Glazing	19.3	3080	15.3
Doors	0.0	0	0.0
Ceilings	1.7	2294	11.4
Floors	3.3	4607	22.8
Infiltration	4.4	4870	24.1
Ducts		1390	6.9
Piping		0	0.0
Humidification		0	0.0
Ventilation		394	2.0
Adjustments		0	
Total		**20189**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	1.3	1610	11.0
Glazing	25.7	4112	28.2
Doors	0.0	0	0.0
Ceilings	2.1	2935	20.1
Floors	0.0	0	0.0
Infiltration	1.4	1537	10.5
Ducts		2021	13.8
Ventilation		267	1.8
Internal gains		2120	14.5
Blower		0	0.0
Adjustments		0	
Total		**14603**	**100.0**



Overall U-value = 0.097 Btuh/ft²-°F

Data entries checked.

Building Analysis
Office Space
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

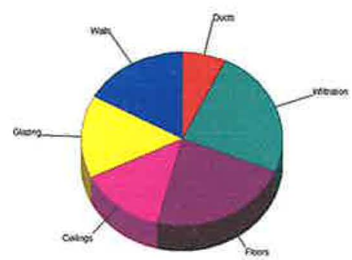
Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	0

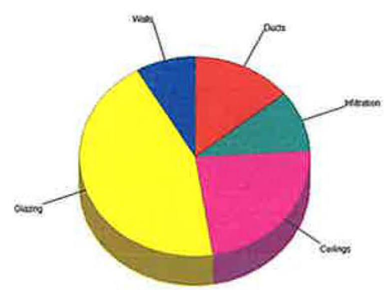
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.0	1265	16.8
Glazing	19.4	1163	15.4
Doors	0.0	0	0.0
Ceilings	1.7	1043	13.9
Floors	2.7	1715	22.8
Infiltration	4.4	1813	24.1
Ducts		529	7.0
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**7527**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	1.1	478	8.4
Glazing	42.2	2532	44.2
Doors	0.0	0	0.0
Ceilings	2.1	1334	23.3
Floors	0.0	0	0.0
Infiltration	1.4	572	10.0
Ducts		807	14.1
Ventilation		0	0.0
Internal gains		0	0.0
Blower		0	0.0
Adjustments		0	
Total		**5724**	**100.0**



Overall U-value = 0.088 Btuh/ft²-°F

Data entries checked.

Building Analysis
Youth
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

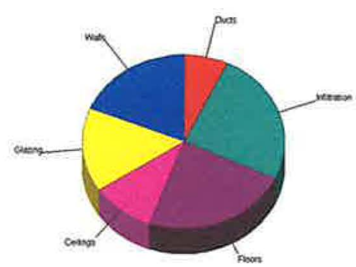
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method Simplified
Construction quality Average
Fireplaces 0

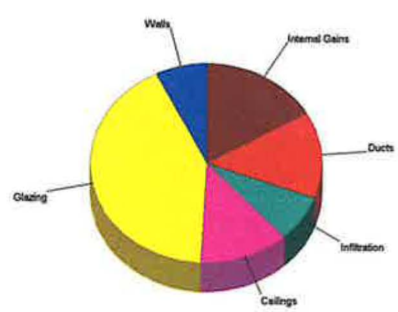
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.0	2289	18.7
Glazing	19.2	1918	15.6
Doors	0.0	0	0.0
Ceilings	1.7	1251	10.2
Floors	3.9	2892	23.6
Infiltration	4.4	3057	24.9
Ducts		862	7.0
Piping		0	0.0
Humidification		0	0.0
Ventilation		0	0.0
Adjustments		0	
Total		**12268**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	1.2	917	7.2
Glazing	53.7	5367	42.0
Doors	0.0	0	0.0
Ceilings	2.1	1601	12.5
Floors	0.0	0	0.0
Infiltration	1.4	965	7.6
Ducts		1800	14.1
Ventilation		0	0.0
Internal gains		2120	16.6
Blower		0	0.0
Adjustments		0	
Total		**12770**	**100.0**



Overall U-value = 0.103 Btuh/ft²-°F

WARNING: suspicious slab-on-grade floor perimeter in Youth Room.

AED Assessment
Entire House
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

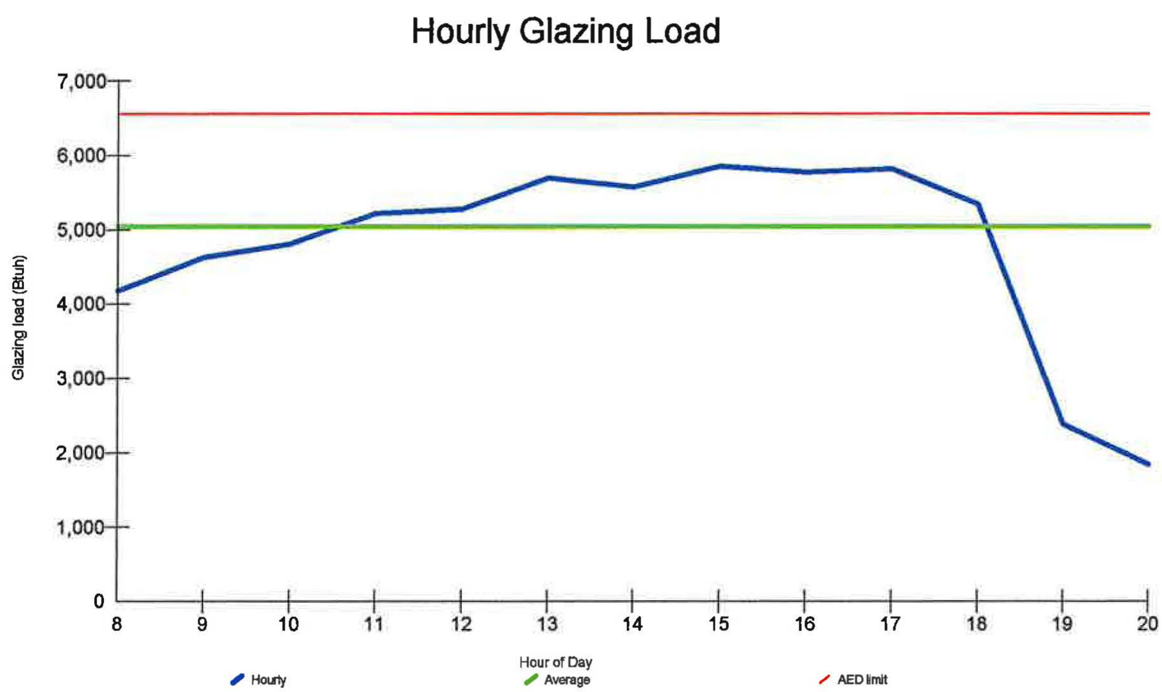
Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 16.0%.

House has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

AED Assessment
Office Space
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

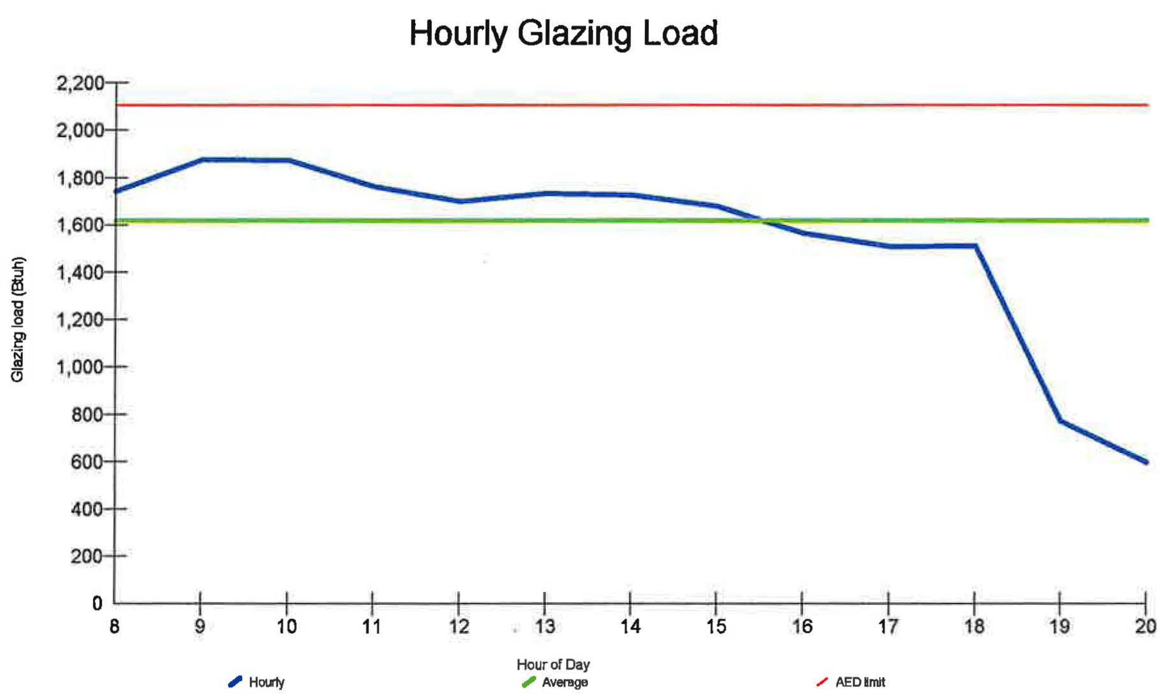
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:

Method	Simplified
Construction quality	Average
Fireplaces	0

Test for Adequate Exposure Diversity



Maximum hourly glazing load exceeds average by 15.8%.

Zone has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

AED Assessment
Youth
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

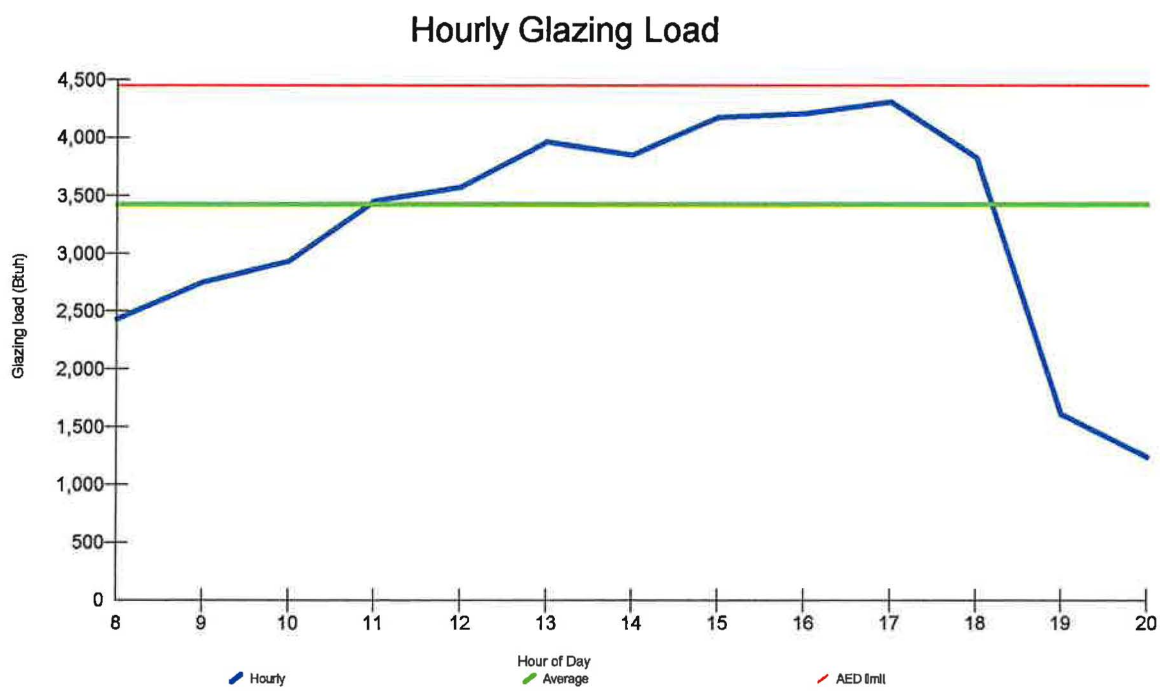
Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method Simplified
Construction quality Average
Fireplaces 0

Test for Adequate Exposure Diversity

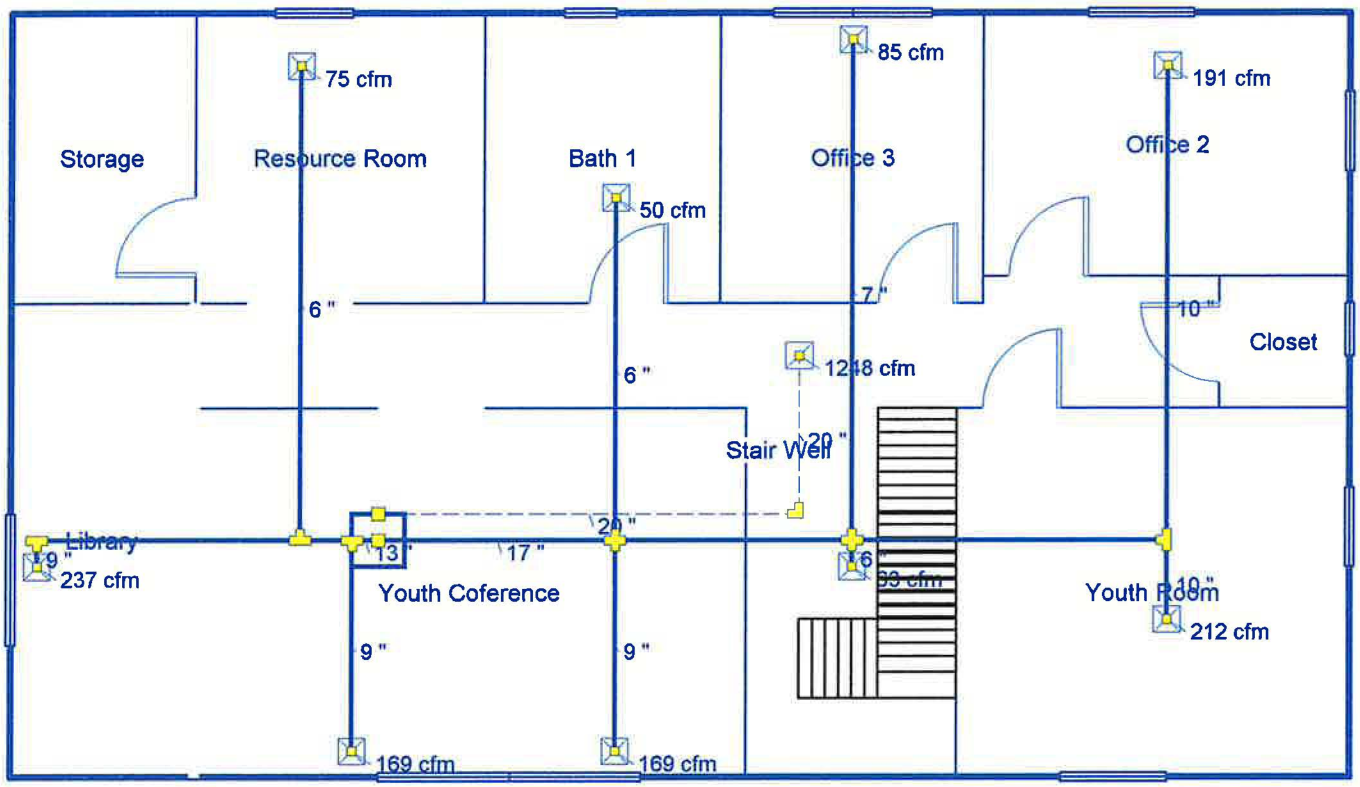


Maximum hourly glazing load exceeds average by 25.9%.

Zone has adequate exposure diversity (AED), based on AED limit of 30%.

AED excursion: 0 Btuh

Sheet 1



Job #: Performed by for: First Congregational Church Riverside, CA	Sabbatical Project Mount San Antonio College March 2004,	Scale: 1 : 88 Page 1 Right-Suite Residential 5.9.37 RSR31228 2004-Sep-13 14:04:31 C:\My Documents\Wrightsoft HVAC\L...

Project Summary
Entire House
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Notes: Performed as part of a Sabbatical Project for the AIRC Department at Mount San Antonio College

Design Information

Weather: Riverside, March AFB, CA, US

Winter Design Conditions

Outside db	36	°F
Inside db	70	°F
Design TD	34	°F

Summer Design Conditions

Outside db	98	°F
Inside db	75	°F
Design TD	23	°F
Daily range	H	
Relative humidity	50	%
Moisture difference	-8	gr/lb

Heating Summary

Structure	18405	Btuh
Ducts	1390	cfm
Central vent (11 cfm)	394	Btuh
Humidification	0	Btuh
Piping	0	Btuh
Equipment load	20189	Btuh

Sensible Cooling Equipment Load Sizing

Structure	14336	Btuh
Ducts	2021	Btuh
Central vent (11 cfm)	267	Btuh
Blower	0	Btuh
AED excursion	0	Btuh
Use manufacturer's data	n	
Rate/swing multiplier	1.03	
Equipment sensible load	15041	Btuh

Infiltration

Method	Simplified
Construction quality	Average
Fireplaces	0

	Heating	Cooling
Area (ft²)	1377	1377
Volume (ft³)	11016	11016
Air changes/hour	0.75	0.35
Equiv. AVF (cfm)	138	64

Latent Cooling Equipment Load Sizing

Structure	469	Btuh
Ducts	-130	Btuh
Central vent (11 cfm)	-57	Btuh
Equipment latent load	282	Btuh
Equipment total load	15323	Btuh
Req. total capacity at 0.70 SHR	1.8	ton

Heating Equipment Summary

Make n/a
Trade
Model

Efficiency	80	AFUE
Heating input	0	Btuh
Heating output	0	Btuh
Temperature rise	0	°F
Actual air flow	811	cfm
Air flow factor	0.041	cfm/Btuh
Static pressure	0.08	in H2O
Space thermostat		

Cooling Equipment Summary

Make Carrier
Trade WeatherMate 38CKG
Cond 38CKG03030
Coil CK5A/CK5BW036+58CV(A,X)090-16

Efficiency	11	SEER
Sensible cooling	20300	Btuh
Latent cooling	8700	Btuh
Total cooling	29000	Btuh
Actual air flow	967	cfm
Air flow factor	0.067	cfm/Btuh
Static pressure	0.08	in H2O
Load sensible heat ratio	0.98	

Printout certified by ACCA to meet all requirements of Manual J 8th Ed.

Component Constructions
Entire House
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:	
Method	Simplified
Construction quality	Average
Fireplaces	0

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12B-2bw: Wood stud frame, brick veneer, R-2 foam board, R-11 cavity insulation	n	292	0.086	13.0	2.92	854	1.33	389
	e	168	0.086	13.0	2.92	491	1.33	224
	s	352	0.086	13.0	2.92	1029	1.33	469
	w	124	0.086	13.0	2.92	363	1.33	165
	all	936	0.086	13.0	2.92	2737	1.33	1248
Partitions								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation		264	0.091	13.0	3.09	817	1.37	363
Windows								
1D-c2ow: Operable, clear glass, wood frame, 2 pane; 50% blinds 45°, medium; 50% outdoor insect screen; 1.5 ft overhang	n	12	0.570	0.0	19.4	233	17.1	205
1D-c2ow: Operable, clear glass, wood frame, 2 pane; 50% blinds 45°, medium; 50% outdoor insect screen	n	48	0.570	0.0	19.4	930	17.1	819
	e	24	0.570	0.0	19.4	465	46.2	1108
	all	72	0.570	0.0	19.4	1395	26.8	1927
1D-c2ow: Operable, clear glass, wood frame, 2 pane; 50% blinds 45°, medium; 1.5 ft overhang	s	16	0.570	0.0	19.4	310	19.0	303
1E-c2fw: Fixed sash, clear glass, wood frame, 2 pane; 50% drapes, medium; 50% outdoor insect screen; 1.5 ft overhang	s	40	0.560	0.0	19.0	762	17.6	703
	w	20	0.560	0.0	19.0	381	48.7	974
	all	60	0.560	0.0	19.0	1142	27.9	1676
Doors								
(none)								
Ceilings								
16C-19al: Ceiling under vented attic, no radiant barrier, light shingles, R-19 insulation		1377	0.049	19.0	1.67	2294	2.13	2935
Floors								
22A-tpl: Tile covered slab on grade, light dry soil, No edge insul, No horiz insul		137	0.989	0.0	33.6	4607	0.00	0

Component Constructions
Office Space
Sabbatical Project

Job:
Date:
By:

Mount San Antonio College, March 2004,

Project Information

For: First Congregational Church
Riverside, CA

Design Conditions

Location:
Riverside, March AFB, CA, US
Elevation: 1539 ft
Latitude: 34°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	36	98
Daily range (°F)	-	29 (H)
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	34	23
Relative humidity (%)	30	50
Moisture difference (gr/lb)	8.3	-8.0

Infiltration:
Method: Simplified
Construction quality: Average
Fireplaces: 0

Construction descriptions	Or	Area (ft²)	U-value (Btuh/ft²-°F)	Insul R (ft²-°F/Btuh)	Htg HTM (Btuh/ft²)	Loss (Btuh)	Clg HTM (Btuh/ft²)	Gain (Btuh)
Walls								
12B-2bw: Wood stud frame, brick veneer, R-2 foam board, R-11 cavity insulation	n	216	0.086	13.0	2.92	632	1.01	219
	e	68	0.086	13.0	2.92	199	0.99	67
	s	64	0.086	13.0	2.92	187	0.80	51
	all	348	0.086	13.0	2.92	1018	0.97	338
Partitions								
12C-0sw: Wood stud frame, siding or stucco, no board insulation, R-13 cavity insulation		80	0.091	13.0	3.09	248	1.76	141
Windows								
1D-c2ow: Operable, clear glass, wood frame, 2 pane; 50% blinds 45°, medium; 50% outdoor insect screen	n	48	0.570	0.0	19.4	930	28.3	1359
	e	12	0.570	0.0	19.4	233	97.7	1173
	all	60	0.570	0.0	19.4	1163	42.2	2532
Doors								
(none)								
Ceilings								
16C-19al: Ceiling under vented attic, no radiant barrier, light shingles, R-19 insulation		626	0.049	19.0	1.67	1043	2.13	1334
Floors								
22A-tpl: Tile covered slab on grade, light dry soil, No edge insul, No horiz insul		51	0.989	0.0	33.6	1715	0.00	0

Section Three

Educational Activities

Air Conditioning Contractors of America Certification to Teach Manual J 8
for Heat Load Calculations
Los Angeles, California
January 26-28

Air Conditioning Contractors of America

Certifies that

Darrow Soares

has successfully completed the Manual J™8 Instructor Certification Program and is qualified to teach the concept and theory of MJ8 residential load calculation.

President

January 27, 2003

Course date

ACCA

Quality Contractors Building a Quality Industry

Background

The Air Conditioning and Refrigeration Department at Mount San Antonio College committed to become certified to teach Manual J-8 by The Air Conditioning Contractors of America (ACCA). From January 5th through the 7th, two faculty members and I attended a seminar to prepare us for this certification in Orlando, Florida. This seminar was hosted by the ACCA national office in Arlington VA. and taught by the text book's author, Hank Rutkowski. I re-attended the ACCA certification for instructors in Los Angeles from January 27th through the 29th.

Application

The January 6th seminar was so poorly planned and executed that the other Mt. SAC faculty members and I left the seminar on day two to work on Manual J-8 by ourselves. We returned, however, on day three for the closing and to pick up the exam required for certification. ACCA required the exam be returned within 60 days. We worked on the exam for the duration of our stay and on the flight back to California.

Since the Orlando seminar was presented so poorly, I decided to re-attend later that month in Los Angeles. My hope was that the ACCA office from San Francisco, and a different instructor, would clarify the changes in Manual J-8 and I could submit the exam by the deadline.

The seminar was hosted by the ACCA office in San Francisco and taught by the author, H. Rutkowski. The Los Angeles presentation had not changed from that in Orlando, even though I was told a different method would be presented. I did, however, remain for the entire presentation. At the conclusion of the Los Angeles session, I was convinced that the work the other faculty members and I did in our Orlando hotel room was far more valuable than attending the seminar. As a result, I decided that if I were to submit the exam by the deadline, I would have to research the organization of Manual J-8 on my own. I submitted the exam in February and received my results in March.

ACCA®
Air Conditioning Contractors of America

The Essential Partner
For Contractor Excellence

2800 Shirlington Road • Suite 300 • Arlington,VA 22206 • (703) 575-4477 • Fax: (703) 575-4449

March 20, 2003

Darrow Soares
3866 Westwood Dr
Riverside, CA 92505

Dear Darrow ,

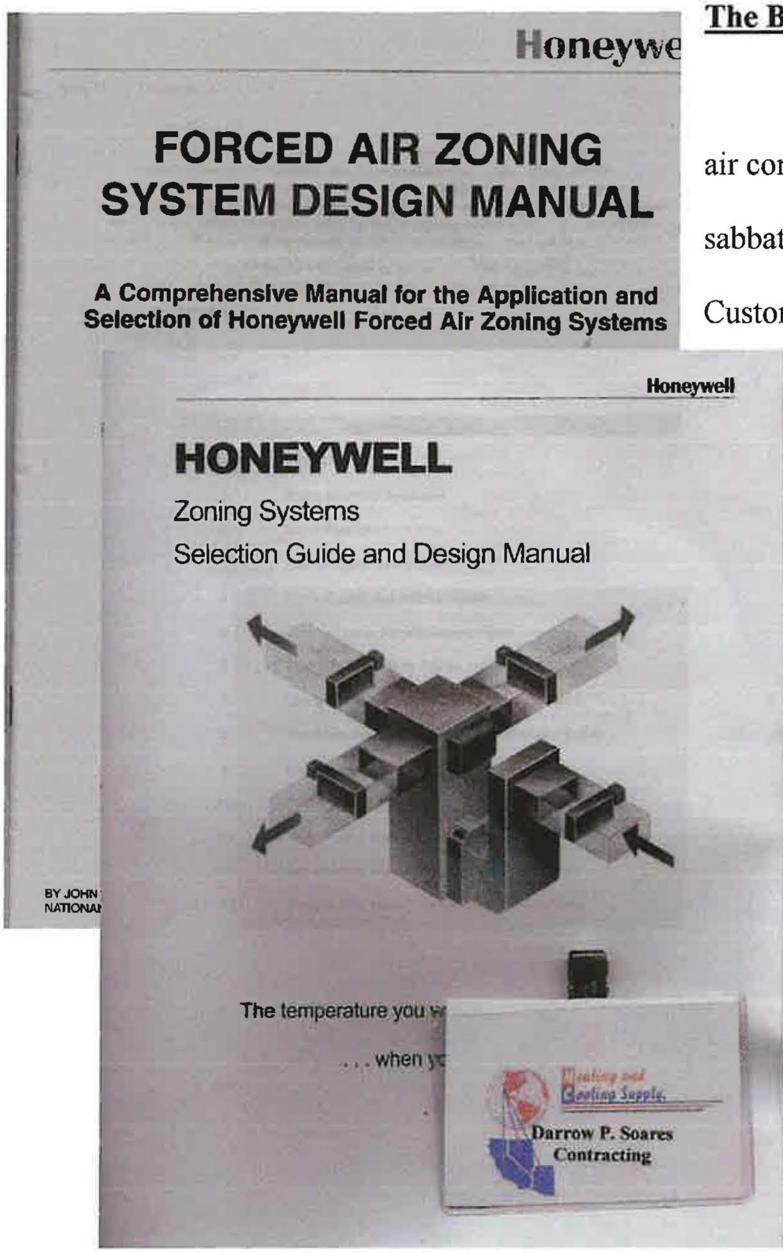
Congratulations on successfully completing the Manual J8th Edition Instructor Certification Program. Enclosed is your certificate. Also enclosed is a form entitled Manual J8 Training Certification which authorizes ACCA to add your name to the list of ACCA Authorized Instructors of MJ8. This list will be provided to the ACCA membership and chapters as well as made available on the ACCA web site. For consistency, authorized trainers are asked to follow the enclosed outlines for level 1,2, and 3 Contractor Courses. ACCA will supply blank certificates to authorized trainers to provide to graduates.

Thank you for participating in the MJ8 Instructor Certification Program, if you have any questions about the program, please feel free to call.

Sincerely,

Chris Hoelzel
VP Business Development and Marketing
703-824-8851
Chris.Hoelzel@acca.org

Honeywell Controls Seminar
Heating and Cooling Supply Riverside, California
February 17, 2003.



The Background

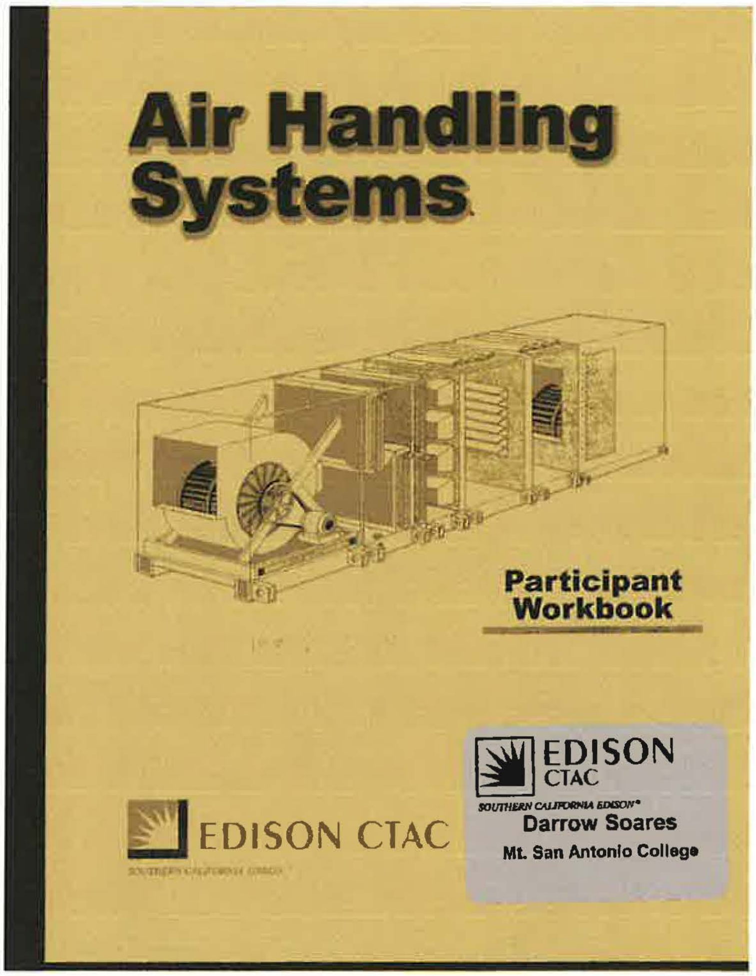
My interest in zone control for air conditioning grew during my sabbatical involvement with the Customer Assurance Department at Southern California Air Conditioner Distributors (SCACD) in January of 2003. While working with technicians and answering their technical questions regarding the Carrier Comfort Zone systems, I realized I wanted more practical experience with zoning. This would only come through the design and installation of zone control systems of my own.

The Application

I attended the Honeywell seminars on zone control in order top design my own sytems. During my experience at SCACD it became clear that my knowledge of the subject was not adequate to comfortably assist contractors with their technical questions or design my own systems later. I chose the Honeywell training based on its affordability and my relationship with the supplier, Heating and Cooling Supply. In addition, it appeared Honeywell was eager to work with me as a contractor new to zoning and a teacher at the community college. By attending the February 17th training, I was able to develop a relationship with John Edwards, the National Field Sales Zoning Leader for Honeywell Controls. I communicated with Edwards often during the design phase of the systems I installed. He proved to be a valuable resourse.

In addition to the February 17th training, I attended a repeat seminar in Anaheim in March of 2003 and a demonstration installation in Moreno Valley in April of 2004 conducted by John Edwards.

Air Handlers for Energy Management Systems
Irwindale, CA
March 5, 2003



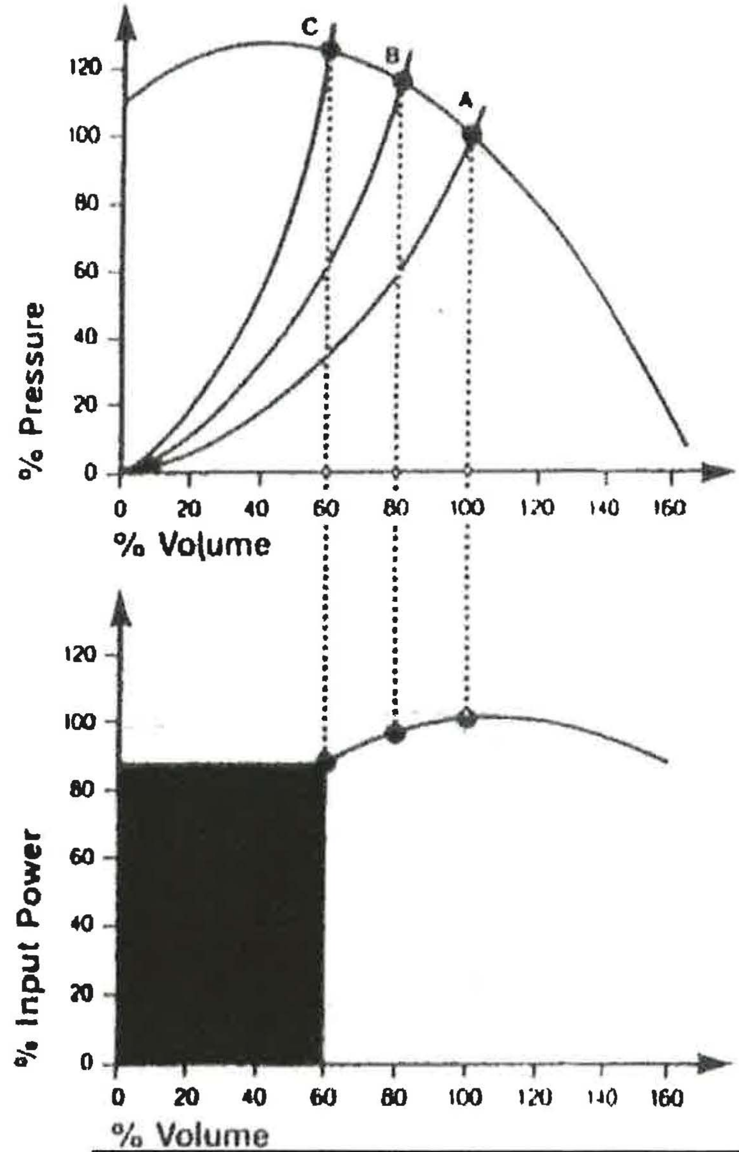
The Background

The purpose of this seminar was to explore energy efficient methods of air distribution for air conditioning systems. The seminar compared the utility costs of conventional air distribution systems including constant air volume and variable air volume methods to technologies using adjustable speed drives to control air flow.

The Application

In many facilities, air handlers operate 24 hour a day, 7 days a week. Energy consumption can be reduced in many different ways, including selecting the proper fan type, designing cooling coils with low face velocity, and proper duct design. If these factors are properly applied, variable air volume (VAV) flow control of the fan offers the next greatest opportunity for savings. Three methods of VAV flow control include outlet damper control, variable inlet vane control and variable speed control.

If a fan system must operate over a range of capacities, some means of adjusting either the fan characteristics or the system characteristics must be provided. System changes can be achieved by inserting gradual outlet damper controls in the main duct work. This was the earliest method of air volume control and many systems are still in operation. Unfortunately, the pressure required on the fan is higher at reduced ratings than at design ratings. This is because the damper increases system pressure. But, Savings is still achieved since mass flow rate has been reduced.

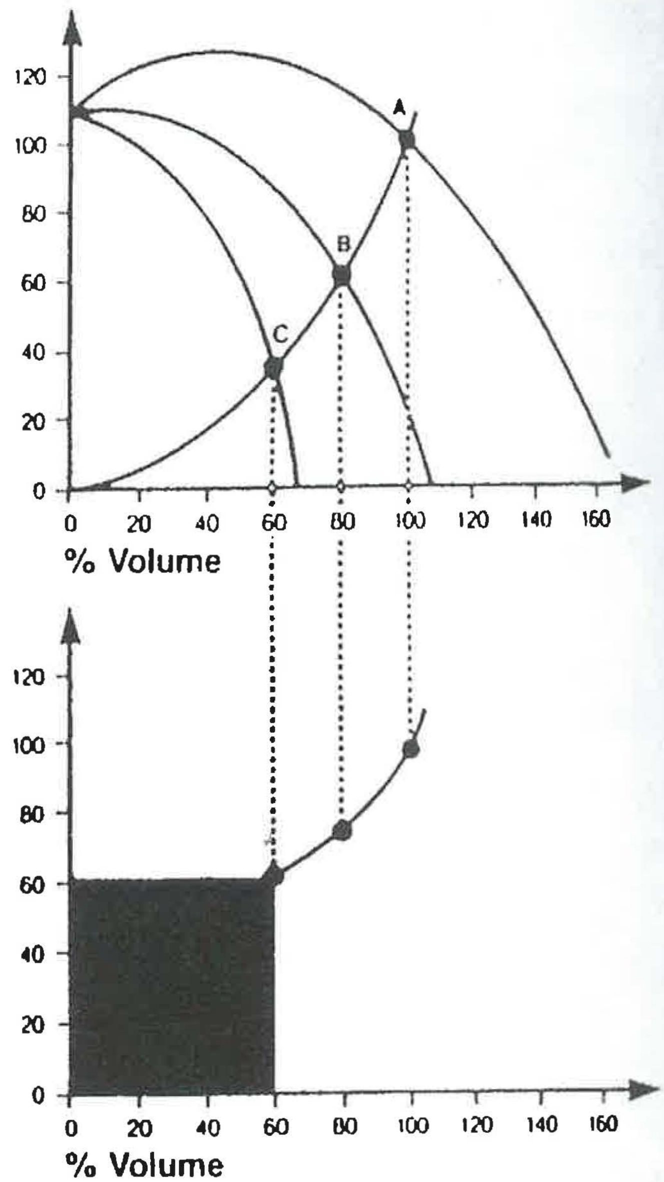


As air volume is reduced 20%, duct pressure rises 10%, and power consumption is reduced 10%

Variable inlet vane control offer another method of volume control. Inlet vanes are controlled by either electric or pneumatic actuators that are controlled by a demand for heat or cooling. By placing the vanes before the inlet of blower, the horsepower required by the fan at reduced capacities fall below outlet damper control.

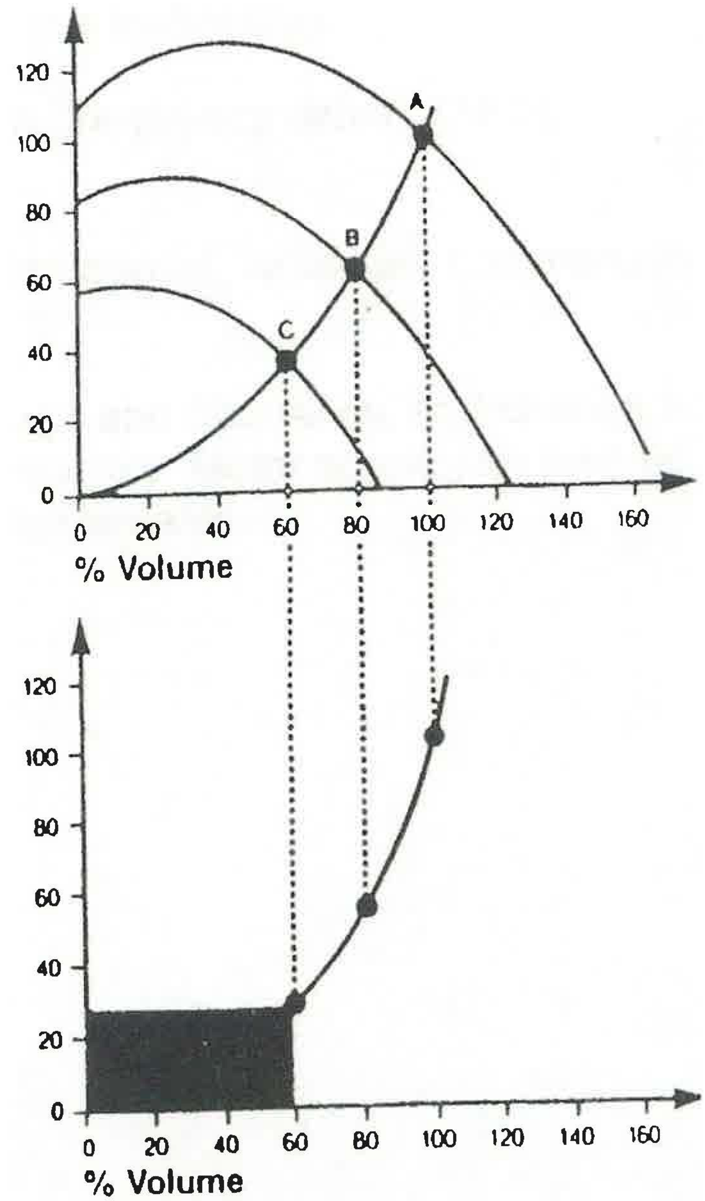
Variable speed control systems using adjustable speed drives (ASDs) take an alternating current with a fixed voltage and frequency, and change it into an alternating current with adjustable voltage and frequency. Motor speed can then be adjusted and coordinated to match the exact air flow requirements.

An adjustable alternating current voltage and frequency supply lets a motor operate at many different speeds with about the same performance as its original speed. ASDs offer the benefit of gains in system efficiency, precision and reliability. In addition, ASDs allow more efficient and effective use of electric power. This in turn reduces energy costs and increases equipment life.

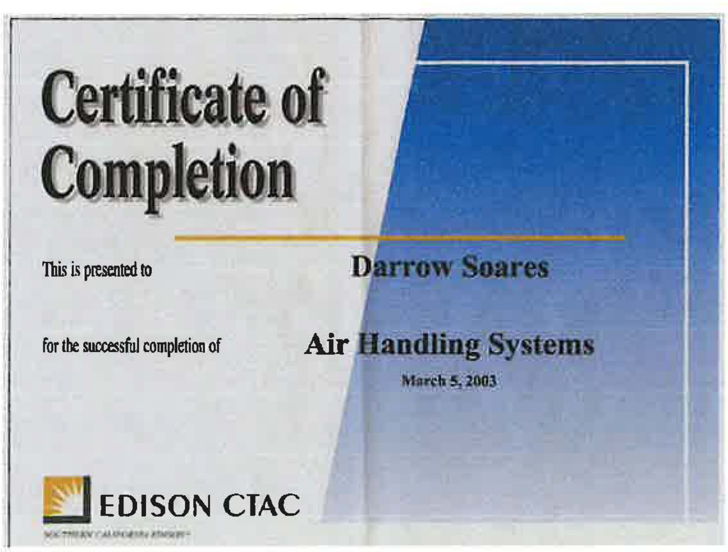


Savings are increased with variable inlet control. A 20% reduction in air volume, results in a 30% reduction in power requirements

Adjustable speed drives have evolved to the point where they are now very reliable for controlling foreword curved induction motors. ASDs are now available in applications as little as 5 horsepower and up to many thousand horsepower. ASDs have replaced most other methods of volume control including DC motors, vane control and belt driven adjustable speed systems.



Savings are the greatest with ASDs. At a 20% reduction in air volume, power requirement are cut in half.



Sempra Energy Seminar on Heat Load Calculation .
March 11th and 12th 2003
Fullerton, California.

The Gas Company's **ENERGY RESOURCE CENTER**

CERTIFICATE OF COMPLETION

The Energy Resource Center certifies that the candidate named below has completed the seminar listed and has performed to the center's educational standards.

AWARDED TO:

Darrow Soares

For completion of

ACCA Manual J Residential Load Calculation & Equipment Selection

March 11, 2003

6 Hours

The Energy Resource Center is committed to providing energy decision-makers with information on the latest energy-efficient technologies through comprehensive seminars and workshops led by industry specialists.

The Gas Company's **ENERGY RESOURCE CENTER**

CERTIFICATE OF COMPLETION

The Energy Resource Center certifies that the candidate named below has completed the seminar listed and has performed to the center's educational standards.

AWARDED TO:

Darrow Soares

For completion of

ACCA Manual D Residential Duct Design

March 12, 2003

6 Hours

The Energy Resource Center is committed to providing energy decision-makers with information on the latest energy-efficient technologies through comprehensive seminars and workshops led by industry specialists.

Douglas Beaman, CBA, Instructor

The Background

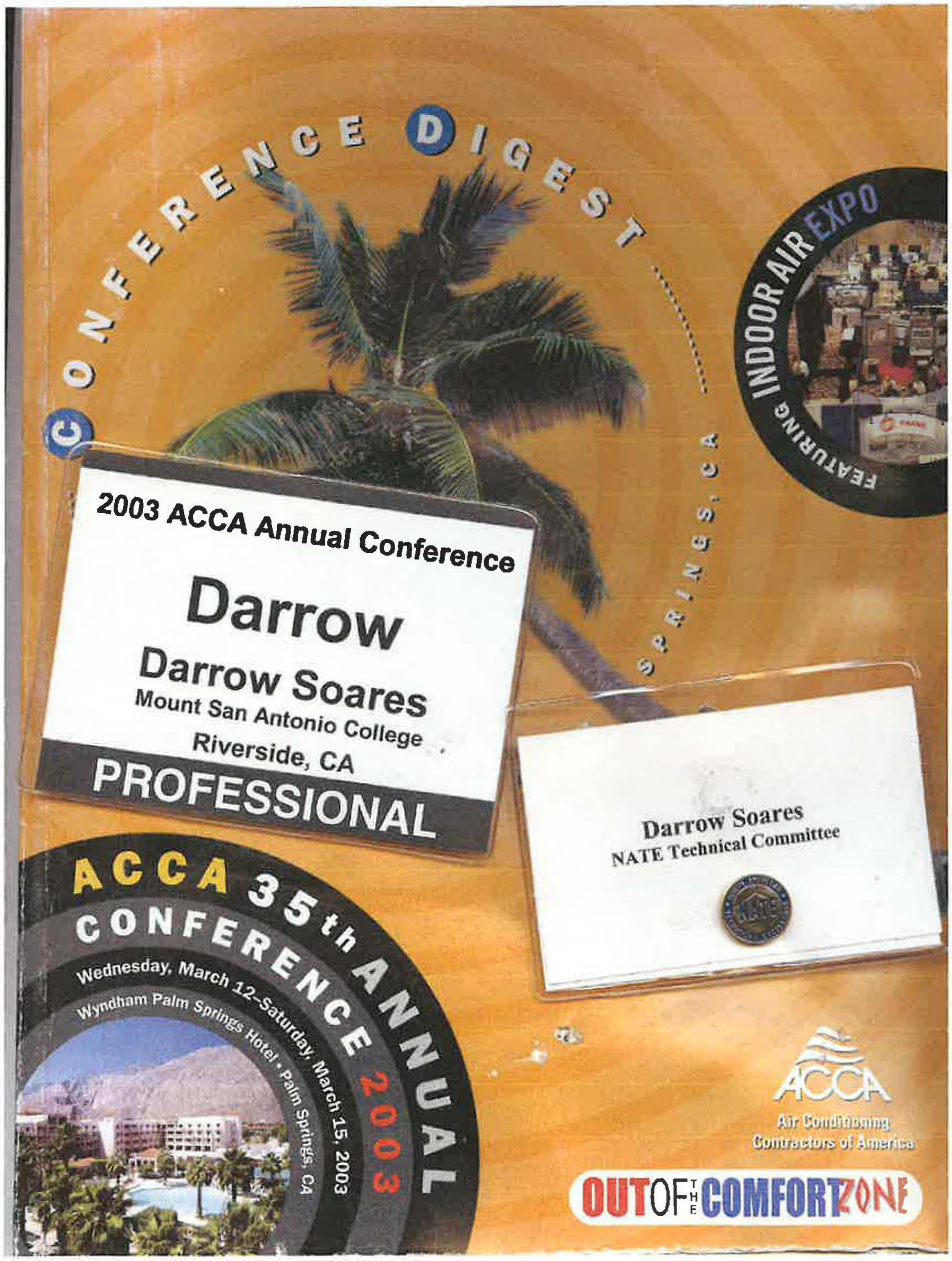
The purpose Sempra Seminar on Heat Load Calculations was to introduce HVAC designers and contractors to the new edition of the Air Conditioning Contractors of America (ACCA) Manual J-8. In 2001, new standards were imposed by the Public Utilities Commission (PUC) on C-20 air conditioning contractors. It required that contractors accurately document heat load calculations before applying for installation permits. The new rule was a result of the electrical company's inability to meet California energy needs and the trend to oversize air conditioning equipment on homes and buildings

City planning departments began enforcing the standards in 2003 for all contractors applying for permits to install any form of heating, ventilation, or air conditioning equipment. As a result, many utility companies offered seminars to encourage air conditioning contractors to use the more thorough method of heat load calculation offered by ACCA's Manual J-8.

The Application

In January, I started the certification to teach Manual J-8. The new version was far more complicated than Manual J-7. The process became more quantitative, used more tables and required many more forms. I could not visualize how to present the new version in a classroom setting. The logistics of demonstrating, in front of students, multiple forms at the same time, while moving between numerous tables presented a challenge. I attended the seminar, in order to observe Doug Beaman's method of presenting the new version of Manual J-8. Beaman is respected instructor in the HVAC industry and the first to present this material to technicians and designers.

ACCA 35th Annual Conference
Palm Springs, CA
March 12th -15th



Background

The purpose of the annual Air Conditioning Contractors of America (ACCA) Conference was to bring together contracting businesses that focus on the design, installation or maintenance of air conditioning for comfort cooling. The focus of the conference was improving business practices and technical education. This year's conference offered four break-out session tracks running concurrently throughout the conference. The tracks included commercial contracting, residential contracting, the business of contracting and indoor air quality. The conference included over 250 exhibitors, 55 workshops and 1,200 pre-registered air conditioning contracting firms.

Application

I had two intentions for attending the ACCA conference. The NATE technical committee was meeting and I hoped to meet with the author of the heat loads text book currently used in the AIRC Department at Mount San Antonio College.

I have served on the North American Technical Excellence (NATE) technical committee for three years. NATE was formed in 1997 to establish a national skill standard for technicians working in the air conditioning industry. The NATE exam results in a certification of technical knowledge that technicians can display anywhere in the United States, Canada, and Mexico. On , Thursday March 13th, the NATE technical committee was reviewing statistics on NATE test validity and methods of marketing the NATE exam in the western United States.

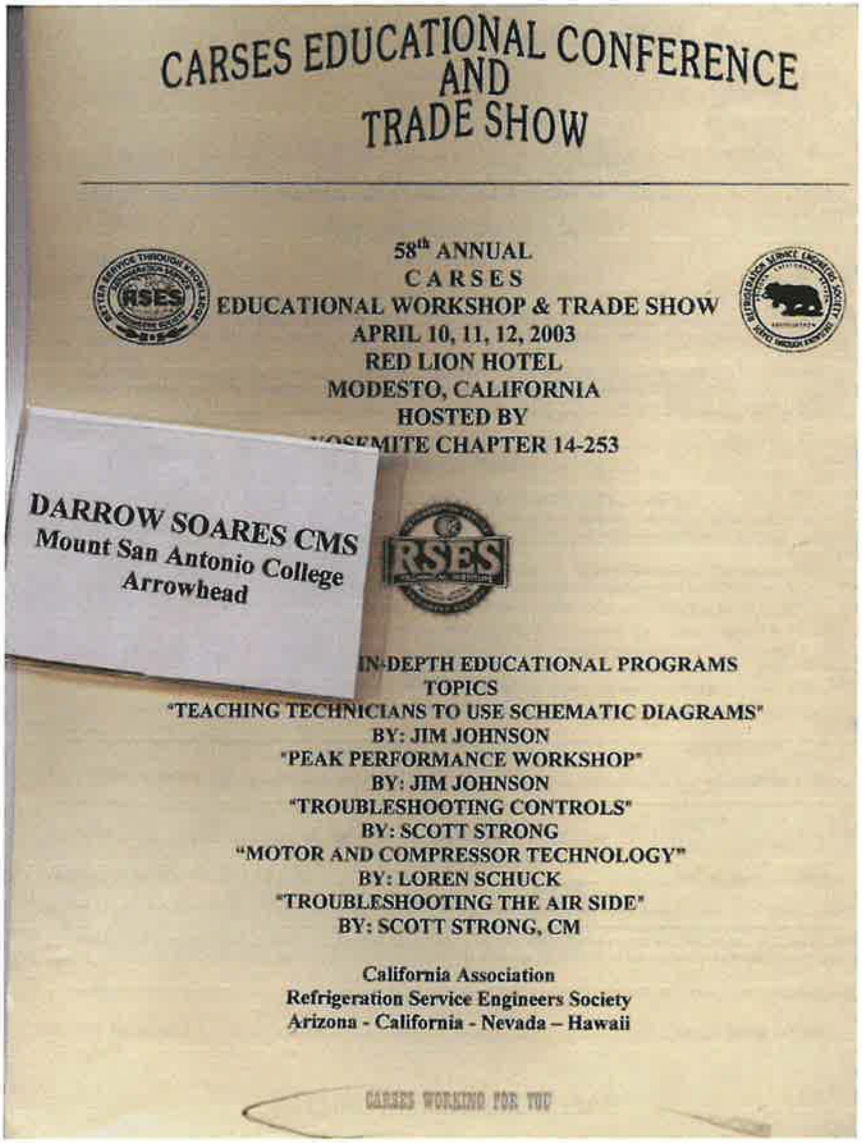
On Friday, March 14th the conference hosted the author of the ACCA heat load calculation text book, Manual J-8. The author, Hank Rutkowski, originally authored the textbook in 1967. In edition eight, Rutkowski greatly increased the sensitivity of the heat load process and added many forms to the procedure. Since I passed the certification to teach the new edition in January, this was an excellent opportunity to discuss the changes and clarify methods of instruction.

I attended two sessions of the author's presentation titled Navigating the New Manual J 8th Edition: A new Tool For Heat Load Calculations. Since the target population was small, the session was held in a conference room. By the second session, only two contractors and I met with the author. As a result, the presentation took on the form of dialogue. I was able to ask specific questions about the interaction of the text and the accompanying software currently used in the AIRC 30 Heat Loads class taught at Mount San Antonio College.

58th Annual RSES Educational Conference
Modesto, CA
April 10th-12th ,2003

The Background

The Refrigeration Service Engineers Society (RSES) was founded in 1933 as a non-profit educational society serving the "rank and file" tradesperson. RSES has approximately 20,000 individual members, and over 400 chapters through out the United States, Mexico and Canada. It offered the original industry competency measure with its Certificate Member examination in 1935, and now offers six additional Specialist categories.



RSES conducts educational meetings, seminars, workshops, technical qualification and examination programs. Its publications include the monthly RSES Journal, and the Service Application Manual (SAM) Manuals.

The Application

I attended the RSES conference to make up for the canceled Copeland compressor seminar on March 18th 2003. I chose this meeting because two industry authorities, Loren Shuck and Scott Strong were giving presentations on their specialties. In addition, I planned to take the RSES Specialist exam in Commercial Refrigeration.

Shuck's niche is compressor technologies. He gave an excellent presentation on the new Copeland scroll compressor technologies. He compared Copeland's scroll design with others currently on the market including Danfoss and Mistubishi. Copeland's new designs include the digital scroll that unloads incrementally based on the cooling demand of the supermarket display cases. Scroll compressors have not been able to unload until recently and part load was achieved by de-energizing compressors that were installed parallel with numerous other compressors. Scroll and digital scroll technology is having a broad effect on supermarket refrigeration by dropping utility costs and reducing the number of small compressors required in multi-compressor applications. By reducing the number of compressors, the cost of controls and the initial manufacturing costs are reduced.

Scott Strong demonstrated his method of diagnosing air conditioning system problems based on the treatment of air as it passes across the evaporator. Strong introduced software that replaces the manual method used with the psychrometric chart. By inputting as few as two variables, a technician can begin troubleshooting system problems and possibly avoid major mechanical failures. If a system is set up with remote sensors, trouble shooting can occur over the internet with software developed by Emerson Electric and CPC controls.

The draw back to this method is that it puts the information in the hands of a few. Only technicians working behind a computer monitor will have access to the information; not technicians working with the tools. This could set a dangerous trend of requiring lower skill levels of those working in the field.

The seminar finished with technical certification. I prepared for technical certification in Commercial Refrigeration for over a year. A CMS designation through the Refrigeration Service Engineers Society is highly respected in the air conditioning industry . I took the exam on Saturday, April 12th and received the results on April 22nd.

Refrigeration Service Engineers Society

A Non-Profit Educational Association . . .

Better Service Through Knowledge for the U.S. & International Heating, Ventilation, Air Conditioning, & Refrigeration Industry

INTERNATIONAL HEADQUARTERS: 1666 RAND ROAD, DES PLAINES, ILLINOIS 60016-3552 PHONE: 847 / 297-6464 FAX: 847 / 297-5038

URL: http:/ /www.rses.org E-mail: general@rses.org

April 22, 2003

DARROW P SOARES
3866 WESTWOOD DRIVE
RIVERSIDE CA 92504

Dear DARROW P SOARES:

My congratulations to you on your success in passing the CM Specialist Examination in COMMERCIAL REFRIGERATION.

A Specialist Plaque will be forwarded to your Chapter soon for presentation to you on a suitable occasion.

Best Wishes for your continued success.

Sincerely,

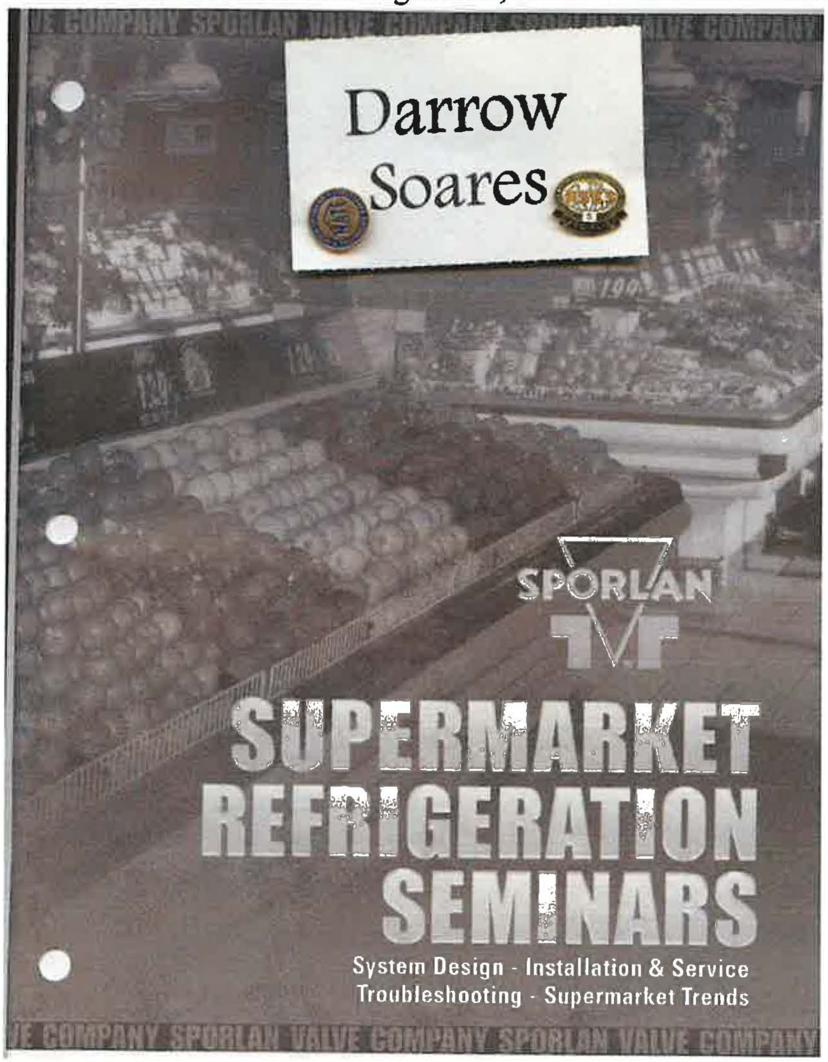
Loren Shorty Shuck CMS

Loren "Shorty" Shuck, CMS
Chairman, E & E Board

Controls for Market Refrigeration
Reno, Nevada
May 21st and 22nd, 2003

The Background

The Air Conditioning and Refrigeration Department at Mount San Antonio College teaches refrigeration for markets and grocery stores through the classes Advanced Mechanical Refrigeration, AIRC 34 and Advanced Electrical, AIRC 31. This



seminar focused only on refrigeration for supermarkets and was offered by Sporlan Valve Company and Emerson-CPC Controls. Both companies are leaders in the supermarket refrigeration. By attending, I had the opportunity to maintain current knowledge with automated controls and refrigerant handling technologies. In addition, it helped prepare me for technical certification in Market Refrigeration Controls through the Refrigeration Service Engineers Society (RSES) at their annual meeting in San Diego, California in September, 2004.

The Application

Recently, the AIRC department at Mount San Antonio College designed and built a market refrigeration system typical of those used in grocery stores for food storage and display. The process has been a work in process for over three years. Our department chose Computer Process Controls (CPC) to control the sequence of operation and Sporlan valves manage the refrigerant. Attending this seminar was valuable. I learned that mechanical devices to control refrigerant flow have remained the same in three years, but the digital controls installed on our refrigeration rack are already obsolete.

The advancements in mechanical controls offered by Sporlan Valve focus on oil management methods, multi capacity electronic expansion valves and electronic pressure control valves. Advances in oil management are a result of our industry's need to work with alternative, less stable refrigerants and to design systems that require lower volumes of refrigerant. Both of these conditions have influenced the flow of oil though a refrigeration system and have created opportunities to improve oil management methods.

CPC controls are the leader in electronic supermarket control and refrigerant leak detection. CPC controls can be found on large parallel refrigeration racks and single unit compressor systems for walk-in boxes. CPC controls can now be found controlling gasoline pumps, car washes and small ice machines and refrigerators.

CPC made its mark on the refrigeration industry with the Reflecs RMCC controller. The RMCC was very versatile. It operated from a local 20 key keypad with an 8 line, 40 character display that allowed the technician on site access. It also interacted with windows based software that allowed remote internet communication.

The RMCC controlled 22 compressor stages and 48 refrigeration cases. It was the first to offer refrigerant leak detection. It was limited, however, in its control strategies. To control building loads, contractors often installed additional CPC controllers, including the Reflecs BEC for air handlers and boilers and the Reflecs BCU to control package air conditioning equipment.

The CPC Einstein and E2 controllers have far greater capabilities their predecessor. These controllers have the capabilities of the RMCC plus the ability to control air handlers, building temperature zones, lighting circuits and diverse load schedules.

In addition, CPC has introduced a scaled down controller: the E2 CX. The E2 CX is designed for small applications comparable to convenience stores. It affordably handles the diverse control and scheduling of lighting, air conditioning, refrigeration reach-in boxes, stand alone freezers and gasoline pumps. It also offers remote access and alarming through modem dial out.

The refrigeration rack installed at Mt. SAC uses the CPC Reflects RMCC and Sprolan valves. We will not replace the electronic controls in the near future. But, it is important to see how CPC products have evolved and the technology in refrigerant flow control has remained the same.

Section Four

Conclusion

Conclusion

In my initial sabbatical proposal I stated that:

I propose to reenter the work environment and culture of construction and building facilities management for air conditioning and refrigeration. This will include being involved with the labor and commerce of at least four air conditioning and refrigeration contracting companies and at least one organization in facilities management. I plan to restore my awareness of work culture and study the practical use of new technologies for building automation and energy management.

Looking back on my sabbatical experience I can safely say that I've accomplished most of what I set out to do. I left the security of the community college environment and entered the culture of construction and commerce. Although this may sound like a lofty goal to base one's sabbatical leave, the differences are acute. In the community college system, I feel our biggest challenge is at the beginning of our employment. First we must have the endurance to obtain the qualifications and academic degree to be considered for a teaching position. Second, we must demonstrate superior knowledge and intellect above others applying with the same credentials. And third, we must please our associates for four years. After that, the pressures to perform and be creative are mostly intrinsic.

The world of construction and commerce operate on different rules. Every day business owners are faced with the reality of success or failure. Many have mortgaged their personal property to fund their companies; risking their families and all they have achieved. Success is measured on a month by month basis with no arbitration if they loose motivation or become complacent. Doug Scott, the owner of Vacom Technologies, described it well. While describing the nature of his business, he said, "You know that final exam you give in the AIRC 20 class, how stressful it is? Well, every day is a final exam here." This stress transfers down the line to employees at all levels. A common question posed to me while at Southern California Air Conditioning Distributors was: "who do you *really* work for?" In other words, are you a spy planted by management to identify the weakest and least productive? Yet I also experienced unconditional support and compassion. The owners and employees of Huffman Roofing gave up their weekends for three weeks in a row to install the roofs for Habitat for Humanity homes in Moreno Valley.

These conditions are what motivated me to ask for flexibility with the Salary and Leaves Committee. I secured the opportunity of uncompensated employment with all the companies I listed in my original proposal. When it came time to participate, however, the conditions had often changed. In some cases, the departments had reorganized or did not exist. In the case of Vacom, they required a commitment that would extend beyond the scope of my sabbatical leave. What often worked best was to remain independent and practice the trade and pursue my interests as an independent.

Honeywell and Southern California Air Conditioning Distributors offered the best experience in building automation. It was a pleasure to associate with Scott Strong of SCACD. In the short time I had in the Customer Assurance Department, I extended my knowledge of the comfort zone I and II beyond my expectations. In addition, as a result of my experience there, wireless and communicating thermostats will enter the enter our curriculum when resources allow.

John Edwards of Honeywell, proved to be reliable and patient mentor to their line of controls. I also give credit to Susan Sawyer and the First Congregational Church for allowing me to experiment with their home and office. In both cases, increased comfort levels were absolutely achieved. On the other hand, reduced energy consumption has not materialized as expected. In both cases, it appears the air conditioning system runs longer and utility have remained the same or increased. In both applications, the demand seems to shift between zones too rapidly for the system to satisfy any single zone. This is not to say that zoning cannot reduce energy consumption. There has been enough research documenting its benefit to continue my involvement.

The most striking reality was learning how quickly control systems become obsolete. The AIRC Department installed the CPC RMCC control system on our refrigeration rack three years ago. We thought it would offer students the opportunity to work with control systems commonly found in our industry. The number of RMCC systems I encountered was very small. Most have been replaced with the more flexible E I and E II systems designed since Emerson Electric purchased CPC controls in 2002.

The ten months and two summers I spent working in the industry were a very valuable experience. I was re-acquainted with the realities of the working outside the community college, both culturally and technologically. I was also able to practice the basic skills of working with tools and organizing installations. These skills and knowledge will be reflected in the classroom in the form of legitimate understanding of what my students will experience as tradespersons. I want to thank the Sabbatical and Leaves Committee for approving this experience and the taxpayers for financing it.

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